OKLAHOMA SCHOOL TESTING PROGRAM

TEST BLUEPRINT AND ITEM SPECIFICATIONS

GRADE 8 SCIENCE

OKLAHOMA Education

Important Note:

The material in the test and item specifications should not be used as a curriculum guide.

TABLE OF CONTENTS

TABLE OF CONTENTS

OKLAHOMA SCHOOL TESTING PROGRAM

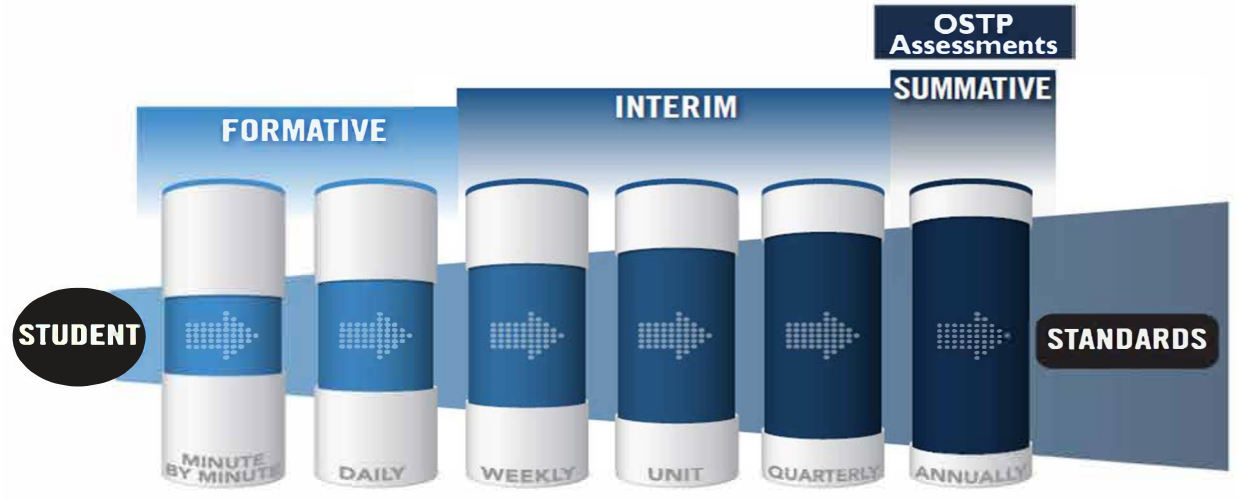
Grade 8 Science Test

Purpose

A robust assessment system is predicated upon the knowledge that no one assessment is able to provide answers to all questions affecting instructional decisions. An assessment system utilizes different types of assessment to gather multiple pieces of evidence to provide timely, relevant, actionable, and reliable information about what students know and can do relative to a set of standards.

Assessments According to the Oklahoma ESSA Plan

According to page 48 of the Oklahoma ESSA Consolidated State Plan, Oklahoma recognizes that a **robust assessment system** is tied closely to students' learning and teachers' instructional practices by valuing and promoting **local, classroom-based formative assessments** that help make **student learning visible**. At the same time, that system should provide a **strong summative assessment** program that fits as a component within a multifaceted state, district, and school accountability system.



The OSDE supports an assessment system by working with Oklahoma educators and stakeholders to:

- Ensure that state and federally required annual summative assessments delivered through the Oklahoma School Testing Program (OSTP) are effective and meaningful to families, districts, educators, and members of the community;
- Develop instructional resources to support local formative and interim assessments through the curriculum frameworks projects and assessment guidance toolkit; and
- Build and deliver professional learning through face-to-face and web-based resources to support local assessment needs and interpretation of state assessment data.

Annual assessments delivered through the OSTP are aligned to the Oklahoma Academic Standards and can therefore provide point-in-time data for programmatic and curricular decisions by supporting criterion-referenced interpretations at appropriate levels and grain size (e.g., grade, student group, teacher, building/district administrator, state). Standards-based formative and interim assessments conducted at the local level can provide additional information and evidence of learning at a smaller grain size to inform instructional decisions made at the student and classroom level.

While state summative assessments are only one measure of what students know and can demonstrate, having Oklahoma students take OSTP assessments:

- ✓ Helps students, their families, and the public know how students have grown over time and how they are performing relative to the standards, their peers in Oklahoma, and the nation;
- ✓ Enables teachers to see how their students are performing against grade-level expectations communicated through the Performance Level Descriptors (PLDs) to support evaluation and enhancement of curriculum and programs for the next school year;
- ✓ Provides a standardized and reliable measure for school/district leaders, the state, policymakers, and the public to determine how well a system is meeting the goals of helping every child grow along a continuum to prepare them for careers, college, and life; and
- ✓ Provides comparable information and data to inform continuous improvement of a system and appropriately support federal and state accountability decisions.

Test Structure, Format, and Scoring

The Grade 8 Science test consists of clusters of items. A cluster is either a set of three multiple-choice items linked with a common stimulus or a set of two multiple-choice items and a technology-enhanced item linked with a common stimulus.

- A cluster stimulus consists of the passages, graphs, models, figures, diagrams, data tables, etc. that students must read and examine to respond to the items in the cluster. The stimulus may be a combination of multiple stimulus elements (e.g., some text plus a diagram and a data table), and it must require students to think/reason and/or engage in sense-making.
- Each multiple-choice item within the cluster is worth one point and is scored as correct or incorrect.
- Each technology-enhanced item is worth two points and is scored as completely correct (two points), partially correct (one point), or incorrect (zero points).
- Items within a cluster are arranged logically, typically with easier and/or less complex items first.

The table below shows the total number of items (in clusters) that students respond to and the total number of points allocated on a test form. Further explanation is provided in the paragraph below the table.

Target Number of Items and Score Points for Grade 8 Science Test

Content Assessment	Total Operational Items and Points	Total Field-Test Items	Total Items
Grade 8 Science	45 items (15 clusters) 48 points*	9 items (3 clusters)*	54 items (18 clusters)*

*Item counts and points are approximate and may vary slightly.

As shown in the table, the test form for Grade 8 Science contains both operational clusters and field-test clusters. The operational clusters contribute to the student's score. (Note that because three of the operational clusters contain two multiple-choice items and a technology-enhanced item, rather than three multiple-choice items, the number of operational items and points is not the same.) The field-test clusters do not contribute to the student's score, but the results are used to evaluate new clusters for use in future operational forms. Clusters that have suitable statistics are used to construct operational tests in subsequent years.

Each cluster aligns to a single OAS-S standard (consisting of a Science and Engineering Practice, Disciplinary Core Idea(s), and Crosscutting Concept). The clusters are also structured to assess a range of skills and knowledge applications within the standard. In this way, the assessment will gather data measuring a breadth and depth of student ability within the standards.

Test Alignment with Oklahoma Academic Standards for Science (OAS-S)

Criteria for Aligning the Test with the Oklahoma Academic Standards Content Standards
1. Range of Knowledge Correspondence The Grade 8 Science test is constructed so that a minimum of 75–80% of the standards in each reporting category have at least one corresponding cluster of items in the operational portion of the assessment.
2. Categorical Concurrence The Grade 8 Science test is constructed so that there are at least 10 score points measuring each reporting category. This number of points is based on the typical psychometric recommendations for a minimum of 10–12 score points needed to produce a reasonably reliable estimate of a student's mastery of the constructs measured.
3. Consistency of Cognitive Complexity On the Grade 8 Science test, the items in the clusters require students to use various levels of cognitive complexity. Because items in a cluster are structured to assess a range of skills and knowledge applications within a standard, the level of complexity of the items (and therefore the cognitive demand required of students) will vary for individual assessment items. In general, the cognitive complexity of the assessment items will be reflective of the complexity called for by the three dimensions of the standard.

OKLAHOMA SCHOOL TESTING PROGRAM
TEST BLUEPRINT SCIENCE GRADE 8

This blueprint describes the content and structure of the Grade 8 Science Content Assessment and defines the ideal range of test items by reporting category of the Oklahoma Academic Standards – Science (OAS-S).

REPORTING CATEGORIES

PHYSICAL SCIENCES 33 - 40%

8.PS2.1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
8.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.
8.PS2.3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
8.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.
8.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.
8.PS4.1	Use mathematical representations to describe patterns in a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
8.PS4.3	Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

LIFE SCIENCES 40 - 46%

8.LS1.4	Use arguments 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.
8.LS1.5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.
8.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.

8.LS3.2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.
8.LS4.1	Analyze and interpret data to identify patterns within the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth.
8.LS4.2	Apply scientific ideas to construct an explanation for the patterns of anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships.
8.LS4.3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.
8.LS4.4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
8.LS4.5	Gather and synthesize information about the practices that have changed the way humans influence the inheritance of desired traits in organisms.
8.LS4.6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

EARTH AND SPACE SCIENCES 21 - 27%

8.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.
8.ESS1.2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
8.ESS1.3	Analyze and interpret data to determine scale properties of objects in the solar system.

Standards will be assessed using a cluster-based format: a set of three multiple-choice items linked with a common stimulus or a set of two multiple-choice items and a technology-enhanced item linked with a common stimulus. The Grade 8 test consists of some clusters containing only multiple-choice items and some clusters containing both multiple-choice and technology-enhanced items. Each cluster will align to a single standard with its associated Disciplinary Core Idea(s), Science and Engineering, Practice, and Cross Cutting Concept.

The Grade 8 Science operational test will contain a total of 15 clusters.

OKLAHOMA Education

Cognitive Complexity Assessed by Test Items

The OSTP Science Assessment will have items within a cluster structured to assess a range of skills and knowledge applications within a standard. Clusters require sense-making and problem solving using the three dimensions. Sense-making happens when students have to apply, via the science and engineering practices, their understanding of core ideas and crosscutting concepts to address the uncertainty associated with a scenario. The degree of sense-making required to complete an item is directly correlated to the level of cognitive complexity the student must engage with, as described in the following table.

Category	Description
Scripted	· Only one dimension is present, or two dimensions are present but only one is used in application or reasoning for sense-making. · Heavy scaffolding – Scripted "Cookbook instructions" · Little to no sense making
Moderate Support	· Multidimensional 2-3 dimensions are evident but only one is heavily used in sense-making while the other may be used minimally. · Moderate scaffolding – Students have to apply ideas and practices, however they are often told which ones to engage with and supported in using them · Low to Medium degree of sense making
Low Support	· Multidimensional 2-3 dimensions are evident with at least 2 being necessary to use or reason with in sense-making. · Minimal scaffolding – Students are cued and guided to pursue certain lines of thinking, but have to make some decisions about how and what to engage · Medium to High degree of sense making – High; Students must connect multiple pieces of information in a novel way
Doing (rarely achievable on summative assessments)	· The three dimensions are used together to engage in sense-making to a high degree throughout the task · Student-designed exploration of science Limited to no scaffolding · Students work like scientists to use various scientific practices to be able to develop or deepen an understanding of a scientific idea or problem as they explore a phenomenon. In most cases if a student actually is engaged in 3 dimensions and has to develop the model, or develop the explanation or develop the argument from raw data or information, they are being asked to do science.

Note: These descriptions are adapted from Achieve.

A more detailed framework for categorizing cognitive complexity is shown in the appendix.

Universal Design for Learning (UDL) Considerations

Universal Design for Learning (UDL), as applied to assessments, is a framework that provides flexibility in the way information is presented and in the ways students demonstrate knowledge and skills. This reduces barriers while maintaining high expectations for all students, including students with disabilities and students who are limited English proficient. In the Oklahoma School Testing Program, items and instructions have been designed to provide maximum readability, comprehensibility, and legibility for all students. This includes such changes as reduction of language load in content areas other than Reading, increased font size, fewer items per page, and boxed items to assist visual focus. Specifically in the Science tests, the cluster-based design reduces

the number of unique stimuli that students must process. The stimuli and items are constructed with clear wording and presentation, and they exclude extraneous information. Additionally, the vocabulary level for the Grade 8 Science test is two grade levels below, except for science content words.

Test Administration Details

Online Administration

During online testing, the items within a cluster will be presented one at a time. The stimulus will appear on the screen with each associated item.

For longer stimuli or items, a scroll bar will be present to allow students to scroll through the text and/or answer choices.

Students may use the embedded scientific calculator or a scientific calculator that meets the current Oklahoma School Testing Program's calculator policy as documented by SDE. (See sde.ok.gov/documents/ostp-accommodation-manuals-companion-documents.)

No reference sheets/resource materials may be used by students during the Grade 8 Science test. All necessary formulas and information will be provided within the items.

Students will be able to use scratch paper or blank grid paper for the online Grade 8 Science test. This paper must be collected and destroyed immediately following the test. The test administrator must not look at what the student has written on the scratch paper.

Paper Administration

Paper/pencil testing is used only as a testing accommodation. In the paper/pencil test booklet, any technology-enhanced items that appear in the online test form will be replaced by paired multiple-choice items that target the same constructs.

Students may use a scientific calculator that meets the current Oklahoma School Testing Program's calculator policy as documented by SDE. (See sde.ok.gov/documents/ostp-accommodation-manuals-companion-documents.)

Students will be able to use scratch paper or blank grid paper for the paper Grade 8 Science test. This paper must be collected and destroyed immediately following the test. The test administrator must not look at what the student has written on the scratch paper.

Estimated Testing Time

The Grade 8 Science test is divided into two sessions. Districts may exercise flexibility in determining how to administer the sessions. The Grade 8 Science test is meant to be administered in two sessions within one day or on consecutive instructional days. When testing a session, test administrators may give students additional time if they need it, but the additional time is to be given as an extension of that specific testing session.

The following table provides estimates of the time required to administer the Grade 8 Science test by session. These time approximations are provided to facilitate planning administration logistics within schools and to ensure adequate testing time for all students. Actual testing times may vary from these approximations.

Grade 8 Science Estimated Online Testing Time	
Distributing login information Test instructions/tutorial and reviewing sample items	Approximately 5 minutes Approximately 10 minutes
Administering Section 1 of the G8 Science Online Test	50–60 minutes
Administering Section 2 of the G8 Science Online Test	50–60 minutes
Total testing time (Suggested Maximum Time: 270 minutes)	**115–135 minutes**

ITEM SPECIFICATIONS

Introduction

The item specifications documentation is intended to provide guidance on the structure and content of the test material developed for the Oklahoma School Testing Program (OSTP) for Grade 8 Science. The Grade 8 standards of the Oklahoma Academic Standards for Science (OAS-S) will be assessed on the Grade 8 Science test using a cluster-based format: a set of three multiple-choice items linked with a common stimulus or a set of two multiple-choice items and a technology-enhanced item linked with a common stimulus.

Functionally, the item specifications documentation represents a bridge between the constructs in the OAS-S, the Oklahoma Science Framework, the test specifications, and the test blueprint for Grade 8 Science. The item specifications delineate core emphases, examples, and boundaries for item clusters written for each OAS-S standard as well as expectations for the format and structure of the cluster stimuli and items. In this way, the item specifications help ensure that the item clusters appearing on the Grade 8 Science test consistently and accurately reflect the constructs in the OAS-S and validly measure students' proficiency.

The information utilized for the specifications for each Grade 8 OAS-S standard draws extensively from the OAS-S and from the Oklahoma Science Framework, thus providing a strong link between instruction and assessment. The information in the item specifications is also informed by the tenets in *A Framework for K–12 Science Education*[1] and recognized best practices in assessment (*Standards for Educational and Psychological Testing*[2], *Code of Fair Testing Practices in Education*[3]).

The item specifications are intended to be used by multiple audiences: Oklahoma educators, Oklahoma State Department of Education staff, and testing vendors. The item specifications provide outlines and suggestions for the types of content and presentation that can be utilized in developing the item clusters for the Grade 8 Science test. As such, the item specifications provide all users with information to gauge the types of skills and understandings that students will be asked to demonstrate on the Grade 8 Science test. This information is useful to Oklahoma educators in planning instruction and conducting classroom formative and summative assessment. It is also useful to Oklahoma educators and State Department of Education staff in reviewing and approving item clusters for use on the Grade 8 Science test because it provides a clearly delineated description of the intent of each standard and what item clusters aligned to each standard should measure.

1 National Research Council. (2011). *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on a Conceptual Framework for New K–12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

2 American Educational Research Association, American Psychological Association, and National Council on Measurement in Education (2014). *Standards for Educational and Psychological Testing*. Washington, DC: American Educational Research Association.

3 *Code of Fair Testing Practices in Education* (2004). Washington, DC: Joint Committee on Testing Practices.

General Cluster Specifications

The Grade 8 performance expectations of the OAS-S will be assessed on the Grade 8 Science test using a cluster-based format: a set of three multiple-choice items linked with a common stimulus or a set of two multiple-choice items and a technology-enhanced item linked with a common stimulus. The Grade 8 test consists of some clusters containing only multiple-choice items and some clusters containing both multiple-choice and technology-enhanced items.

A cluster requires students to actively use the Science and Engineering Practice of the performance expectation while applying their knowledge of the Crosscutting Concept and drawing on their understanding of the Disciplinary Core Idea(s) to explain a phenomenon or to solve a science/engineering problem. This process requires students to engage with sense-making as they actively reason and think about a phenomenon/problem.

Cluster Stimulus

A **cluster stimulus** consists of the passages, graphs, models, figures, diagrams, data tables, etc. that students must read and examine in order to respond to the items in the cluster. To meet the intent of the OAS-S, stimuli must represent a variety of topics and scenarios, many of them novel. An individual stimulus may be a combination of multiple stimulus elements (e.g., some text plus a diagram and a data table).

While the specific content and context requirements of a stimulus will vary depending on the standard being assessed (and are outlined in the individual specification for each standard), the following characteristics are necessary for all cluster stimuli:

- Information in the stimulus is representative of the Science and Engineering Practice, Disciplinary Core Idea(s), and Crosscutting Concept for a specific performance expectation.
- Making sense of phenomena or addressing a problem is necessary to accomplish the cluster. The stimulus is cognitively demanding, sufficient, engaging, and relevant with high levels of student analytic thinking as appropriate for Oklahoma students in 8th grade.
- The stimulus provides sufficient information (in the form of tables, graphs, text, diagrams, etc.) for the assessment of a specific standard. In other words, the stimulus must supply sufficient information to allow students to engage three dimensionally with the Science and Engineering Practice of the performance expectation in conjunction with the Disciplinary Core Idea(s) and Crosscutting Concept to respond to items by using sense-making.
- The stimulus information must be necessary, but not conceptually sufficient, for the student response (i.e., students must also utilize their own knowledge of the constructs in the standard to answer the items).
- The problem or phenomena motivating the task provides sufficient information to engage students in reasoning or sense-making as the items build logically through the cluster.
    a. The stimulus enables sense-making or problem-solving by allowing students to connect their existing understanding and abilities to new information (provided in the stimulus or item) in order to construct new understandings of the scenario presented. Students may be asked to: identify and/or generate evidence, apply evidence to claims or ideas with reasoning, evaluate or critique claims, or ask questions in order to evaluate claims, data, evidence or reasoning related to a problem or phenomenon.
- The information included within the stimulus must pertain to multiple items. Unique lead information that supports only one item will be placed in the introduction to that particular item. Extraneous information should be eliminated from the cluster stimulus and from item lead information (i.e., only relevant, concise information is utilized in order to reduce information overload).

- There is a balance of graphic and textual stimulus materials among the set of clusters for the test form. The pictorial and graphic representations in the stimulus are appropriate for the grade level and standard being assessed. The stimulus (text and graphic elements) is presented on the screen in the layout that best facilitates student accessibility. Scrolling is minimized when possible.
- The placement of graphic and textual materials within the stimulus follows a logical flow of information. This is facilitated by the use of clear language, transitions, and pointers between text and graphics.
- The stimulus avoids material or subject matter that might introduce bias or sensitivity issues:
  a. The material is balanced and culturally diverse.
  b. There is a balance of gender and active/passive roles by gender.
  c. The stimulus does not display unfair representations of gender, race, ethnicity, disability, culture, or religion; nor does the stimulus contain elements that are offensive to any such groups.
  d. The content of the stimulus avoids subject matter that might prompt emotional distress on the part of the students.
  e. The content is accessible to all learners, including students who are English learners or are working below or above grade level.
- The content of the stimulus is developed and verified using valid and reliable scientific sources for contexts, examples, and data.
- Permission to use stimuli from copyrighted material is obtained as necessary by the testing vendor.
- The stimulus supports the development of 6–8 associated items. (While clusters will contain only three items on the operational test, additional items must be field-tested with the stimulus to ensure enough items are available to construct the operational clusters. Items are sometimes rejected after the field test if the performance data for the item do not meet psychometric requirements.)
- Careful attention is given to the wording, length, and complexity of the stimulus:
  - word count of approximately 50–300 words
  - vocabulary level two grade levels below, except for science content words
  - use of footnotes to define unfamiliar science content words (exception: one-word parentheticals may be used)
  - focus on shorter sentence structure and less complex grammatical constructions
  - consideration of qualitative and quantitative readability measures to review text complexity

Note: The exact vocabulary, word count, and complexity of each stimulus will be reviewed by Oklahoma educators and approved by the Oklahoma State Department of Education to achieve the most appropriate stimulus for each cluster based on the grade level and content being assessed.

Cluster Items

The items within each cluster must work together cohesively to provide a valid measure of the standard being assessed. The flow of the item should also progressively develop student sense-making while avoiding being dependent on prior items. The following criteria should guide the development of items in each cluster:

- The items are tied closely to their specific stimulus so that the impact of non-curricular knowledge and experience, while never wholly avoidable, is minimized.
- The cluster elicits artifacts from students as direct, observable evidence of how well students can use the targeted dimensions together to make sense of phenomena and design solutions to problems.
- The items do not assess Science and Engineering Practices that are not part of the performance expectation that the cluster is aligned to.
- The items within a cluster address different depths and breadths of understanding of the specific standard. Items are to be written to a range of cognitive complexity, which is proportional to the three-dimensional expectations of the standard.
- The model item stems described in the specifications for each standard are utilized often. The model item stems represent general ways (and specific ways, in brackets) to assess the multiple dimensions of each standard. The model item stems are not meant to be an exhaustive listing; rather, they represent a selection that can be used with an appropriate stimulus to craft well-aligned items. Other stems may be used in place of these model item stems, but they must capture multiple dimensions such that the finished cluster shows alignment to all three dimensions of the standard.
- Graphics and information for all cluster items are generally placed in the cluster stimulus, but items may have additional information or graphics when necessary. (Unique lead information supporting only one item will be placed in the introduction to that specific item.) Graphics must be clearly associated with their intended items.
- Each item in the cluster is independent of the other items; that is, the answer to one item is not required to answer the other items, although clusters logically develop as students progress through the items in service of sense-making around the phenomenon or problem introduced in the stimulus.
- To the greatest extent possible, no item or answer choice clues the correct answer to any other item.
- The items in the cluster are presented to the student one at a time online. The stimulus appears on the screen with each item in the cluster.

General Item Writing Mechanics

All items written during the development of the item clusters for the Grade 8 Science test will follow best practices in assessment pertaining to the structure and format of the items per item type.

The distribution of newly developed or modified items is based on content and process alignment, difficulty, cognitive ability, percentage of art/graphics, and grade level appropriateness as determined by an annual Item Development Plan approved by the Oklahoma State Department of Education.

Multiple-Choice Items

- Each multiple-choice item has a stem (formatted as a question or an incomplete statement) and four answer options, only one of which is correct.
- All item stems clearly indicate what is expected in the item to help students focus on selecting a response. The stem presents a complete problem so that students know what to do before looking at the answer choices; students should not need to read all the answer choices before knowing what is expected.
- All multiple-choice options—the correct response and the three distractors—are similar in length and syntax. Students should not be able to rule out an incorrect answer or identify a correct response solely because it looks or sounds different from the other answer choices. Distractors are created so that students reason their way to the correct answer rather than simply identify incorrect responses because of a distractor's obviously inappropriate nature. Distractors should always be plausible (but incorrect) in the context of the item stem.
- Any art within individual items (e.g., additional lead art, graphic options) must be functional and necessary for the item.
- Most item stems are positively worded and avoid the use of the word "not." If a negative is required, the preferred format is "All of the following . . . except."
- The responses "Both of the above," "All of the above," "None of the above," and "Neither of the above" are not used as options.

Technology-Enhanced Items

- Technology-enhanced items should be used to more authentically address some aspects of the OAS-S performance expectations and/or to provide more opportunity for students to construct rather than select their response.
- Interaction types are match, hot-spot, drag-drop, ordering, graphing and drop-down. Each technology-enhanced item contains only one interaction type per item.
- For each technology-enhanced item, the interaction type used is that which is the most appropriate and enhancing to the construct to be measured.
- Each technology-enhanced item is structured to contain the question (content) first, followed by directions on how to complete the interaction in that item. Consistent style and language are used in these directions (e.g., "Drag the pictures," "Click the object").
- Each technology-enhanced item is worth two points. Students may earn two, one, or zero points for their response; the scoring rubric will define responses that are completely correct and partially correct based on the skill and understanding being assessed.

- Note that for each technology-enhanced item that is authored, a paired multiple-choice item is also created for the paper accommodation. Each paired multiple-choice item consists of two linked multiple-choice questions and assesses information similar to that in the technology-enhanced item. The paired multiple-choice item, like the technology-enhanced item, is worth two points.

Item Vocabulary

- No single source is available to determine the reading level of various words. Therefore, the appropriateness and difficulty of a word is determined in various ways. Vocabulary is checked in the following: *EDL Core Vocabularies in Reading, Mathematics, Science, and Social Studies*; *Basic Reading Vocabularies*; the *Living Word*; or other reliable readability sources.
- In addition, each vocabulary word must be approved by Oklahoma's Content Review Committee. The committee, composed of Oklahoma educators from across the state, reviews proposed vocabulary in item clusters for grade-level appropriateness.
- Except for science content words, the Grade 8 Science test will have a vocabulary level two grade levels below.
- Unfamiliar science words in stimuli are to be defined using footnotes. The exception to this is single-word definitions, which may be placed in parentheses [e.g., mean (average)].

Overview of Layout of Item Specifications and Performance Expectation

For each OAS-S performance expectation, the item specifications are organized in the following way:

Core Idea Category: Performance Expectation Code[1]

Performance Expectation Code and Text[2]

OAS-S Clarification Statement:[3]

OAS-S Assessment Boundary:[4]

Science & Engineering Practice:[5]	Disciplinary Core Idea:	Crosscutting Concept:

In Lay Terms:[6]

Cluster Clarifications: [7]

Cluster Stimulus Attributes:[8]

Typical stimulus elements:

Possible contexts:

Content and evidence to be included:

Types of student responses that need to be supported:

Allowable Item Types:[9]

Model Item Descriptions for Performance Expectation:[10]

Item Type	Model Stem	Response Characteristics*
MC		
MC		
MC		
MC		
MC		
MC		
MC		
MC		

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:[11]

Sample Cluster for Performance Expectation:[12]

1 Core idea category and code for each performance expectation from the OAS-S (e.g., **Biological Unity and Diversity: 8.LS4.3**)

2 Coding and text of the performance expectation from the OAS-S

3 Clarification statement for the performance expectation from the OAS-S

4 Assessment boundary for the performance expectation from the OAS-S

5 Science & Engineering Practice, Disciplinary Core Idea(s), and Crosscutting Concept that underpin the performance expectation from the OAS-S

6 Description of the basic meaning and intent of the standard in easily understandable terms

7 Additional details, clarifications, and content limits needing to be conveyed

8 Specific information about the typical features of the stimuli for clusters aligned to this standard

9 Item types that may comprise the item clusters

10 Descriptions of possible item stems/starters that could be included in clusters for this standard; i.e., general statements (and/or specific statements, in brackets) of ways to assess each standard are given

11 Common student misconceptions related to the standard, to be used when writing items

12 Example of a cluster for this standard (*will eventually be available for all clusters)

Item Specifications by Performance Expectation

*Sample Cluster

Standards Resources

Oklahoma Academic Standards Webpage

2020 Oklahoma Academic Standards for Science

Oklahoma Academic Standards for Science Grade 8 Shifts

Important Note:

The material in the test and item specifications should not be used as a curriculum guide.

The item specifications provide guidelines and suggestions for the type of content to be included in item clusters, but they do not provide an exhaustive list of what can be included. The cluster stimulus attributes, model item descriptions, and sample item clusters are not intended to be completely definitive in nature or construction—the cluster stimuli and items may differ from one test form to another, as may their presentations.

All item clusters are expected to be of the highest quality and be tightly aligned to the OAS-S. All item clusters developed using these specifications are reviewed by Oklahoma educators and approved by the Oklahoma State Department of Education.

Motion and Stability: Forces and Interactions: 8.PS2.1

back to "Item Specifications by Performance Expectation"

8.PS2.1. Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects in a system.

OAS-S 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.

OAS-S Assessment Boundary:

Assessment is limited to vertical or horizontal interactions in one dimension.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Designing Solutions • Apply scientific principles to design an object, tool, process, or system.	**PS2.A: Forces and Motion** • For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). • The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.	**Systems and System Models** • Models can be used to represent systems and their interactions (such as inputs, processes, and outputs) and energy, matter, and information flows within the systems.

In Lay Terms:

Students should be able to apply the idea of action-reaction to describe how to modify a device, process, or system involving collision of objects to model this concept, or to evaluate or explain the results of modifications to a system involving colliding objects.

Cluster Clarifications:

- Do not include calculations apart from net force (e.g., momentum).
- Focus is on action-reaction, not Newton's first or second law.
- Students are not responsible for recognizing the name or text of Newton's third law.
- Force diagrams and vectors (showing one-dimensional movement) can be used but do not use the term vector.
- Describe contact forces only (not action at a distance, e.g., gravity).
- Context (stimulus) must clearly present the problem for which the solution is needed.
- Contexts should demonstrate or allow students to conclude/show that a larger action has a larger reaction.

Motion and Stability: Forces and Interactions: 8.PS2.1

Cluster Stimulus Attributes:

Typical stimulus elements:

- data tables
- diagrams or models of devices
- diagrams or text descriptions of mechanisms/explanations

Possible contexts:

- problems related to football, bike helmets, bumper cars, Roomba vacuum, baseball, pool, water balloons, knee pads while skating, pole vaulters, jousting, gymnastics springboard design, baseball bat (including bats of different masses), shot put, softball
- vehicles of different masses
- toy trains, cars (e.g., how can I reduce the impact forces in a collision between two toy cars?)
- asteroids and meteors colliding with each other or with Earth, space vehicles (e.g., how can NASA use a rocket to move an asteroid off course?)
- designing or modifying a device to keep an egg from breaking
- modifying a Newton's cradle or similar device to ensure a specific result occurs (e.g., how do I make sure 4 balls are set in motion?)

Content and evidence to be included: comparisons of multiple designs, data tables, and diagrams showing components of design

Types of student responses that need to be supported: predicting effect of changing variables; evaluating designs; modifying designs; describing and explaining diagrams of device designs and forces

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS2.1:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Identify the evidence that supports the students' conclusion about a design. [Which data support the conclusion that Design X will be most effective in reducing damage from a crash?] [Which of the following explains why a heavier bat is more likely to drive the ball a greater distance?]	Distractors may include data that do not provide sufficient/valid evidence, or data related to other processes.
2	**MC**	Describe how to modify a design to meet a particular design criterion or constraint. [How should the students change their design to decrease the movement of car B after a collision?] [Based on the data in the table, which change will decrease the amount of damage to the egg?] [Based on the students' results, which set of changes would be most useful to meet the requirements of this device?] [How would increasing the mass of part X affect the way it interacts with part Y?]	Distractors may include modifications that are irrelevant to a design criterion or which exceed or fail to meet the constraint.
3	**MC**	Evaluate different designs to determine which would be the best for a particular goal, or how to incorporate specific strengths of each into a new design. [How should the student combine these designs to create a device that demonstrates the idea of equal and opposite forces on the objects?]	Distractors may include designs that do not achieve a particular goal or which incorporate features that are less effective at meeting the goal.
4	**MC**	Relate observations to the idea of energy transfer involving the motion of two colliding objects. [Which of the following observations shows the correct motion of two objects after energy transfer in a collision?]	Distractors may include observations that show motion in an incorrect direction or that describe incorrect action-reaction pairs, or may include observations that are unrelated to action-reaction.
5	**MC**	Describe the practical application or value of a design or device incorporating Newton's third law. [Which of the following describes how this design could be applied to a real-life situation?]	Distractors may include irrelevant applications, or applications that do not apply Newton's third law.

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
6	**MC**	Predict how a given modification to a model or device will affect how well it meets a design criterion. [How will increasing the mass of car 2 change the net force in this collision?] [How can this device (ruler with track for marbles) be changed so that when two balls are rolled onto the track and collide with balls that are already there, three balls always roll off the track?] [How much force will car 1 exert on car 2?] [Based on the students' previous observations, how will increasing the number of sides on the box affect the likelihood of the egg breaking?] [Based on the data collected, which graph predicts how the speed of a rocket is likely to affect the movement of an asteroid?]	Distractors may include predictions that will not affect the design criterion or which contradict results obtained from previous investigations. Distractors may include responses that misinterpret the relationship between force, mass, and motion or the idea of action-reaction.
7	**MC**	Describe the data or processes needed to test the design solution or modification of the design. [What observations and measurements should the students make to test the design solution?]	Distractors may include incorrect descriptions of processes or data.
8	**MC**	Identify or evaluate constraints, which may include amount and cost of materials, safety, and time of functioning. [Which constraints did the students build into this design?] [How well does this design meet the criteria and constraints of the project?]	Distractors may include constraints not built into the design, or characteristics that are not identified in the stimulus as constraints.
9	**MC**	Explain how a design solution meets a specific criterion. [Which of the following explains why design B is most effective at reducing the damage from a crash?]	Distractors may include explanations that misinterpret the concept of action-reaction, or otherwise misaddress the criterion or design.
10	**MC**	Use science concepts to explain why a design does or does not work. [Which of the following best explains why the student's design was unsuccessful at preventing damage to the egg?] [Which of the following explains how the mass of the ball affects its ability to knock down pins?]	Distractors may include statements that do not sufficiently explain; statements that explain alternate phenomena; or statements lacking critical conceptual connections.

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
11	**MC**	Describe the system of interacting parts within a given model for the problem or device. [Which parts of the model are involved in the collision?] [How do parts X and Y demonstrate the idea of action-reaction?] [How does the student's design use the idea of equal and opposite forces on the objects?]	Distractors may include descriptions that incorrectly describe the relationship among force, mass, and motion. Distractors may include components which are not interacting as action-reaction pairs.
12	**TEI**	Show the predicted behavior of parts of a device or system before, during, or after a collision. [Show the most likely locations of the toy cars after the collision.]	Drag-drop interaction. Correct responses show correct positions or effects for all objects required. Partial credit would be given for a subset of correct responses based on number and/or complexity.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Action-reaction forces balance or cancel each other out. (In reality, forces can only balance when they are on the same object—action-reaction forces are on two different objects.)
- Newton's third law is briefly suspended when motion begins, but then takes over again (in reality motion occurs because forces are not balanced).

From newyorkscienceteacher.com/sci/pages/miscon/phy.php:

- If an object is at rest, no forces are acting on the object.

From www.sciepub.com/reference/95496:

- An object with a constant (non-zero) net force will have a constant speed.
- Faster moving objects have a larger force acting on them.

From edtechdev.wordpress.com/2010/01/02/misconceptions-about-design/:

- Engineering is a linear process, not one that moves in iterative cycles that revisit past decisions and consider alternate strategies/design pathways.
- Engineering is only about coming up with ideas, not implementing them.
- Engineers can ignore design constraints, to come up with the best design regardless of cost or other factors.
- The first solution is the best solution.

Motion and Stability: Forces and Interactions: 8.PS2.2*

back to "Item Specifications by Performance Expectation"

8.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.

OAS-S 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. An increase in force can be caused by increasing the mass, the acceleration, or both the mass and acceleration of an object. An example of evidence could include reasoning from mathematical expressions (F=ma).

OAS-S 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.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Planning and Carrying Out Investigations • Plan an investigation individually and collaboratively; 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.	**PS2.A: Forces and Motion** • 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.	**Stability and Change** • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

In Lay Terms:

Students should be able to describe how to carry out an investigation that helps demonstrate

- the effect of the mass of an object on its motion (the greater the mass, the more force required for a given amount of motion), and/or
- the effect of balanced and unbalanced forces (and the magnitude of the unbalanced force) on an object's motion (the larger the force, the larger the change in motion).

Cluster Clarifications:

- Items may discuss Newton's second law qualitatively, but students are not responsible for quantitative manipulations of the equation $F=ma$ (i.e., items may ask how a change in mass is likely to affect the motion of an object, but students are not responsible for directly explaining the mathematical relationship between force, mass, and acceleration).
- Students are not responsible for identifying Newton's laws by name.
- Do not include gravity or falling of objects on different planets.
- Force diagrams may only show forces in one dimension (i.e., forces applied in the same or opposite directions, not perpendicular or at angles).
- Controlled variables are a part of this performance expectation, but control *groups* are not.
- Context may include multiple investigations, each addressing a different variable, but any data tables should be shown separately to be clear only one variable is to be changed per investigation.

**associated sample cluster included*

Motion and Stability: Forces and Interactions: 8.PS2.2*

Cluster Stimulus Attributes:

Typical stimulus elements:

- investigation questions
- diagrams and/or text-based descriptions of investigation plans
- (partial) data tables

Possible contexts:

- investigations of lab-based or real-world examples of balanced and unbalanced forces including, but not limited to: use of spring scales to measure forces in same or opposite directions, tug of war, empty versus full shopping cart, linebacker versus kicker, car braking, table tennis ball launcher, air resistance/parachute/feather/falling objects (on Earth)
- identification of the ball or other object with the most appropriate mass for a given purpose, based on investigating the force/mass/motion relationship
- investigations of the relationship among force, mass, and motion
- simulations of balanced and unbalanced forces
- force diagrams within the context of an investigation

Content and evidence to be included: descriptions of problems or phenomena related to the cause of change in motion that is to be investigated, or descriptions of investigations about changes in motion to be evaluated

Types of student responses that need to be supported: describing and/or evaluating proper investigation procedures, tools, measurements, and data that will show the cause of an object's change in motion (mass or force differences)

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS2.2:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Based on supplied data/observations, identify the phenomenon being investigated.	Distractors may include related phenomena or claims that cannot be investigated with the data or observations supplied.
2	**MC**	Describe the data/observations that would support the purpose of an investigation or claim being investigated. [Which of the following observations would provide evidence that motion occurs because of unbalanced forces acting on an object?]	Distractors may include observations or ideas based on misconceptions and incorrect reasoning.
3	**MC**	Describe *how* data can be used as evidence of the phenomenon being investigated. [Which statement describes how the data being collected will help the students answer the question (about the cause of a change in an object's motion)?]	Distractors may include incorrect interpretations or applications of the data being collected.
4	**MC**	Explain how to measure relevant properties of the object(s) being investigated (e.g., motion, speed, direction), including units where appropriate. [Which tool and unit should students use to measure the force applied to the cart?] [Which statement explains how the students should measure the forces acting on the car?]	Distractors may include incorrect procedures, correct procedures but incorrect units, English (customary) units (mph), or derived units that are written incorrectly (sec/m), or the use of familiar but incorrect or less useful or accurate tools.
5	**MC**	Explain how to manipulate or analyze measurements to be collected in an investigation. [Which diagram shows how to calculate net force for the objects studied in this investigation?]	Distractors may include manipulations of inappropriate addends or factors.
6	**MC**	Describe the investigation plan that will provide the most useful evidence to answer a given question or support/refute a claim related to changes in forces, mass, and motion. [Which investigation plan should the students use to demonstrate the idea that changes in motion depend on both the mass of an object and the force placed on the object?]	Distractors may include irrelevant procedures or data collection that will be less useful in answering the question or supporting/refuting the claim.
7	**MC**	Modify an investigation plan to improve the data and evidence to answer a question or support a claim related to changes in force, mass, and motion. [Which of the following shows how to modify the investigation to test whether both mass and force can affect an object's motion?] [How should the students modify their investigation to be more certain of their conclusions?]	Distractors may include modifications which will make the data less useful, or which will add procedures that are irrelevant. This may include increasing the number of trials while introducing uncontrolled variables; limiting uncontrolled variables while also decreasing the number of trials; or increasing the amount of data collected while reducing the number of trials for each factor tested.

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
8	**MC**	Identify independent, dependent, and/or controlled variables in an investigation related to differences in the scale of forces or changes in force, mass, motion. [In this investigation, what is the independent variable?] [What is a variable the students should control to improve this investigation?]	Distractors may include other variable or factors, including variables that are already controlled.
9	**MC**	Explain what the data are expected to show. [What should the data collected in this investigation reveal about the relationship between mass and changes of motion?]	Distractors may include statements that reveal an incorrect understanding of the question or claim being studied.
10	**TEI**	Complete the diagram to show an investigation setup that will test the question or claim described. [Complete the diagram to show the direction and strength of the forces that should be used in this investigation.]	Drag-drop interaction. Draggable objects and goal boxes should include not only the correct parts but also parts that would show incorrect understanding (e.g., for a force diagram, arrows of different size and direction and goal areas to represent different locations relative to the object being studied). Correct responses place all required components into correct locations. Partial credit would be given for a subset of correct responses.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From newyorkscienceteacher.com/sci/pages/miscon/phy.php:

- The terms "energy" and "force" are interchangeable.
- An object at rest has no energy.
- If an object is at rest, no forces are acting on the object.

From www.sciepub.com/reference/95496:

- An object with a constant (non-zero) net force will have a constant speed.
- Faster moving objects have a larger force acting on them.

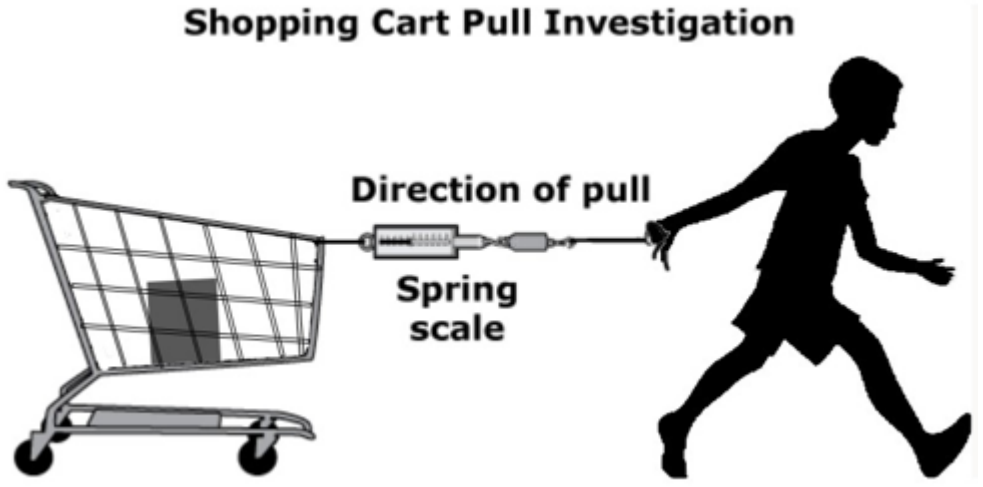
Sample Cluster for 8.PS2.2:

Use the information to answer the following questions.

A Green Team and a Blue Team prepare for a shopping cart race. They carry out an investigation that will help them so they can do well in the race. They used a spring scale to measure the force in newtons (N = newtons). The procedure and a diagram of the experimental setup are shown.

Procedure:

1. Place 25 kg of groceries in a shopping cart.
2. Attach a rope and a spring scale to the front of the shopping cart.
3. Have a runner pull the cart 10 meters across a parking lot as fast as they can.
4. Use the spring scale to measure the amount of force, in newtons, the runner applies to the cart while pulling.
5. Measure the time it takes for the runner to pull the cart 10 meters.
6. Use the time and distance to calculate the speed of the runner.
7. Repeat the steps for each runner.



The data collected during the investigation are shown in the table.

Team	Runner	Pull Force (N)	Time it took to travel 10 meters (s)
Green	1	8	5.6
Green	2	3.3	8.7
Green	3	14.2	4.2
Green	4	5.1	7.0
Blue	5	4.7	7.3
Blue	6	4.2	7.7
Blue	7	3.9	8.0
Blue	8	5.4	6.8

(Items on the following pages)

1 The teams decided to investigate the effects of mass on the force needed to pull the shopping cart.

What could the students change in the investigation to make the cart go faster?

A Put more mass in the cart.

B Put less mass in the cart.

C Use a longer rope to pull the shopping cart.

D Use a larger shopping cart.

Standard: 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.

Cognitive Complexity:
SEP: Medium
DCI: Medium
CCC: Medium
Overall Cognitive Complexity: Moderate Support

Distractor Rationale:
A. Putting more mass in the cart will make the cart heavier and thereby harder to pull making it slower.
B. Correct. Putting less mass in the cart will make the cart lighter and therefore go faster.
C. Using a different rope will not make the cart lighter and thereby easier to pull.
D. The shopping carts will have the same relative mass thereby this would not change the outcome of the investigation.

2 The students noticed the surface they were racing on had different sized rocks on it. They wondered if the rocks being in the way would affect their race.

Which explanation best describes how the rocks will affect the shopping cart?

A Only the big rocks will affect the shopping cart because the force of the rocks will be going in the same direction as the shopping cart's wheels when it hits them.

B Only the small rocks will affect the shopping cart because the force of the rocks will be going in the same direction as the shopping cart's wheels when it hits them.

C None of the rocks will affect the shopping cart because the rocks have zero force.

D All the rocks will affect the shopping cart because the force of the rocks will be going in the opposite direction as the shopping cart's wheels when it hits them.

Standard: 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.

Cognitive Complexity:
SEP: Medium
DCI: High
CCC: Medium
Overall Cognitive Complexity: Low Support

Distractor Rationale:
A. The big rocks will affect the shopping cart but so will the small rocks because the rocks have an opposite net force as the shopping cart's wheels upon impact.
B. The small rocks will affect the shopping cart but so will the big rocks because the rocks have an opposite net force to the shopping cart's wheels upon impact.
C. The shopping cart could roll over some of the rocks but all the rocks will slow down the shopping cart because the rocks have an opposite net force to the shopping cart's wheels upon impact.
D. Correct. All the rocks will affect the shopping cart because the rocks have an opposite net force to the shopping cart's wheels upon impact.

3 **Based on the data in the chart which two runners should the Green Team select to win the race and why?**

A Runners 2 and 3, because together they have the lowest pull force and slowest time.

B Runners 1 and 3, because together they have the highest pull force and fastest time.

C Runners 4 and 1, because together they have the lowest pull force and fastest time.

D Runners 2 and 4, because together they have the highest pull force and slowest time.

Standard: 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.

Cognitive Complexity:
SEP: Medium
DCI: High
CCC: Low
Overall Cognitive Complexity: Low Support

Distractor Rationale:
A. Runners 2 and 3 have a combined pull force of 17.5 N and an average time of 6.45 s.
B. Correct. Runners 1 and 3 have a combined pull force of 22.2 N and an average time of 4.9 s, making them the fastest and the strongest pull force.
C. Runners 4 and 1 have a combined pull force of 13.1 N and an average time of 6.3 s.
D. Runners 2 and 4 have a combined pull force of 8.4 N and an average time of 7.85 s.

Motion and Stability: Forces and Interactions: 8.PS2.3

back to "Item Specifications by Performance Expectation"

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

OAS-S 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.

OAS-S Assessment Boundary:

Assessment about questions that require quantitative answers is limited to proportional reasoning. Assessment of Coulomb's Law is not intended.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Asking Questions • 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.	**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.	**Cause and Effect** • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.

In Lay Terms:

Students should be able to understand that there are invisible forces between objects that have electric and magnetic properties. Students should be able to understand that these forces can become stronger or weaker depending on how close or far the objects are from one another and depending on the magnitude of the charges, currents, or magnetic strength. Students should also understand that there are factors that cause objects to repel one another and also factors that cause these objects to be attracted to one another.

Cluster Clarifications:

- Students should ask questions to determine factors that affect the strength of force on objects.
- Students should ask questions to be investigated in order to demonstrate that electric and magnetic forces can be attractive or repulsive.
- Students should ask questions to investigate electric forces and create a hypothesis to determine factors that increase or decrease the strength of their force.
- Students should ask questions to be investigated to determine how to increase the strength of an electromagnet.
- Students are not expected to do algebraic manipulations.
- To address the CCC, students should be looking at the cause-and-effect-relationship that exists between electric and magnetic forces involving interacting objects.

Motion and Stability: Forces and Interactions: 8.PS2.3

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and/or diagrams of investigations involving electric and magnetic forces between interacting objects
- diagrammatic models of electric and magnetic forces between interacting objects
- diagrams that model invisible forces
- tables of data showing the effect of making changes to electromagnets, electric motors, generators, or other devices which use electric and magnetic forces

Possible contexts:

- static cling
- rubbing a balloon on hair and the hair standing up
- doors that lock with electromagnets
- two electrically charged objects of various charge intensities at various distances
- two identical magnets at various distances and relative orientations
- two magnets of different strength, size, shape, or material
- a magnet and another object that may or may not be ferromagnetic
- a magnet and items of unknown composition
- magnets and other materials that serve a specific purpose, such as latching a door or keeping a hook attached to a wall

Content and evidence to be included: information/descriptions about electric and magnetic forces

Types of student responses that need to be supported: formulating questions that arise from examining given data of objects

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS2.3:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Identify questions about the distance between interacting objects and the strength of forces.	Key may focus on how distance affects the strength of the forces. Distractors may include questions that do not address strength of force.
2	**MC**	Identify a question that tests the conclusion or claim about electrical currents. [How does the number of turns of wire on the coil affect the magnitude of the electric current?]	Key will relate the number of turns to increased electrical current. Distractors may include questions that do not address the premise of the claim or that do not correctly relate the cause and effect.
3	**MC**	Identify which evidence is needed to address a question about relative orientation of magnets and its effect on magnetic forces.	Key may focus on aligning north and south poles for attraction or same poles for repulsion. Distractors may include the wrong evidence or evidence that only partially answers the question.
4	**MC**	Identify which of two or more questions or predictions is best supported by the data evidence (and explain the reasoning for why).	Key may focus on the supportive link between the data and the question/prediction presented. Distractors may include statements that incorrectly reason from the data or fail to have a preponderance of support for the reasoning.
5	**MC**	Evaluate whether a question or prediction can be addressed with the information/ evidence provided and/or whether the question will clarify/extend understanding of the topic.	Key should focus on the quality of the question and potential to be answered and/ or provide useful information (related to DCI content). Distractors may include misconceptions and/or invalid reasoning for the merit of a particular question.
6	**MC**	Identify which question will provide the best evidence to support a specific cause-and-effect relationship.	Key should focus on questions eliciting data that show a specific cause-and-effect relationship.
7	**TEI**	Sort questions that allow students to predict the strength of electric and magnetic forces due to cause-and-effect relationships. [Using the data from the study, classify questions related to distance between objects and the strength of forces.]	Drag-drop, drop-down, or match interaction Reasoning associations may be incorporated in some items. Correct responses show proper classifications for questions distinguishing correct and incorrect causes. Partial credit would be awarded for a subset of correct responses.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From oksciencefamework.pbworks.com/w/page/111524845/Introduction%20to%20the%20OKScience%20Framework

- Static electricity is a buildup of electrons.
- Fields don't exist unless there is something to detect them.
- The electric force is the same as the gravitational force.
- A charged body only has one type of charge.
- Magnetic forces only act between objects when they are in contact.
- The separation of a magnet into two halves creates two monopoles: one north and one south.

Motion and Stability: Forces and Interactions: 8.PS2.4

back to "Item Specifications by Performance Expectation"

8.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.

OAS-S 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.

OAS-S Assessment Boundary:

Assessment does not include Newton's law of gravitation or Kepler's laws. Assessment should be focused on qualitative observations and data or other quantitative data that do not require mathematical computations beyond basic central tendencies.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
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.	**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 objects have large mass (e.g., Earth and the Sun).	**Systems and System Models** • Models can be used to represent systems and their interactions (such as inputs, processes, and outputs), as well as energy and matter flows within systems.

In Lay Terms:

Gravity is an attractive force that depends on the mass of each interacting object as well as the distance between them.

Cluster Clarifications:

- Students are able to recognize that larger masses exert greater gravitational forces than smaller masses do.
- Students can construct arguments showing that there are gravitational forces between different masses and recognize the strengths and limitations of their design.
- Students can select a correct argument that shows that there are gravitational interactions between different systems.
- Students can select a correct argument that shows that there are gravitational forces between different distances and recognize the strengths and limitations of their design.
- Students use evidence to show that gravitational forces are always attractive.
- Students make a claim to be supported about a given phenomenon. In their claim, students include the following idea: gravitational interactions are attractive and depend on the masses of interacting objects.
- Students can construct arguments that there are gravitational forces between different objects and that the distance between them affects these forces. Do not include the inverse-square relationship (neither quantitatively nor qualitatively).

Motion and Stability: Forces and Interactions: 8.PS2.4

Cluster Stimulus Attributes:

Typical stimulus elements:

- data generated from simulations or digital tools
- data tables
- system models

Possible contexts:

- patterns in data/graphs illustrating that as the mass of one or both of the interacting objects increases, the magnitude of gravitational force at a given distance increases
- patterns in data/graphs illustrating that as distance between objects of a given mass increases, the strength of the gravitational forces decreases
- simulations in which students can observe patterns of movement in two or more objects interacting via gravity after altering the mass or relative distance between the objects

Content and evidence to be included: descriptions and data about interacting masses

Types of student responses that need to be supported: providing explanations with evidence and reasoning

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS2.4:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Determine/infer evidence/data that supports a claim or a model or explanation about gravitational interactions.	Distractors may include evidence that does not support an argument or misconceptions about gravitational interactions.
2	**MC**	Make an argument that data, models, and other evidence show that the force between two objects increases or decreases directly with an increase or decrease in the mass of the interacting objects	Distractors may include a misinterpretation of data or misconceptions about gravitational interactions.
3	**MC**	Describe the evidence that supports that gravitational interactions are always attractive and occur at a distance and not through direct contact.	Distractors may include evidence that does not support a claim or misconceptions about gravitational interactions.
4	**MC**	Use data to explain 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.	Distractors may include a misinterpretation of data or misconceptions about gravitational interactions.
5	**MC**	Argue that (and/or why) some effects of gravitational interactions may only be observable in interactions between very massive objects.	Distractors may include the common misconception about gravity only applying to large objects, like planets.
6	**MC**	Identify which model or argument is most accurate.	Distractors may include misinterpretations of the system model or incorrect explanations.
7	**MC**	Describe how (and/or why) the argument may be improved.	Distractors may include incorrect improvements or contradictions to the original argument.
8	**MC**	Describe additional evidence that would support the claim.	Distractors may include evidence that does not further support the given claim.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- A force can become part of an object. For example, the force involved in throwing or hitting an object becomes part of the thrown or hit object.
- Passive objects cannot exert a force.

From mosamack.com/home/gravity

- Gravity is a pushing force. Gravity pushes toward Earth.
- Gravity only applies to objects when they are falling or when they are in the air.
- Gravity is defied when jumping in the air.
- The magnitudes of the gravitational forces exerted on interacting objects are not equal, with the smaller mass receiving a larger force and the larger mass receiving a smaller force.
- Gravitational force only applies to large objects such as planets and stars.
- There is no gravity in space.

Motion and Stability: Forces and Interactions: 8.PS2.5

back to "Item Specifications by Performance Expectation"

8.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.

OAS-S Clarification Statement:

Examples of this phenomenon could include the interactions of magnets, electrically charged strips of tape, and electrically charged balloons. Examples of investigations could include first-hand experiences or simulations.

OAS-S Assessment Boundary:

Assessment is limited to electric and magnetic fields and limited to qualitative evidence for the existence of fields.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
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.	**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).	**Cause and Effect** • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.

In Lay Terms:

Students should be able to understand that there are invisible forces between objects that have electric and magnetic properties. Students should be able to understand that there are invisible fields between objects.

Cluster Clarifications:

- Students should be able to conduct an investigation to produce data to provide evidence that fields exist and exert forces, demonstrating the forces of static electricity.
- Students should be able to conduct an investigation to produce data demonstrating the forces of magnetic fields.
- Experiments should focus on qualitative observations.
- Observations can include motions of objects, suspension of objects, simulation of objects that produce either electric or magnetic fields, and/or a push or pull exerted on a hand or an object.
- Students should be able to assess whether the data produced by the investigation can provide evidence that fields exist between objects.

Cluster Stimulus Attributes:

Typical stimulus elements:

- investigation questions
- diagrams and/or text-based descriptions of investigation plans
- (partial) data tables

Possible contexts:

- magnetic properties of magnetite rock
- compasses
- iron filings forming patterns near a magnet
- electrically charged strips of tape
- electrically charged balloons

Content and evidence to be included: descriptions of problems or phenomena related to magnetic or electric fields that are to be investigated, or descriptions of investigations about invisible fields

Types of student responses that need to be supported: describing and/or evaluating proper investigation procedures, tools, measurements, and data

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS2.5:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Based on supplied data/observations, identify the phenomenon being investigated.	Distractors may include related phenomena or claims that cannot be investigated with the data or observations supplied.
2	**MC**	Describe the data/observations that would support the purpose of an investigation or claim being investigated.	Distractors may include observations or ideas based on misconceptions and incorrect reasoning.
3	**MC**	Describe *how* data can be used as evidence of the phenomenon being investigated. [Which statement describes how the data being collected will help the students answer the question?]	Distractors may include incorrect interpretations or applications of the data being collected.
4	**MC**	Explain how to manipulate or analyze measurements to be collected in an investigation.	Distractors may include manipulations of inappropriate addends or factors.
5	**MC**	Describe the investigation plan that will provide the most useful evidence to answer a given question or support/refute a claim.	Distractors may include irrelevant procedures or data collection that will be less useful in answering the question or supporting/refuting the claim.
6	**MC**	Modify an investigation plan to improve the data and evidence to answer a question or support a claim.	Distractors may include modifications that will make the data less useful or that will add procedures that are irrelevant. This may include increasing the number of trials while introducing uncontrolled variables, limiting uncontrolled variables while also decreasing the number of trials, or increasing the amount of data collected while reducing the number of trials for each factor tested.
7	**MC**	Evaluate an experimental design and its components (control, independent, and dependent variables).	Distractors may include other variables or factors, including variables that are already controlled.
8	**MC**	Explain what the data are expected to show.	Distractors may include statements that reveal an incorrect understanding of the question or claim being studied.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From oksciencefamework.pbworks.com/w/page/121762203/Sixth%20Grade%20Forces

- Static electricity is a buildup of electrons.
- Fields do not exist unless there is something to detect them.
- The electric force is the same as the gravitational force.
- A charged body only has one type of charge.
- Electric/magnetic fields do not exist because they cannot be seen.
- Electric/magnetic fields exist in one dimension.
- Electric and magnetic fields are the same.
- Magnetism results from how electrons are distributed in a magnet and because the poles of a magnet are charged, with the north pole as "positive" and the south pole as "negative."
- A force exerted by a field stems from charged objects moving across field lines to either push or pull on other objects.

Waves and Their Applications in Technologies for Information Transfer: 8.PS4.1*

back to "Item Specifications by Performance Expectation"

8.PS4.1. Use mathematical representations to describe patterns in a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

OAS-S Clarification Statement:

Emphasis is on describing waves with both qualitative and quantitative thinking.

OAS-S Assessment Boundary:

Assessment does not include electromagnetic waves and is limited to standard repeating waves.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Using Mathematical and Computational Thinking • Use mathematical representations to describe and/or support scientific conclusions and design solutions.	**PS4.A: Wave Properties** • A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.	**Patterns** • Graphs and charts can be used to identify patterns in data.

In Lay Terms:

Students should be able to use mathematical representations (e.g., graphs and charts) to demonstrate qualitatively and quantitatively that

- a wave has characteristic properties,
- each wave has a repeating pattern of wavelengths, frequency, and amplitude, and/or
- there is a relationship between the amount of energy transferred by a wave and the wave's characteristics.

Cluster Clarifications:

- The stimulus should involve a physical system or phenomenon, so that the mathematic representation/model is applied to something real (actual utility).
- Wave characteristics that should be focused on are wavelength, frequency, and amplitude, as listed in DCI. Minimize extension to other wave features like crest, trough, etc.
- Students should not be assessed on the concept or calculation of wave speed.
- Descriptions of relationships among wave characteristics should be textual statements of relationships or graphical displays, not equations.
- Information may be quantitative and/or qualitative (e.g., as energy increases, amplitude increases).
- Students should know that volume corresponds to amplitude, that frequency corresponds to pitch, and that amplitude is related to energy.
- Seismic waves may be used as examples; however, students are not responsible for knowing the names or characteristics of these waves (e.g., surface [Rayleigh and Love] waves, body waves including secondary or s-waves, compression, primary or p-waves).
- When representing radio or television frequencies, write out frequency (e.g., 50,000 cycles per second rather than 5 KHz or 5×10^4 KHz).

**associated sample cluster included*

Waves and Their Applications in Technologies for Information Transfer: 8.PS4.1*

Cluster Stimulus Attributes:

Typical stimulus elements:

- graphs
- diagrams
- text descriptions
- tables showing amplitude, frequency, speed, and/or wavelength, plus energy

Possible contexts:

- waves that are familiar to middle school students within the classroom, including but not limited to seismic waves, ocean waves
- models of sound waves (toy ropes, slinky, or balls showing compression)
- devices that can make sound, such as bottles, rubber bands, radio stations, etc.

Content and evidence to be included: graphs, tables, or other relevant information about waves

Types of student responses that need to be supported: displaying and describing relationships seen in models/graphs of waves; explaining and predicting wave characteristics using the models/graphs

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS4.1:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Compare the energy, frequency, wavelength, and/or amplitude of waves shown as a drawing or graph. [Which of the following waves has the greatest frequency?] [Which diagram shows the wave with the longest wavelength?]	Distractors may contain graphs or diagrams showing different wave characteristics.
2	**MC**	Identify where or how the wavelength, frequency, and/or amplitude of a wave is represented in a graph or diagram. [Which diagram shows how to measure the amplitude of the wave shown in the graph?] [What is the wavelength of the wave shown in the diagram?]	Distractors may contain ways to measure other characteristics of waves, or incorrect procedures to make these measurements.
3	**TEI**	Show where or how the wavelength, frequency, and/or amplitude of a wave is represented in a graph or diagram. [Label the wavelength and amplitude of the graph (by dragging the labels).]	TEI interaction could be drag-drop, drop-down, or match to label parts of the graph or diagram. Correct responses show all parts correctly matched or labeled. Partial credit would be given for having some correct labels identified.
4	**MC**	Analyze diagrams of waves with different characteristics to determine which of several waves has the most energy. [Which of the waves shown has the greatest amount of energy?] [Which of the waves shown will be able to transfer the most energy when it hits the shore?] [Which of the waves shown will cause the most damage to a nearby building?]	Distractors may contain waves of different amplitude, wavelength, and frequency.
5	**MC**	Compare graphs or diagrams showing changes in mechanical wave characteristics including amplitude, wavelength, frequency, or velocity to select which change will produce changes in energy. [Which of the changes will result in the biggest increase in the energy of the wave?] [How will the energy of this wave change if its amplitude increases to 2 meters?]	Distractors may contain wave pairs showing different combinations of amplitude, frequency, and wavelength.
6	**MC**	Transform data into graphic representations of waves. [Which graph/drawing best represents the sound wave data shown in the table?]	Distractors may contain graphs misrepresenting the data, showing it as other wave properties (e.g., representing wavelength as frequency, etc.).

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
7	**MC**	Using the model, predict the change in the wave graph or traits of the model, based on a change in the system/phenomenon. [How would the graph change if the speed of the phenomenon (e.g., vibration) increased?]	Distractors may contain changes and representations that concentrate on a different wave property than the one affected, or that reflect misconceptions.
8	**MC**	Explain the reason for a particular difference in the characteristics of waves. [The diagrams shown represent the voice of a person in two different situations. How has the person changed their voice to create the pattern shown in graph 2?] [Which of the following explains why the frequency of these two waves differs?]	Distractors may include causes of changes in other characteristics of waves such as pitch, volume, etc.
9	**MC**	Describe a relationship about waves or their properties based on data. [How does the energy of this wave change when its amplitude is doubled?]	Distractors may contain incorrect relationships related to misconceptions or incorrect interpretations of the data.
10	**MC**	Identify the graph that shows the higher pitch/volume. [Which of the following graphs shows an increase in the pitch of the voice?]	Distractors may contain changes to the other wave characteristics.
11	**MC**	Evaluate how well a model represents a given wave phenomenon (and explain why). [Which model is most useful to represent a sound wave?]	Distractors may include models that represent only a portion of characteristics of the wave phenomenon.
12	**TEI**	Match real life properties of phenomena to graphic representations. [Match the station frequency and volume shown for each radio to the correct graph.]	Match interaction. Correct responses show all radio station descriptors matched to the correct graph for that wave broadcast. Partial credit would be given for a subset of correct matches.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From Conceptual Curriculum for Physics. National Science Foundation. 16 07 2009.

- Waves transport matter.
- Waves do not have energy.
- Big waves travel faster than small waves in the same medium.
- All waves travel the same way.
- Frequency is connected to loudness for all amplitudes.
- Pitch is related to intensity.

From Hapkiewics, A. (1992) Finding a List of Science Misconceptions. MSTA Newsletter, 38 (Winter '92) pp11-14.

- Sound can be produced without using any material objects.
- Hitting an object harder changes the pitch of the sound produced.
- Loudness and pitch of sounds are the same thing.
- Sounds cannot travel through liquids and solids.
- In wind instruments, the instrument itself vibrates (not the internal air column).
- Matter moves along with water waves as the waves move through a body of water.
- When waves interact with a solid surface, the waves are destroyed.

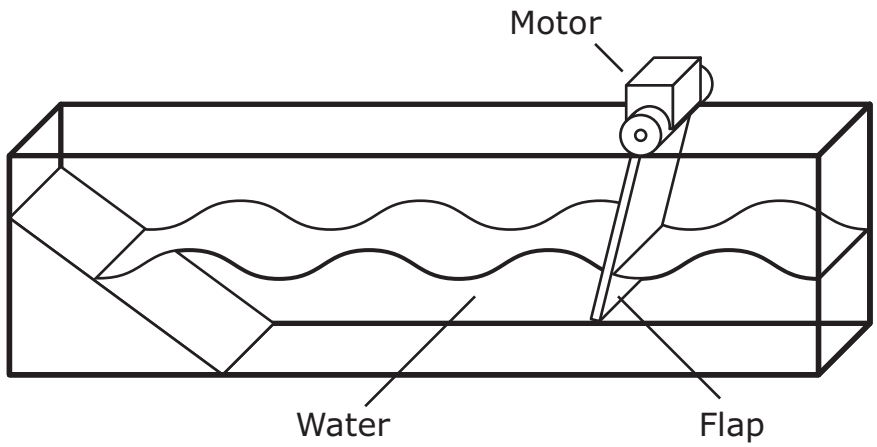
Sample Cluster for 8.PS4.1:

Use the information to answer the following questions.

A student observed small waves on a lake. The next day, the waves on the lake were two times higher. The student wonders why the wave height changed.

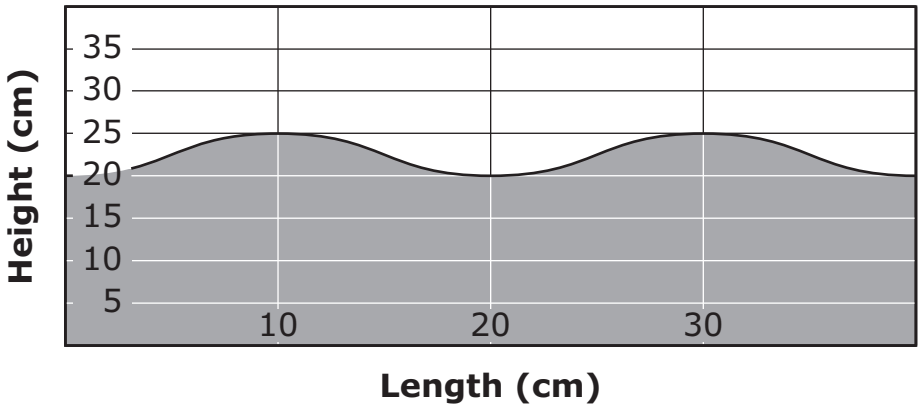
The student plans an investigation using a wave tank. A wave tank is a large, clear plastic container filled with water. A flap at one end of the tank can be moved back and forth by a motor. This motion creates waves in the tank. The diagram shows a wave tank.

Wave Tank



The student can measure characteristics of the waves created in the tank. The diagram shows a wave in the tank. The tank has scales marked on the side and bottom.

Measuring Wave Characteristics



(Items on the following pages)

1 The student studies the Measuring Wave Characteristics diagram to find the amplitude of the wave in the tank. The student wants to draw a line showing where the amplitude of the wave is.

Based on the diagram, where should the amplitude of the wave be drawn?

A The amplitude line should be drawn halfway between the 0 and 25 cm lines on the *y*-axis.

B The amplitude line should be drawn at the 20 cm line on the *y*-axis.

C The amplitude line should be drawn halfway between the 20 and 25 cm lines on the *y*-axis.

D The amplitude line should be drawn at the 25 cm line on the *y*-axis.

Standard: 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.

Cognitive Complexity:
SEP: Med
DCI: Med
CCC: Low
Overall Cognitive Complexity: Moderate Support

Distractor Rationale:
A. This represents the height of the crest but the amplitude is found by looking at the difference in the trough height and the crest height and dividing it in half.
B. This height represents the trough, but the amplitude is found by looking at the differences in the trough height and the crest height and dividing it in half.
C. Correct. From trough to crest the wave is 5.0 cm. The amplitude would be half of the total height, which is 2.5 cm.
D. This represents the height of the crest but the amplitude is found by looking at the difference in the trough height and the crest height and dividing it in half.

2 The student thinks about the waves on the lake being two times higher than the day before.

How could the student cause the waves in the wave tank to become two times higher?

A Change the energy input from the motor to one-quarter the original amount.

B Change the energy input from the motor to one-half the original amount.

C Change the energy input from the motor to two times the original amount.

D Change the energy input from the motor to four times the original amount.

Standard: 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.

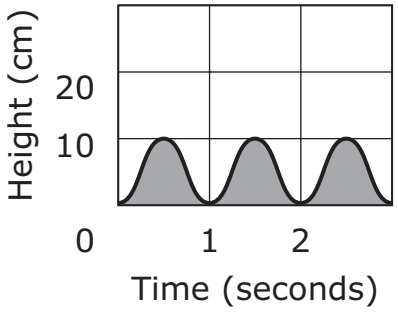
Cognitive Complexity:
SEP: Med
DCI: High
CCC: Low
Overall Cognitive Complexity: Low Support

Distractor Rationale:
A. This is the taking the energy of the wave and making it reversely proportional to the square of the amplitude.
B. This is taking the energy of the wave and making it reversely proportional to the amplitude.
C. This is taking the energy of the wave and making it proportional to the amplitude.
D. Correct. The energy of the wave is proportional to the square of the amplitude. If the height of a water wave is doubled, each wave will have four times the energy.

This question has two parts. Be sure to answer both parts of the question.

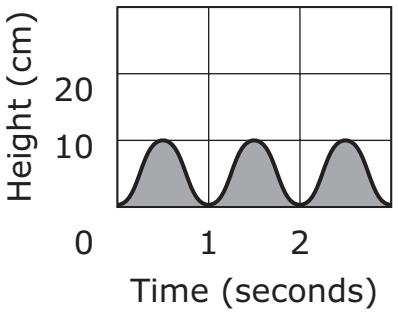
3 The student wants to make two wave models. One wave model will represent a decrease in wavelength without changing the amplitude. The other wave model will represent an increase in frequency with a change in the amplitude.

The diagram represents the original wave.

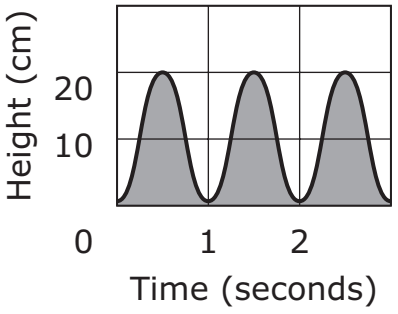


Which diagram represents a decrease in wavelength for the original wave without a change in amplitude?

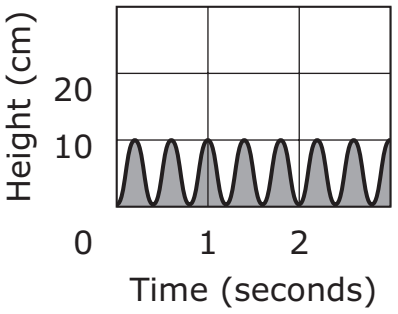
A



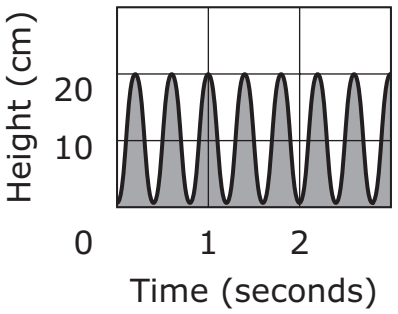
B



C



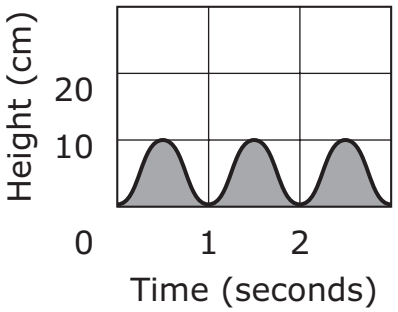
D



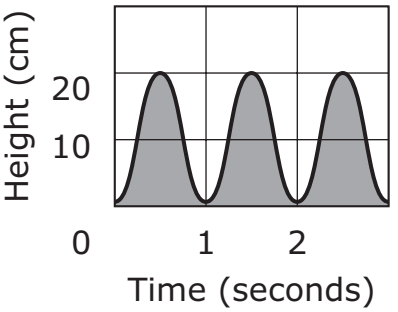
(continued on next page)

Which diagram represents an increase in frequency for the original wave with a change in amplitude?

A



B



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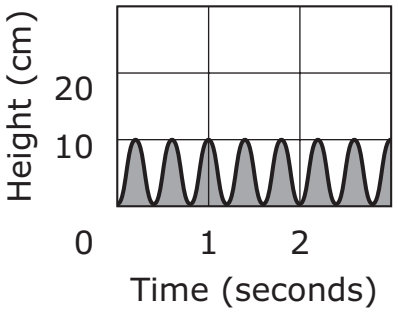
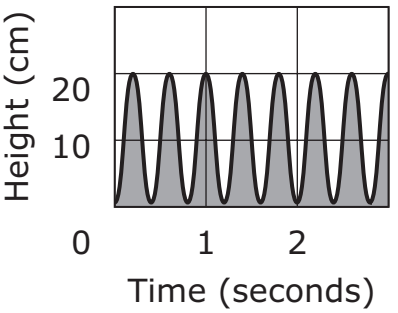


D



Standard: 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.

Cognitive Complexity:
SEP: High
DCI: High
CCC: Low
Overall Cognitive Complexity: Low Support

Distractor Rationale:
A. This wave model does not change the wavelength or the amplitude.
B. The wavelength stays the same but the amplitude is changed in this wave.
C. Correct. The amplitude is the same because it is the same height and the wavelength decreases because the distance between crests is closer together than the original wave.
D. Both the wavelength and the amplitude has changed for this wave.

A. This wave model does not change the frequency or the amplitude.
B. The frequency stays the same but the amplitude is changed in this wave.
C. The amplitude is the same because it is the same height and the frequency increases because the number of crests in 2 seconds is more than the original wave.
D. Correct. Both the frequency and the amplitude has changed for this wave.

Waves and Their Applications in Technologies for Information Transfer: 8.PS4.3

back to "Item Specifications by Performance Expectation"

8.PS4.3. Integrate qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.

OAS-S 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. Examples of reliability in encoding could include transmitting digital information at a higher quality than analog signals (digital vs. analog photographs or videos, or digital vs. analog thermometer). Examples of reliability in transmission could include the degradation of an analog signal compared to a digital signal.

OAS-S Assessment Boundary:

Assessment does not include binary counting or the specific mechanism of any given device.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Obtaining, Evaluating, Communication of Evidence • Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings.	• Many modern communications devices use digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	**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.

In Lay Terms:

Scientific and technical information can be obtained and integrated into student-constructed explanations that digital signals are a more reliable way (than analog signals) to encode and transmit information.

Cluster Clarifications:

- Students are not required to know binary counting or the specific mechanism of any given device.
- Should be focused on qualitative features not quantitative.
- Students should be able to identify why modern communications are more reliable.

Cluster Stimulus Attributes:

Typical stimulus elements:

- models
- images
- data tables

Possible contexts:

- images and/or models of digital vs analog devices
- data table that contains qualitative information

Content and evidence to be included: information/descriptions of digital and analog communication devices

Types of student responses that need to be supported: obtain qualitative technical information related to the communication reliability features of digital signals and compare those features to analog signals

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.PS4.3:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Select a claim that is supported by data that shows how analog and digital signals are transmitted. [Which claim about signal transmission is supported by the data?]	Key could go to how analog signals are more distorted during transmission than digital signals. Distractors may include misconceptions about only one signal carrying information, or to statements that are not supported by what is shown in the provided data.
2	**MC**	Evaluate a claim about how analog and digital devices compare in terms of storing information. [Which statement **best** evaluates the claim that analog devices are better at storing information than digital devices?]	Distractors may include false reasoning about why analog devices are not better at storing information than digital devices, or misconceptions about matter being stored or transported through waves.
3	**MC**	Choose a statement that supports a claim about the reliability of digital and analog signals. [Which statement supports the claim that digital signals are more reliable than analog signals?]	Key could go to how digital signals produce pictures and sounds that are more like the original source than what analog signals can produce. Distractors may include true statements that do not support the claim.
4	**TEI**	Complete an inline choice statement to evaluate the claim that analog devices are better at storing information than digital devices.	Incorrect dropdowns could have flawed reasoning for how the devices store information, which could draw upon misconceptions that waves transport matter.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Waves transport matter.
- There must be a medium for any wave to travel through.

From Molecules to Organisms: Structure and Processes: 8.LS1.4

back to "Item Specifications by Performance Expectation"

8.LS1.4. Use arguments 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.

OAS-S Clarification Statement:

Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from the 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.

OAS-S Assessment Boundary:

Assessment should not focus on the identification of the reproductive plant structures.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
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 phenomena.	**LS1.B: Growth and Development of Organisms** • Animals engage in characteristic behaviors that increase the odds of reproduction. • Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.	**Cause and Effect** • Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

In Lay Terms:

Within every population, there are variations of organisms. Some of these variations exhibit traits and behaviors that will favor the chance to survive and reproduce.

Cluster Clarifications:

- Students are not required to know specifics about particular plant or animal species.
- Information about plants and animals should be provided for students to analyze.
- Students should be able to identify evidence from the given information that supports claims about the probability of increased reproduction.
- Students should be able to develop scientific arguments that are supported by evidence.
- Students should be able to explain that plants sometimes depend on animal behavior for reproduction.
- Students should be able to use an argument to support or refute an explanation or model.
- Students should be able to identify the characteristics that cause increased reproductive success.
- Students should be able to identify behaviors that cause increased reproductive success.

From Molecules to Organisms: Structure and Processes: 8.LS1.4

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and data for different organisms

Possible contexts:

- courtship behaviors involved in attracting a mate
- behaviors that provide offspring with shelter, food, and protection from predation
- cichlids brooding young in their mouths
- flower characteristics that attract birds, bats, and insects for pollination
- adaptations that facilitate seed dispersal by gravity, wind, water, or animals
- adaptations that enable seeds to sprout in different environments
- transporting pollen between flowers
- transporting seeds to new locations (e.g., carrying seeds, eating fruit, and eliminating seeds)
- animal behaviors that influence the reproductive success of plants

Content and evidence to be included: information/descriptions about traits or behaviors of different organisms

Types of student responses that need to be supported: using empirical evidence to support scientific arguments

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS1.4:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Identify/describe the evidence that supports/ rejects a claim related to the relationship between a behavior/structure and increased reproduction.	Distractors may include evidence that is irrelevant or does not appropriately align with the evaluation of the claim.
2	**MC**	Describe *how* a given data set supports or rejects an argument about the relationship between a trait and increased reproduction.	Distractors may include descriptions that incorrectly explain how the given data support or reject the argument or that show a misunderstanding of the premise of the argument.
3	**MC**	Evaluate arguments related to reproduction rates to choose the one that is best supported by the data in a graph/table.	Distractors may include arguments that are only partially supported by the data, or that are not supported by the data.
4	**MC**	Select the reasoning that best supports a claim/conclusion regarding a cause-effect relationship.	Distractors may include reasoning that incompletely supports the claim or conclusion or that could be used to reject the conclusion.
5	**MC**	Evaluate data in support of a claim made in a model.	Distractors may include evaluations of data which incorrectly assign importance to irrelevant results or claims which are not supported by the data shown.
6	**MC**	Evaluate the merit of a claim based on data or evidence.	Distractors may include reasoning about merit that does not follow from the data presented in the stimulus.
7	**MC**	Describe the argument that best supports or rejects a claim based on the evidence.	Distractors may include arguments which incorporate misconceptions and/or evidence irrelevant to the claim.
8	**MC**	Explain how the evidence provided supports one claim but not an alternative claim(s). [How does the evidence support claim 1 over claim 2?] [What evidence would be required to support claim 2 over claim 1?]	Distractors may include explanations that do not adequately explain the usefulness of the data to distinguish among claims.
9	**MC**	Use reasoning to qualify additional support for a claim or argument.	Distractors may include evidence that can be used to reject the claim or is irrelevant or neutral to the claim.
10	**TEI**	Use the drop-down menu to construct an argument using the appropriate evidence.	Distractors may include evidence that can be used to reject the claim or is irrelevant or neutral to the claim.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Behaviors are choices made by animals; they are not genetically controlled.
- Plants are consciously attracting animals.
- All plants need pollinators to reproduce.

From www.cde.ca.gov/ta/tg/ca/castitemspecs.asp

- Animal behaviors do not influence the reproductive success of plants.

From Molecules to Organisms: Structure and Processes: 8.LS1.5

back to "Item Specifications by Performance Expectation"

8.LS1.5. Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

OAS-S 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.

OAS-S Assessment Boundary:

Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Constructing Explanations • 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.	**LS1.B: Growth and Development of Organisms** • Genetic factors, as well as local conditions, affect the growth of the adult plant.	**Cause and Effect** • Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

In Lay Terms:

An organism's growth is affected by many different environmental and genetic factors.

Cluster Clarifications:

- Students will not have to determine an organism's genotype for a particular trait.
- The focus should be on how environmental conditions and genetic factors influence organism growth.
- Students use evidence and reasoning to construct a scientific explanation for the given phenomenon that supports environmental and genetic factors' influence on the growth of organisms.
- Student should look at evidence to determine the most probable explanation and use probability to determine the most likely cause of a phenomenon.
- Students use multiple valid and reliable sources of evidence to construct an explanation that supports environmental and genetic factors' influence on the growth of organisms.
- Students connect the evidence and support an explanation for a phenomenon involving genetic and environmental influences on organism growth.
- Students connect the probability of an organism's growth and survival based on genetic and environmental factors.

From Molecules to Organisms: Structure and Processes: 8.LS1.5

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and data about an organism's growth
- graphs, charts, or experimental data

Possible contexts:

- an experiment showing that different factors (including light, space, water, and nutrients) can influence differential growth
- the size of a goldfish in relation to the size of the fish tank
- fertilized versus non-fertilized plant growth
- drought leading to a food shortage for certain animal species
- trees growing smaller as altitude increases
- animal breeds and their varying sizes based on genetic factors (standard poodle, miniature poodle, teacup poodle)

Content and evidence to be included: information/descriptions/experiments about organism's growth

Types of student responses that need to be supported: creating, completing, and/or improving scientific explanation using appropriate data

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS1.5:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Explain cause-effect relationships between genetic factors and the organism's growth.	Distractors may include statements that do not sufficiently explain; statements that explain alternate phenomena; or statements lacking critical conceptual connections.
2	**MC**	Identify the most likely evidence that supports conclusions related to the causes of different height in the plants.	Distractors may include statements explaining reasoning for other outcomes of distribution or erroneous explanations.
3	**MC**	Explain the probable relationship between the environment and the size difference of different animals.	Distractors may include alternate explanations for formation or rarity of resources or alternate statements with incomplete or invalid explanations.
4	**MC**	Identify the most likely explanation that matches the cause of the differential growth rate.	Distractors may include statements applying alternate mechanisms.
5	**MC**	Identify the evidence that best supports the explanation.	Distractors may include data that do not provide sufficient/valid evidence or data related to other formation processes.
6	**MC**	Describe the reasoning that connects the evidence to the explanation of the phenomenon.	Distractors may include statements including invalid/unsupported reasoning or reasoning for alternate phenomena.
7	**MC**	Identify which statement/clarification will best improve the explanation.	Distractors may include statements including invalid/unsupported reasoning or reasoning for alternate phenomena.
8	**TEI**	Drag and drop the evidence that supports the cause of the plant's extreme height.	Distractors may include evidence that does not support the cause of the phenomenon.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Genetics will always control the growth of organisms, regardless of environmental conditions.
- Plant growth is not controlled by genetics.
- Only animals inherit genes from their parents.

Heredity: Inheritance and Variation of Traits: 8.LS3.1

back to "Item Specifications by Performance Expectation"

8.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.

OAS-S Clarification Statement:

Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins. Examples include radiation-treated plants, genetically modified organisms (e.g., Roundup-resistant crops, bioluminescence), and mutations both harmful and beneficial.

OAS-S Assessment Boundary:

Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Developing and Using Models • Develop and use a model to describe phenomena.	**LS3.A: Inheritance of Traits** • Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of one 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 its traits. • 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.	**Structure and Function** • Complex and microscopic structures and systems can be visualized and modeled to describe how their function depends on the shapes, composition, and relationships among their parts; therefore complex natural structures/ systems can be analyzed to determine how they function.

In Lay Terms:

Mutations can introduce variations in traits in both sexual and asexual reproduction, which can be harmful, neutral, or advantageous for an organism. A mutation is a permanent change in the sequence of DNA whereby genetic information is altered. Changes (mutations) to genes can result in changes to proteins, which affect the structures and resulting functions of the organism's trait characteristics.

Heredity: Inheritance and Variation of Traits: 8.LS3.1

Cluster Clarifications:

- Develop and use a model to describe changes (mutations) to genes that can result in changes to proteins, which can affect both the structure and, as a result, the function of an organism, and thereby change its traits.
- Students develop a model in which they identify the relevant components for making sense of a given phenomenon involving the relationship between mutations and their effects on the organism.
- Students use the model to describe how beneficial, neutral, or harmful changes to protein function can cause beneficial, neutral, or harmful changes in the structure and function of organisms.
- To address the CCC and SEP, models should show how the structure is relating to the function of the protein or genes.
- Students use or make a model to show that genetic information can be altered because of the mutation.
- Students do not need to know the terms "transcription" and "translation" or understand protein synthesis mechanisms.
- Students do not need to understand the terms "codon," "triplet code," or "amino acids." Clusters should focus on a conceptual understanding that changes in the gene result in changes in the proteins, which relate to a change in traits.
- Using bioengineering to genetically modify animal and plant organisms should be avoided due to sensitivity issues.

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and/or data about structural changes
- diagrammatic models of genes, proteins, and/or traits

Possible contexts:

- dimples, heterochromia, freckles, cleft chin are all caused by mutations
- Williams syndrome is caused by deletions of genes on chromosome 7, which causes children to be social and friendly
- mutations that cause diseases, caused by deletions
- animals with albinism
- antibiotic-resistant bacteria
- seedless watermelon
- mutations caused by exposure to UV radiation

Content and evidence to be included: information/descriptions about genetic changes, traits, and/or models of proteins

Types of student responses that need to be supported: creating, completing, and/or improving models of structural changes; describing and interpreting these models with the focus on structure and function

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS3.1:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Describe the components that are shown/need to be shown by the model.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
2	**MC**	Describe the purpose of a model.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
3	**MC**	Use the model to predict the function based on the change in the structure. [Based on the model, how will the change in the gene affect the shape of the cells?]	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
4	**MC**	Complete the model to demonstrate the underlying concept.	Distractors may include incorrect concepts or a misinterpretation of the model.
5	**MC**	Revise the model to demonstrate the underlying concept about mutations causing changes to the organism.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
6	**MC**	Select the best model to describe/represent how changes to proteins can affect observable structures and functions in organisms.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
7	**MC**	Relate the model to its underlying concept: that each distinct gene has a certain sequence (code) that determines the structure of a specific set of proteins.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
8	**MC**	Explain *how* the data fit/support the model (i.e., are evidence for the model). [How do the data collected in this investigation support the model?]	Distractors may include explanations that incorrectly relate the data to the model.
9	**MC**	Identify evidence that supports the model. [Which evidence supports this model?]	Distractors may include evidence that is irrelevant or that can serve to reject the model.
10	**TEI**	Complete a model to show how the mutation affected the protein.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From mosamack.com/home/mutations/overview

- All mutations are bad.
- The meaning of the terms "DNA," "gene," and "chromosome."
- There is only one gene for every trait.
- All mutations that occur will be passed on to offspring.

Heredity: Inheritance and Variation of Traits: 8.LS3.2

back to "Item Specifications by Performance Expectation"

8.LS3.2. Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

OAS-S Clarification Statement:

Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause-and-effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

OAS-S Assessment Boundary:

The assessment should measure the students' abilities to explain the general outcomes of sexual versus asexual reproduction in terms of variation seen in the offspring.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Developing and Using Models • Develop and use a model to describe phenomena.	**LS1.B: Growth and Development of Organisms** • Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. **LS3.A: Inheritance of Traits** • Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. **LS3.B: Variation of Traits** • In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.	**Cause and Effect** • Cause-and-effect relationships may be used to predict phenomena in natural systems.

In Lay Terms:

Students learn the difference between sexual and asexual reproduction. Sexual reproduction is the production of new living organisms by combining genetic information from two individuals of different types (sexes). Genetic information is transferred to the offspring through egg and sperm cells. Variations of those inherited traits between the parent and offspring arise from those genetic differences. Using a model to show those differences would be beneficial. In asexual reproduction, the offspring normally results in identical genetic information.

Heredity: Inheritance and Variation of Traits: 8.LS3.2

Cluster Clarifications:

- Students develop a model for a given phenomenon involving the differences in genetic variation that arise from sexual and asexual reproduction. In the model, students identify and describe the relevant components.
- During reproduction (both sexual and asexual), parents transfer genetic information in the form of genes to their offspring.
- Under normal conditions, offspring have the same number of chromosomes, and therefore genes, as their parents.
- Students use the model to describe a causal account for why sexual and asexual reproduction result in different amounts of genetic variation in offspring relative to their parents.
- Students use cause-and-effect relationships found in the model between the type of reproduction and the resulting genetic variation to predict that more genetic variation occurs in organisms that reproduce sexually compared to organisms that reproduce asexually.
- Punnett squares should only be used in the context of describing a phenomenon.
- Items using Punnett squares or pedigrees should only assess inheritance of one trait at a time.
- Inheritance should be limited to dominant/recessive traits. Co-dominance and incomplete dominance are beyond the scope of the standard.
- Students may be presented with the concept of parthenogenesis, but they do not need to know the term.

Cluster Stimulus Attributes:

Typical stimulus elements:

- diagrams/models that illustrate a causal relationship as to why sexual and asexual reproduction result in different amounts of genetic variation
- data on offspring and whether their genetic makeup is the same as the parent(s)
- comparing data between sexual and asexual reproduction

Possible contexts:

- comparison of asexual and sexual reproduction in plants/fungi (spider plants, ferns, or molds compared to flowering plants which illustrate transfer of pollen)
- certain fungi, plants, and animals that can undergo sexual and asexual reproduction
- parthenogenesis in organisms
- diagrams that compare inherited traits on offspring from sexual and asexual reproduction

Content and evidence to be included: information/descriptions/models about traits of organisms that result from both sexual and asexual reproduction, models of genes, gametes, and zygotes

Types of student responses that need to be supported: creating, completing, and/or improving models of the outcomes of sexual and asexual reproduction

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS3.2:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Describe the components that are shown/need to be shown by the model.	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
2	**MC**	Identify relationships between inputs and outputs of a model. [Based on the model, which statement describes the relationship between the type of reproduction and the variation of traits in the offspring?]	Distractors may contain statements describing a misunderstanding of what is causing the differing traits in offspring.
3	**MC**	Complete the model to explain the transfer of genetic information to offspring via asexual reproduction.	Distractors may include misinterpretations of the model or incorrect modeling of asexual reproduction.
4	**MC**	Revise the model to predict the genetic makeup of the possible offspring resulting from the cross.	Distractors may include incorrect predictions.
5	**MC**	Select the best model to describe/represent the two different types of reproduction.	Distractors may include models that show common misconceptions.
6	**MC**	Relate the model to its underlying concept about cause/effect relationship between reproduction type and variation of traits.	Distractors may include statements that include misconceptions or misinterpretations of the model.
7	**MC**	Explain *how* the data fit/support the model (i.e., are evidence for the model).	Distractors may include explanations that incorrectly relate the data to the model.
8	**MC**	Identify evidence that supports the model. [Which evidence supports this model?]	Distractors may include evidence that is irrelevant or that can serve to reject the model.
9	**TEI**	Complete the model to show the expected number of offspring with a certain trait.	Drag-drop interaction Correct responses show the model filled out with the correct traits. Partial credit would be given for responses that have correct responses for some of the traits.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From oksciencefamework.pbworks.com/w/page/121762230/Seventh%20Grade%20Heredity

- Sexual reproduction is always advantageous over asexual reproduction.
- Genetic variation in offspring cannot be predicted.
- All organisms reproduce in the same way.

Biological Unity and Diversity: 8.LS4.1*

back to "Item Specifications by Performance Expectation"

8.LS4.1. Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth.

OAS-S Clarification Statement:

Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers. The natural laws that operate today are assumed to operate as they have in the past.

OAS-S Assessment Boundary:

Assessment does not include the names of individual species or geological eras in the fossil record.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Analyze and Interpret Data • Analyze and interpret data to determine similarities and differences in findings.	**LS4.A: Evidence of Common Ancestry and Diversity** • The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found) 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.	**Patterns** • Graphs and charts can be used to identify patterns in data.

In Lay Terms:

Students should be able to transform and analyze data related to fossils to describe patterns and draw conclusions. As fossils are a record of past life, information about the relative abundance, location, and type of fossils found in different locations can be used to make inferences about life in the past, how life has changed over time, and how living things are related.

Cluster Clarifications:

- The terms "change of life" or "change over time" should be used in place of the term "evolution."
- Do not use symmetrical population graphs of fossil abundance to show changes in number of organisms.
- Do not include radioactive/absolute dating, or the difference between relative and absolute age (focus on relative age only).
- Students are not responsible for memorizing names of eras or fossils, but items may use these terms if defined.
- Students are responsible for understanding the concept of the law of superposition, but do not need to know it by name.
- Although items in a cluster may incorporate the ideas of relative ages or rock layers and fossils embedded in them, the stimulus and majority of items in a cluster should focus on patterns of changes in abundance and extinction of organisms.

**associated sample cluster included*

Biological Unity and Diversity: 8.LS4.1*

Cluster Stimulus Attributes:

Typical stimulus elements:

- diagrams
- tables
- charts
- graphs or text descriptions of fossil evidence

Possible contexts:

- diagrams of outcroppings/formations (or comparisons of outcroppings) showing fossils in each layer and magma intrusions
- maps of locations of fossils
- geological timelines
- partial diagrams or table of rock layers; students place fossils based on relative complexity of structures already shown in diagram
- tables showing progressions of a family of fossils over time to show growth in complexity
- graphs, tables, and diagrams showing changes in diversity or abundance of fossils; graphs showing changes in environmental conditions; graphs showing rates of extinction
- Locations for fossils in Oklahoma include, but are not limited to:
  - Lake Texoma
  - Arbuckle Mountains (Devonian trilobites and brachiopods in limestone formation)
  - Criner Hills
  - Turner Falls
  - Black Mesa dinosaur trackway
  - Freedom, OK

Content and evidence to be included: fossil and geological data related to existence, diversity, extinction, and change of organisms over time

Types of student responses that need to be supported: completing data transformations; identifying patterns and conclusions from data; and making inferences about changes in organisms over time

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS4.1:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Interpret/read data in tables, graphs, and diagrams (about complexity, diversity, extinction, distribution, relative age). [Based on the data in the graph and table, in what era did crinoids become extinct?]	Distractors may include misinterpretations resulting from incorrect reading of the graph/ table/diagram, or other data points found in the stimulus.
2	**MC**	Describe simple patterns and trends in tables, graphs, and diagrams (about complexity, diversity, extinction, distribution, relative age). [Based on the data in the graph and table, how did crinoids (diversify) over time?] [Which rock layer shows a dramatic decrease in the number of fossil species that can be observed?]	Distractors may include responses indicating incorrect understanding of trends and patterns.
3	**MC**	Transform tabular or text-based data related to fossil appearance/extinction into the form that best emphasizes the patterns within the data (to show change over time or similarities or differences in data sets). [Which graph should be used to most clearly show the difference between these two groups of fossils?] [Which graph is best for showing the changes within this family of fossils?] [Which timeline correctly shows the appearance of the organisms over time?]	Distractors may include graphs that are better suited to other functions, such as scatterplot, bar graph, histogram, or pie graph.
4	**MC**	Draw specific conclusions about the existence, diversity, extinction, and changes in life forms from data presented in tables, graphs, and diagrams. [What can be concluded about the relative age of these fossils?] [Based on the information shown in the diagram, during which time period were (name of fossil group) most abundant?] [Based on the evidence presented in the rock layer diagram, which fossils are most likely to be found in layer X?] [The diagram shows rock layers containing members of the echinoid family, relatives of modern sea urchins and sand dollars. What can be concluded about the complexity of this family from the diagram?]	Distractors may include conclusions that result from incorrect interpretations of the trends or patterns found in the data.

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
5	**MC**	Describe the data needed to support a given conclusion. [Which data support the conclusion that echinoids diversified into several species before many became extinct?] [Which additional data would be needed to support the idea that the species shown in layer X is the ancestor of the organisms shown in layer W?]	Distractors may include irrelevant data, data that are less useful in supporting the conclusion, or data that actually refute/reject the conclusion.
6	**MC**	Explain *how* specific data support a given conclusion. [How do the data about forams support the conclusion that a die-off of many fossils occurred 100 million years ago?]	Distractors may include explanations that misinterpret the pattern seen in the data.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Geological time/scale may be problematic for students. For example, comprehending the length of time it takes for mountains to erode is difficult for some students.
- Students may define fossils as preserved dead organisms. Many students do not understand that fossils may include evidence such as a portion of remains, impressions, tracks and traces, or that the matter making up an organism may be replaced over time by minerals.
- Students believe that fossils cannot tell us about the environment in which plants or animals lived long ago.

From beyondpenguins.ehe.osu.edu/issue/learning-from-the-polar-past/common-misconceptions-about-fossils-and-the-history-of-the-polar-regions:

- Fossils are pieces of dead animals and plants.
- Fossils of tropical plants cannot be found in cold or dry areas.
- Fossils only represent bones and shells of extinct animals. Soft tissue can never be fossilized.

From education.msu.edu/irt/PDFs/ResearchSeries/rs165.pdf:

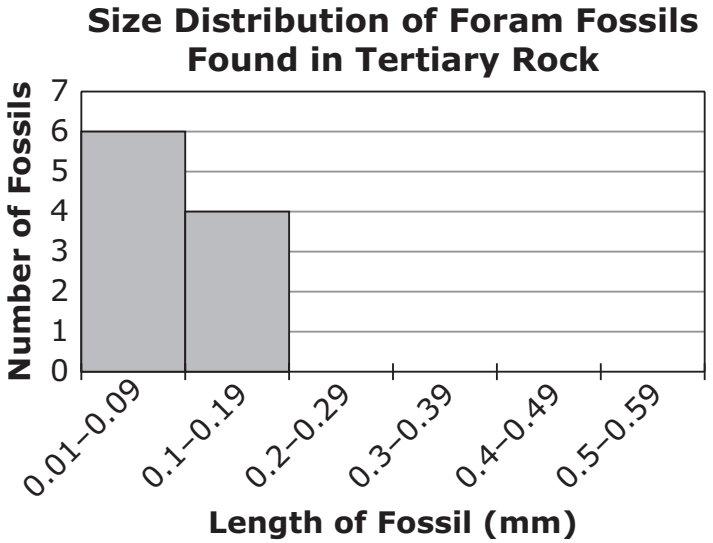
- Organisms develop new traits because they need them to survive.
- A species changes because its members use or fail to use certain body organs or abilities.
- Change occurs to all members of a species.
- The environment directly causes changes to members of a species.
- Traits change progressively in quality as they are passed down to generations of offspring.

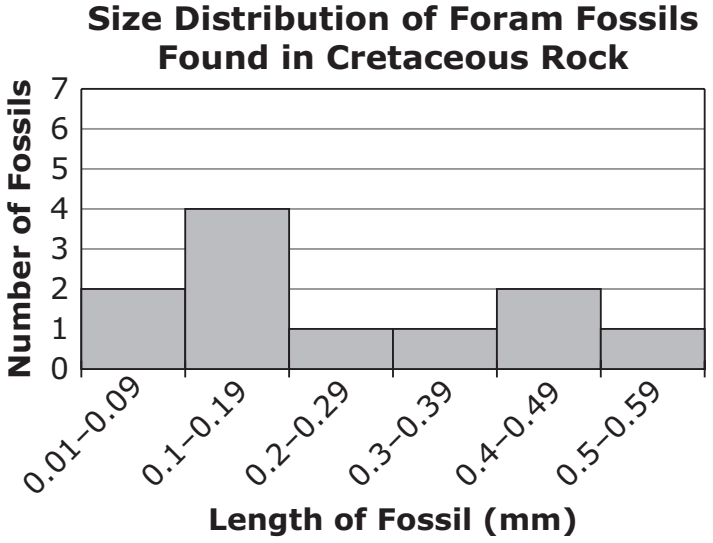
Sample Cluster for 8.LS4.1:

Use the information to answer the following questions.

To answer questions about Earth's history, students looked at rock samples from different layers of the ocean floor. The rock samples contained fossils of very small ocean organisms called forams.

Some of the rock formed during the Cretaceous time period from 145.5 to 65.5 million years ago, before an event called the K-T extinction. The rest of the rock formed during the Tertiary time period from 65.5 to 35.4 million years ago, after the K-T extinction. In their investigation, the students measured the lengths of the foram fossils in the rock samples. The graphs show the size ranges of the foram fossils in rock samples from each time period.





(Items on the following pages)

1 **Which statement is supported by the data in the two graphs?**

A Forams of all sizes had more food sources in the Cretaceous period.

B Forams with a larger size had more predators in the Cretaceous period.

C Forams with a smaller size had a survival advantage in the Tertiary period.

D Forams that were mid-sized had a higher reproductive rate in the Tertiary period.

Standard: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

Cognitive Complexity:
SEP: High
DCI: High
CCC: Low
Overall Cognitive Complexity: Low Support

Distractor Rationale:
A. The student may think that the greater variety of Cretaceous forams indicates that were more food sources.
B. The student may think that the greater variety of Cretaceous forams indicates that were more predators.
C. Correct. The average foram size decreased in the Tertiary period which indicates that smaller size was an advantage.
D. The student may read the Cretaceous graph and may think the data reflects reproductive rates.

2 **Based on the information, how are the foram fossils from the two time periods different?**

A The Cretaceous fossils are found in more locations than the Tertiary fossils.

B The Cretaceous fossils show a greater variety of body size than the Tertiary fossils.

C The Cretaceous fossils were more successful than Tertiary fossils at surviving the K-T extinction.

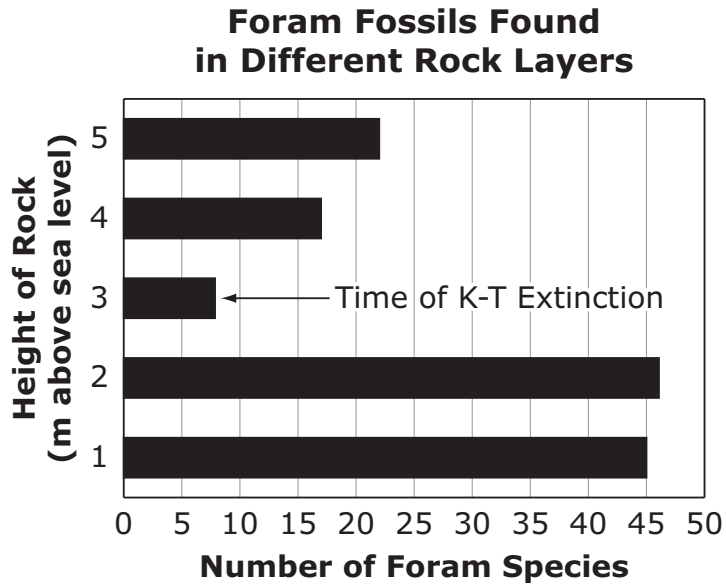
D The Cretaceous fossils became more common and the Tertiary fossils disappeared from the fossil record.

Standard: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

Cognitive Complexity:
SEP: Med
DCI: Low
CCC: Low
Overall Cognitive Complexity: Moderate Support

Distractor Rationale:
A. The student may think that the different rocks come from different locations.
B. Correct. The Tertiary graph shows sizes only from 0.01–0.19 mm, while the Cretaceous graphs shows sizes from 0.01–0.59 mm.
C. The student may be confused regarding the timing of the K-T extinction.
D. The student may think that the zero values in the graph indicate that the fossils disappeared.

3 The students also gathered data about the number of fossilized foram species in rock layers at different heights above sea level from the Cretaceous and Tertiary time periods.



What is the most likely reason for the difference in the number of foram species in the layers from 3 to 5 meters above sea level?

A Individual forams became different species until the time of the K-T extinction.

B The number of foram species decreased steadily until the time of the K-T extinction.

C The surviving foram species diversified to fill the available habitats after the K-T extinction.

D Several foram species moved from other parts of the world to this location after the K-T extinction.

Standard: Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

Cognitive Complexity:
SEP: High
DCI: High
CCC: Med
Overall Cognitive Complexity: Low Support

Distractor Rationale:
A. The student may think that individuals become different species.
B. The student may think that moving down from the surface is going forward in time rather than in reverse.
C. Correct. The number of species increases from layer 3–5 indicating that diversification occurred.
D. The student may think that migration is the most likely explanation.

Biological Unity and Diversity: 8.LS4.2

back to "Item Specifications by Performance Expectation"

8.LS4.2. Apply scientific ideas to construct an explanation for the patterns of anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer ancestral relationships.

OAS-S Clarification Statement:

Emphasis is on explanations of the ancestral relationships among organisms in terms of similarities or differences of anatomical features or structures. Examples could include how structural similarities/differences could determine relationships between two modern organisms (i.e. wings of birds vs. bats vs. insects) or modern and fossil organisms (i.e. fossilized horses compared to modern horses, trilobites compared to horseshoe crabs).

OAS-S Assessment Boundary:

Assessment does not include the names of individual species or geological eras in the fossil record.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Constructing Explanations • Construct a scientific explanation based on valid and reliable evidence.	**LS4.A: Evidence of Common Ancestry and Diversity** • The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found) 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. • Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record serve as evidence of ancestral relationships among organisms and changes in populations over time.	**Patterns** • Graphs and charts can be used to identify patterns in data.

In Lay Terms:

Students should be able to incorporate scientific ideas to analyze anatomical structures and use this data to explain relatedness and ancestry of organisms.

Cluster Clarifications:

- Use the term "reject" in place of "refute."
- Avoid analysis of primate and hominid data.
- At this grade level, anatomy should be the focus of comparisons, not DNA or protein similarities.
- Avoid the term evolution. Use "changes in species" or "change over time" or "adaptation."
- Avoid high school terminology such as adaptive radiation, homologous and analogous, fitness.
- Do not use cladograms or phylogenetic trees.
- Common names should be used where applicable. Students should not be expected to know names of geologic areas or scientific species names, however, both can be given to students within the stimulus.

Biological Unity and Diversity: 8.LS4.2

Cluster Stimulus Attributes:

Typical stimulus elements:

- diagrams including anatomical similarities
- data tables and graphs showing fossil abundance and distribution
- text-based descriptions of anatomy, fossil abundance, and distribution

Possible contexts:

- changes (or lack of changes) in fossil anatomy over time (e.g., changes in ammonoid suture lines [as found in samples from Oklahoma's Lake Texoma]; John Day [Oregon] horse fossils; sharks)
- comparison of fossils found in deep and shallow water to show changes in fossils (e.g., why does fossil sequence show development of legs?)
- comparisons of diversity among plant fossils over time, or comparisons of diversity of plant fossils and existing plants (e.g., fossil of gingko and environment where one would find it today—what can be inferred about past environment?)
- modern anatomical comparisons (e.g., similar forearm structure in bird, bat, frog)

Content and evidence to be included: data related to anatomical characteristics of different organisms, as well as their locations, abundance, time period, etc.

Types of student responses that need to be supported: using evidence and reasoning to explain patterns in relatedness and ancestry of organisms, and/or the relationship between species change and environmental change

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS4.2:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Analyze data to infer the relatedness among modern organisms. [Based on the characteristics shown in the table, which two organisms are most distantly related?] [What can be concluded from the students' analysis of the skeletal structures in a snake and lizard?] [Which of the following inferences can be made about relatedness of organisms using the data in the table?]	Distractors may include inferences that are weakly supported by the evidence (e.g., similar size, similar location, similar color) or are unrelated or contradictory to the evidence.
2	**MC**	Identify which statement/clarification will best improve the explanation of relatedness or ancestry of species. [A student inferred that whales and cows are closely related because they have similar body structures. Which statement improves upon the student's explanation?]	Distractors may include information/ data/trivial statements that do not provide an improved explanation.
3	**MC**	Infer the relatedness among modern and fossil organisms. [The diagram shows the structures found in modern and extinct reptiles. What can be inferred from the differences in these structures?] [Based on the information shown, which two species are most closely related to (extinct organism)?] [Based on the diagram, what is the most recent ancestor of species (X) and (Y)?]	Distractors may include inferences that are weakly supported by the evidence (e.g., similar size, similar location, similar color) or are unrelated or contradictory to the evidence.
4	**MC**	Relate changes in species to changes in environmental conditions. [Based on the description of the environmental changes, which statement explains the characteristics of the plant labeled X compared to the plant labeled Y?]	Distractors may include characteristics or explanations based on misconceptions or unrelated changes.
5	**TEI**	Relate changes in species to changes in environmental conditions. [The table shows changes to the environment in eastern Oregon over past years. Based on the data, select the features that would be expected for a horse living 26 million years ago.]	TEI interaction is hot-spot. Correct responses show all correct identifications. Partial credit would be given for a subset of correct responses.
6	**MC**	Use multiple sources of evidence to explain the causes of specific adaptions. [Based on the data presented, explain what accounts for the difference in beak shape for Galapagos finches.]	Distractors may include statements explaining reasoning for other outcomes, or erroneous explanations.

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
7	**MC**	Identify the evidence that supports the given explanation for how two species (modern, or modern and fossil) are related. [The diagram shows a drawing and information about an extinct crinoid and a modern-day sea fan. Which piece of evidence best supports the inference that these two organisms are related?] [Which evidence best supports the inference that organisms X and Y are more closely related than organisms Y and Z?]	Distractors may include data that does not provide sufficient/valid evidence or which contradicts the explanation.
8	**MC**	Describe the reasoning that connects the evidence of body structures to a conclusion about relatedness or ancestry of species. [Which statement describes the reasoning that led a student to conclude that butterflies and skippers are more closely related than moths and butterflies?]	Distractors may include statements including invalid/unsupported reasoning or valid/supported reasoning for alternate hypotheses or phenomena.
9	**MC**	Describe the reasoning that connects changes over time in anatomical features to lines of evolutionary descent. [Which statement describes the reasoning that led the group to conclude that Primelephas is the most recent extinct ancestor of African elephants?]	Distractors may include statements including invalid/unsupported reasoning or valid/supported reasoning for alternate hypotheses or phenomena.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Earth and space science have a unique aspect of scale that may be problematic for students. For example, comprehending the length of time it takes for mountains to erode is difficult for some students.
- Fossils are the remains of dead organisms. Many students do not understand that fossils also include other types of evidence such as tracks and traces.
- Fossils cannot tell us about the environment in which plants or animals lived long ago.
- Species that are similar can share a common ancestor, but species that have no apparent, obvious, or superficial similarities cannot share a common ancestor.
- Members of different species do not share a common ancestor.
- Species that have no apparent, obvious, or superficial similarities have no similarities at all.
- Plants and animals cannot share a common ancestor.

Biological Unity and Diversity: 8.LS4.3

back to "Item Specifications by Performance Expectation"

8.LS4.3. Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

OAS-S Clarification Statement:

Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance in diagrams or pictures.

OAS-S Assessment Boundary:

Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Analyze and Interpret Data • Analyze and interpret data to determine similarities and differences in findings.	**LS4.A: Evidence of Common Ancestry and Diversity** • Comparison of embryological development of different species also reveals similarities that show relationships not evident in the fully formed anatomy.	**Patterns** • Graphs and charts can be used to identify patterns in data.

In Lay Terms:

During embryological development, organisms across multiple species can have similarities. Students should be able to analyze images comparing embryo development of different species to identify relationships among organisms.

Cluster Clarifications:

- Haeckel's diagrams should be avoided for scientific accuracy. Instead, use representations of embryos that are derived from primary research pictures.
- Students are not expected to identify organisms by name based on embryological images. Identifying information must be provided so that students are only required to analyze images for patterns.
- Students should recognize genetic relatedness and evidence of common ancestry between organisms based on analyzing patterns in embryological development.
- Students may be asked to infer relatedness between organisms using both embryological development and the analysis of displays of pictorial data (e.g. graphs and/or charts).
- Human embryos should be excluded for sensitivity issues.

Cluster Stimulus Attributes:

Typical stimulus elements:

- diagram of embryological development in several different species

Possible contexts:

- the development of limb structures in different organisms that are relevant to a student's observation
- comparison of embryo development in a variety of organisms
- multiple stages of embryological development in different organisms that a student analyzes to understand differences between embryo (e.g., gill slits, tails, digit webbing) and adult anatomical characteristics

Content and evidence to be included: diagrams showing embryos/embryological development

Types of student responses that need to be supported: analyzing patterns in embryological images; inferring relationships from patterns in anatomical structures; describing how the patterns in anatomical structures indicate relatedness and common ancestry

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS4.3:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Interpret or analyze the similarity in patterns between embryos of different species. [Which statement explains the similarity in patterns between embryos?]	Distractors may contain statements describing genetic similarities between embryos rather than anatomical similarities in features.
2	**MC**	Explain how patterns in embryological development indicate common ancestry between organisms. [Which statement explains how patterns in embryos indicate common ancestry between organisms?]	Distractors may contain information about the embryos that is irrelevant to what the patterns indicate about common ancestry.
3	**MC**	Explain how an embryo diagram provides evidence that two or more organisms are related. [Which description about the relatedness between organisms is supported by evidence in the embryo diagram?]	Distractors may contain information about the organisms that is not evidenced from the embryo diagram or information that does not provide evidence of relatedness.
4	**MC**	Explain why evidence of relatedness in adult organisms cannot be determined only with physical features. [Which explanation describes why comparing the physical features of adult organisms alone cannot determine evidence of relatedness?]	Distractors may contain misconceptions that species without any superficial or obvious similarities cannot be similar or share common ancestry.
5	**TEI**	Select words that describe the similarities and differences in physical features between several organisms.	Drag-drop interaction Correct responses show all the words describing the similarities and differences in physical features between several organisms.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- An organism's genetic code can change during its lifetime as the organism develops.
- Different species do not share a common ancestor.
- Species that have no apparent, obvious, or superficial similarities have no similarities at all.
- Species that are similar can share a common ancestor, but species that have no apparent, obvious, or superficial similarities cannot share a common ancestor.
- Plants and animals cannot share a common ancestor.

From www.caaspp.org

- Embryos of different species always look very different.
- Embryos of a single species look the same at every stage.

Biological Unity and Diversity: 8.LS4.4

back to "Item Specifications by Performance Expectation"

8.LS4.4. Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.

OAS-S Clarification Statement:

Emphasis is on using simple probability statements and proportional reasoning to construct explanations for why in a specific environment impacted by different factors (e.g., limited food availability, predators, nesting site availability, light availability), some traits confer advantages that make it more probable that an organism will be able to survive and reproduce there.

OAS-S Assessment Boundary:

N/A

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Constructing Explanations • Construct an explanation that includes qualitative or quantitative relationships between variables that predict and/or describe phenomena.	**LS4.B: Natural Selection** • Natural selection leads to the predominance of certain traits in a population and the suppression of others.	**Cause and Effect** • Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

In Lay Terms:

In every population, there is natural variation between organisms. Some variations can result in traits that increase the probability that organisms with those traits survive and reproduce. Students should be able to explain how a given trait is advantageous for an organism's survival and reproduction in a specific environment.

Cluster Clarifications:

- Items can focus primarily on differential survival rather than reproduction where appropriate, or vice versa.
- Evidence that students could use to construct an explanation includes data on predator threat, effects of environmental change on populations, change in a population's traits over time (life stages), species-specific characteristics within a population, or any other data connecting the traits of organisms in a population to factors that affect survival and reproduction.
- Students are not expected to calculate probability but rather to construct and/or choose explanations that describe the relative likelihood (more, less) of individuals surviving and/or reproducing.
- Students should not be expected to know the term "natural selection" but should understand the concepts of natural selection.

Biological Unity and Diversity: 8.LS4.4

Cluster Stimulus Attributes:

Typical stimulus elements:

- graphs showing survival or reproduction rate in relation to specific environmental factors
- graphs showing environmental factors changing over time
- graphs showing the frequency of a trait in a population

Possible contexts:

- organism with a particular trait more likely to survive and reproduce than an organism of the same species in the same population
- a population with a particular trait affected by an environmental change that makes one variant of that trait more advantageous than another variant of that trait
- changes in available resources that affect the probability of surviving and reproducing in a specific environment
- introduction or removal of a species and its effect on a population's survival and reproduction (Jackson's chameleons, rabbits and disease outbreak)

Content and evidence to be included: information about environmental factors affecting a population/ specific traits/survival or reproduction rate in a population

Types of student responses that need to be supported: constructing explanations that are supported by evidence (data, information in graphs); explaining how a population may change depending on a change in an environmental factor and/or resource

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS4.4:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Select a statement that supports a claim about how an environmental factor affects the frequency of a trait in a population. [Which statement supports the claim that the change in atmospheric carbon dioxide caused an increase in the number of organisms with the heat-resistance gene?]	Distractors may contain statements that do not support the claim or misconceptions of how the heat-resistance gene could become more common in a population.
2	**MC**	Based on information about an environmental factor and adaptations in a population, identify evidence that would explain how a related environmental factor could affect a population over time. [Which evidence explains how the rabbit population could be affected by an increase in seasonal rainfall over time?]	Distractors may contain statements describing a misconception about how evolution can occur in a population over time or information that does not provide evidence of how a population could be affected by an environmental change.
3	**MC**	Select a statement about the population that is supported by the data. [Which statement about changes in the fly population is supported by the data?]	Distractors may contain statements that misinterpret what the data show or information that contains misconceptions about how natural selection occurs.
4	**MC**	Explain the relationship between traits that arose because of changes in the environment. [Which statement explains the relationship between the fur color trait in mice and foxes?]	Distractors may contain statements that are not relevant to both occurring as a result of natural selection or misconceptions about how natural selection occurs.
5	**MC**	Select the factor that could contribute to an adaptation arising in a population. [Which factor could cause an adaptation to arise more rapidly in a population?]	Distractors may contain factors that would not contribute to adaptations becoming more common over time in a population.
6	**MC**	Explain which evidence from the data explains how natural selection occurred in a population. [Which evidence from the data explains why the average thickness of shells in the snail population changed over time?]	Distractors may contain information that cannot be derived from the data or information that is irrelevant to explaining the trend in the data concerning natural selection.
7	**TEI**	Select the statement that explains how a change in the environment affects the frequency of a trait in a population. [As the amount of fox habitat in the area increases, the frequency of rabbits with the spotted fur trait would likely [**increase**, decrease] over time because these rabbits are [**more**, less] likely to survive and reproduce than rabbits without the trait.]	Inline-choice interaction Correct responses show that the frequency of a trait in a population is affected by factors that influence whether individuals with specific traits are more likely to survive and reproduce.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Changes to the environment cannot lead to changes in the traits of species living in that environment.
- Change occurs in the inherited characteristics of populations of organisms over time because organisms observe other, more successful organisms and model their appearance or habits.
- Evolution happens when individual organisms acclimate or "get used to" new conditions gradually.
- Changes in a population occur through a gradual change in all members of a population, not from the survival of a few individuals that preferentially reproduce.
- Change occurs in the inherited characteristics of a population of organisms over time because of the use or disuse of a particular characteristic.
- Individual organisms can deliberately develop new heritable traits because they need them for survival.
- All members of a population are nearly identical.
- The internal chemistry, appearance, and behavior of a species do not change, even over long periods of time.

From www.caaspp.org

- Natural selection occurs within an organism's lifetime.

Biological Unity and Diversity: 8.LS4.5

back to "Item Specifications by Performance Expectation"

8.LS4.5. Gather and synthesize information about the practices that have changed the way humans influence the inheritance of desired traits in organisms.

OAS-S Clarification Statement:

Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy) and on the impacts these practices have on society, as well as the technologies leading to these scientific discoveries.

OAS-S Assessment Boundary:

The assessment should provide evidence of students' abilities to understand and communicate how technology affects both individuals and society.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Obtaining, Evaluating, and Communicating Information • Gather, read, and synthesize information from multiple appropriate sources; assess the credibility, accuracy, and possible bias of each publication and methods used; and describe how they are supported or not supported by evidence.	**LS4.B: Natural Selection** • 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. **ETS1: 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.	**Cause and Effect** • Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

In Lay Terms:

Over time, humans have developed technologies to genetically modify organisms, selecting for desirable traits that are important for industries that societies depend on.

Biological Unity and Diversity: 8.LS4.5

Cluster Clarifications:

- Students are not expected to know specific details of a process by which humans modify organisms, but students are expected to know how this technology affects individuals and society.
- Students may be expected to analyze information about a technology to explain how individuals and society used a technology for a specific purpose.
- Students may be expected to describe how a technology affects the organisms that are being modified using provided information.
- Students may be expected to compare the outcomes and limitations of different technologies that modify organisms genetically as part of a response, but only if information on both technologies is provided to the students.
- Students should be able to determine how humans can affect the traits of animals through selective breeding.
- Students can choose desired parental traits determined by genes which are then passed on to offspring.
- Technology is the application of scientific knowledge for practical purposes. The technology does not need to be complex or recently developed.
- RNAi is a form of genetic modification that students are not expected to know, but it could be a relevant technology with outcomes for society that students could analyze, provided the students are given information on RNAi.
- The focus of this PE is on how these technologies affect society. Therefore, genetic human disease/condition contexts can only be used if it is clear that the purpose of the technology is to improve the human quality of life, improve treatment plans, make medical treatment less expensive, etc.

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and/or diagrams illustrating how humans use a given technology to modify organisms

Possible contexts:

- artificial selection or selective breeding scenarios concerning livestock, domestic animals (e.g., dogs, cats, rabbits, etc.), and farm crops
- gene therapy technologies for certain genetic conditions in humans and organisms that humans depend on
- genetic modification in food crops

Content and evidence to be included: information/descriptions about the technology in question and how it impacts human society

Types of student responses that need to be supported: explaining and/or comparing the impact of technologies on how humans modify organisms; describing the advantages and disadvantages of a given technology for a specific outcome that affects human society; analyzing diagrams that show a technology to explain why it results in a given outcome

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS4.5:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Describe how humans used a given technology to produce organisms with desired traits. [Which statement about the process of gene therapy in the diagram describes how scientists produced pesticide-resistant crops?]	Distractors may contain misinterpretations of the diagram and its components, particularly tied to misconceptions about how this technology would result in organisms with traits desired by humans.
2	**MC**	Select a statement that describes how a technology allows humans to genetically modify organisms. [Which statement describes a result of the gene modification process in the diagram?]	Distractors may contain statements that do not represent how this technology affects human society by allowing humans to select for desired traits in organisms.
3	**MC**	Compare two technologies that humans use to produce organisms with desired traits. [Based on the diagram, which statement describes the student's claim about animal husbandry and artificial selection?]	Distractors may contain statements about the student's claim that are incorrect or an inaccurate statement about how the two technologies compare.
4	**MC**	Describe how one technology has an advantage over another technology in terms of the outcome humans want for society. [Which statement describes an advantage of artificially selecting plants instead of genetically engineering those plants?]	Distractors may contain statements that describe a disadvantage or do not accurately compare the two technologies.
5	**MC**	Describe one way that a technology has impacted society. [Based on the diagram, which statement describes one way that artificial selection has impacted society?]	Distractors may include statements that incorrectly describe artificial selection or misinterpret the information the diagram indicates about the impact of artificial selection on society.
6	**TEI**	Complete a table that compares the advantages of two technologies (gene therapy, artificial selection) humans can use to modify organisms.	Drag-drop interaction Correct responses show each technology associated with advantages specific to that technology.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Some characteristics of an offspring are determined by the parents' environmentally acquired characteristics.
- Offspring resemble parents because trait-bearing "particles" are transferred from parents to offspring during reproduction (e.g., particles of blue for blue eyes).
- In sexually reproducing organisms, genetic information or traits are inherited from only one parent.
- How old an organism is when it acquires an environmentally induced characteristic will affect whether the characteristic is passed on to its offspring. (For example, if a parent lost a finger as a child, they will pass the missing-finger trait to their children, but if they lost their finger as an adult, they will not pass the missing-finger trait to their children.)
- Each parent contributes genetic information for certain characteristics and not others. (For example, an offspring has a trait from one parent and a different trait only from another parent.)

From www.caaspp.org

- Artificial selection is bad for organisms.
- Selection against a species means the species will become extinct.

Biological Unity and Diversity: 8.LS4.6

back to "Item Specifications by Performance Expectation"

8.LS4.6. Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

OAS-S Clarification Statement:

Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.

OAS-S Assessment Boundary:

The assessment should provide evidence of students' abilities to explain trends in data for the number of individuals with specific traits changing over time. Assessment does not include Hardy-Weinberg calculations.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Using Mathematics and Computational Thinking • Use mathematical representation to describe and/or support scientific conclusions and design solutions.	**LS4.C: Adaptation** • 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 change.	**Cause and Effect** • Phenomena may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.

In Lay Terms:

The differential survival and reproduction of organisms in a population can lead to advantageous traits becoming more common in a population over time, while traits that are not advantageous may become less common in a population over time.

Cluster Clarifications:

- Data shown by mathematical models (e.g., graphs with specific numbers, percentages) which relate selective factors in the environment (climate, predation) to changes in the distribution of a specific trait in a population in the same time period need to be provided for students to make the connection between environmental changes and adaptations in populations.
- Assessment of this Performance Expectation primarily focuses on the changing distribution of traits among individuals in a population, so any description of differential survival between organisms needs to be stated in terms of how that affects the frequency of traits in the entire population over time.
- Trends in provided mathematical data should be clear enough for students to describe direct relationships between changing environmental conditions and the frequency of an adaptive trait. Raw data in a graph can be provided, but if the data points are erratic, a trendline should be provided on the graph.
- No questions about human or primate populations.

Biological Unity and Diversity: 8.LS4.6

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and/or graphs that show the distribution of a trait in a population over time and the change in a related environmental condition over the same time
- diagrams that show data about the population in question (geographical distribution, population size) relating how natural selection may lead to increases and decreases of specific traits in populations over time
- numerical descriptions or data tables displaying information about a population

Possible contexts:

- a population of organisms with certain feather or fur colors is affected by a change in the environment in terms of camouflage, with certain feather or fur colors becoming more common in a certain environment
- an adaptation that helps organisms in a population better locate food is related to an environmental change in conditions that affect food sources
- a trend in the frequency of a specific trait in a population is related to changing environmental conditions, with students drawing conclusions about the adaptive trait and the change
- changes in competition within a species or with other species for resources that lead to an increase or decrease of specific traits in a population over time
- plants becoming herbicide-resistant
- plant populations becoming metal-tolerant in contaminated soil

Content and evidence to be included: graphs and/or diagrams about the frequency of traits in a population and related changes in environmental conditions over time

Types of student responses that need to be supported: explaining trends in data on traits in a population and environmental change; selecting evidence that supports claims about trends in data; making conclusions about the relationships between multiple sets of data; predicting how a trend between the frequency of traits and an environmental change could be applied to other organisms with similar traits

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.LS4.6:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Select a claim about natural selection that is supported by information in the graph. [Which claim is supported by information in the graph?]	Distractors may contain misconceptions about natural selection, misinterpretations of the data, or information that is not indicated by the data.
2	**MC**	Identify evidence in a graph that explains how adaptation by natural selection occurred in a population. [Which evidence from the graph explains how adaptation by natural selection occurred in the squirrel population?]	Distractors may contain information that does not provide evidence of adaptation by natural selection or information that illustrates a misconception of adaptation by natural selection.
3	**MC**	Make a conclusion using data about how an environmental change affects the distribution of traits in a population. [Based on the data, which conclusion describes how the population of foxes will be affected by the change in habitat over time?]	Distractors may contain information that inaccurately describes what the data represents or how the population would be affected, including misconceptions concerning how an environmental change would affect the distribution of certain traits in the population.
4	**MC**	Identify evidence that supports a student's claim about an adaptation in a population. [Which evidence would support the student's claim that the proportion of beetles with the green color trait will increase in the population over time?]	Distractors may contain information that would not provide evidence to support the student's claim or information that contains a misconception about why the frequency of a trait would change in a population.
5	**MC**	Predict how an adaptation in one population could affect other nearby mouse populations. [Which prediction about mouse populations is supported by information in the graphs?]	Distractors may contain misconceptions about how the frequency of a trait could change between interbreeding populations or a prediction that is not supported by information in the graphs.
6	**MC**	Explain why the frequency of a trait changed in a population over time based on data. [Which explanation for the change in the frequency of the gray fur trait for the vole population is supported by the data?]	Distractors may contain an explanation about the data that does not explain the change in the frequency of the trait or is not representative of what the data show.
7	**TEI**	Select a statement that concludes how a trend in data correlates to a change in the percentages of organisms with a particular trait in a population.	Inline-choice interaction Correct responses show how a specific environmental change caused the frequency of an adaptive trait to increase in a population.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- Sudden environmental change is required for natural selection to occur.
- Changes to the characteristics of a population of organisms occur over time because of the use or disuse of a characteristic.
- Changes to the environment cannot lead to changes in the traits of species living in that environment.
- Change occurs in the inherited characteristics of a population of organisms over time because of the use or disuse of a particular characteristic.
- All individuals within a population of organisms are the same. Differences among them are trivial and unimportant. All members of a population are nearly identical.
- The internal chemistry, appearance, and behavior of a species do not change, even over long periods of time.

From www.caaspp.org

- Organisms can change their features to suit their environment.
- Animals of the same species all have the same features.
- Natural selection occurs within an organism's lifetime.
- "Survival of the fittest" means the strongest individuals survive.
- Natural selection is goal-oriented.

Earth's Place in the Universe: 8.ESS1.1

back to "Item Specifications by Performance Expectation"

8.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.

OAS-S Clarification Statement:

Earth's rotation relative to the positions of the Moon and Sun describes the occurrence of tides; the revolution of Earth around the Sun explains the annual cycle of the apparent movement of the constellations in the night sky; the Moon's revolution around Earth explains the cycle of spring/neap tides and the occurrence of eclipses; and the Moon's elliptical orbit mostly explains the occurrence of total and annular eclipses. The position and tilt of Earth, as it revolves around the Sun, explain why seasons occur. Examples of models can be physical, graphical, or conceptual.

OAS-S Assessment Boundary:

Definitions of spring or neap tides should not be included.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Developing and Using Models • Develop and use a model to describe a phenomenon.	**ESS1.A: The Universe and Its Stars** • Patterns of the apparent motion of the Sun, the Moon, and stars in the sky can be observed, described, predicted, and explained with models. **ESS1.B: Earth and the Solar System** • The 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.	**Patterns** • Patterns can be used to identify cause-and-effect relationships.

In Lay Terms:

Patterns in the motion of objects in the solar system can be observed, described, predicted, and explained. These patterns are responsible for seasons, tides, eclipses, Moon phases, and the apparent relative motion of objects in the sky. The orbits of the Earth and Moon are predictable, and students should be able to detect their patterns by analyzing their motion through the use of models.

Earth's Place in the Universe: 8.ESS1.1

Cluster Clarifications:

- Tides are not to be assessed.
- Examples of models can be graphical, 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 students' school or state).
- In their models, students describe the relationship between the Earth, Sun, and Moon (such as cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons).
- Do not include energy transfer mechanisms, solar flares, or sunspot cycle.
- Students use patterns observed from their models to provide causal accounts for events.
- Students should not be expected to know the terms "umbra" or "penumbra" in relation to eclipses.
- Students do not need to have specific dates of seasons memorized.
- Students need to know the general pattern of the Moon phases but do not need to know specific names of phases or the terms "waxing" and "waning."
- Students need to know the relative positions of Earth, the Moon, and the Sun for a given phenomenon.
- Students need to know that constellations appear at different times of the year and appear to move across the sky.

Cluster Stimulus Attributes:

Typical stimulus elements:

- data tables
- diagrams or models of components
- diagrams, models, or text descriptions of patterns

Possible contexts:

- solar or lunar eclipse
- same side of the Moon always seen
- the Moon appearing to change shape throughout the month
- seasons occurring at opposite times of the year for locations in different hemispheres
- seeing the Moon during the day
- seeing different constellations during different times of year in an obvious pattern

Content and evidence to be included: models, data, or descriptions relating to events or patterns in the Earth-Moon-Sun system

Types of student responses that need to be supported: creating, completing, and/or improving models of Earth-Moon-Sun systems; describing and interpreting what the models being developed need to show in order to demonstrate cyclical patterns

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.ESS1.1:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Describe the components and/or system that are shown/need to be shown by the model. [What is the system shown by this model?] [According to the model, what causes the pattern seen in the average temperature graph?]	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
2	**MC**	Identify how patterns relate to a model. [Based on the model, which statement describes the relationship between the position of the Earth, Moon, and Sun?]	Distractors may contain misinterpretations of the pattern or model.
3	**MC**	Use the model to predict the Moon phase on a certain date. [Based on the date of the last full moon, on what date will the next full moon occur?]	Distractors may contain incorrect dates based on a misunderstanding of the cyclical patterns of Moon phases.
4	**MC**	Complete the model to demonstrate the position of the Earth, Moon, and Sun during an eclipse. [Where should the Moon be placed to model a solar eclipse?]	Distractors may include placing the Moon or Sun in an incorrect position.
5	**MC**	Select the best model to describe/represent how the orientation of Earth affects seasons. [Which model correctly shows the orientation of Earth during summer in the Northern Hemisphere?]	Distractors may include models that show incorrect placement of Earth or incorrect tilt of Earth.
6	**MC**	Relate the model to its underlying concept of seasons in relation to cyclical patterns. [Based on the model, which of the following locations on Earth will receive the most solar energy?]	Distractors may include statements that include misconceptions or misinterpretations of the model.
7	**MC**	Explain *how* the data fit/support the model (i.e., are evidence for the model). [How do the data collected in this investigation support the model?]	Distractors may include explanations that incorrectly relate the data to the model.
8	**MC**	Identify evidence that supports the model. [Which evidence supports this model?]	Distractors may include evidence that is irrelevant or that can serve to reject the model.
9	**TEI**	Complete a model for a given event (eclipse, season, Moon phase, constellations).	Drag-drop interaction Correct responses show the correct relative positions of Earth, the Moon, and the Sun. Partial credit would be given for responses that have some of the objects in the correct position.
10	**TEI**	Predict when a certain event will take place based on cyclical patterns.	Hot Spot interaction Correct responses select the appropriate date on the calendar for a certain event.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

From oksciencefamework.pbworks.com/w/page/144261870/2020%20Grade%208%3A%20%20Earth's%20Place%20in%20the%20Universe

- The seasons are caused by Earth at times being closer to the Sun (summer) and being further away from the Sun (winter).
- The Moon's phases are caused by the Moon's rotation on its axis.
- The dark side of the Moon does not receive light from the Sun.
- The Moon creates its own light.
- The Moon can only be seen at night.

Earth's Place in the Universe: 8.ESS1.2*

back to "Item Specifications by Performance Expectation"

8.ESS1.2. Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.

OAS-S Clarification Statement:

Emphasis for the model is on the effects of gravity and inertia as the forces that hold together the solar system and Milky Way galaxy and control 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 a school or state).

OAS-S Assessment Boundary:

Assessment does not include Kepler's laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Developing and Using Models • Develop and use a model to describe a phenomenon.	**ESS1.A: The Universe and Its Stars** • Earth and its solar system are part of the Milky Way galaxy, which is one of the many galaxies in the universe. **ESS1.B: Earth and the Solar System** • The solar system consists of the Sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the Sun by its gravitational pull on them. • The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.	**Systems and System Models** • Models can be used to represent systems and their interactions.

In Lay Terms:

Planets, moons, and the Sun each have their own gravitational force, which acts on all these objects. The Sun's gravity keeps all planets in a predictable orbit around it. The gravitational force of Earth acting on objects near Earth's surface pulls objects toward the planet's center. Earth and its solar system are part of the Milky Way galaxy. Our solar system was formed and is held together by gravity, an inward pulling force that keeps objects with less mass around objects with greater mass.

**associated sample cluster included*

Earth's Place in the Universe: 8.ESS1.2*

Cluster Clarifications:

- Students should be able to create and use a model to explain gravity's role in the orbits of the planets around the Sun and the orbits of moons around the planets.
- To make sense of a given phenomenon, students develop a model in which they identify the relevant components of the system (solar system, galaxy, and universe).
- Students describe the relationships and interactions between components of the solar and galaxy systems.
- Students use the model to describe how gravity in space contexts is a predominantly pulling force that can keep smaller/less massive objects in orbit around larger/more massive objects.
- Students use the model to describe how gravity causes a pattern of smaller/less massive objects orbiting around larger/more massive objects in the solar system and in analogous systems within the universe.
- Students indicate the relative spatial scales of solar systems and galaxies in the model.
- Students do not need to know the composition of stars by studying light spectra or brightness.
- Students do not need to know facts about specific planets, stars, or galaxies.
- Students do not need to know the terms "red shift" or "blue shift" or understand the mechanics behind the big bang theory.
- Clusters should focus on the components of the solar system, not the mechanisms of the formation of the solar system.
- Black holes should not be assessed.

Cluster Stimulus Attributes:

Typical stimulus elements:

- text descriptions and/or data tables with information about celestial bodies
- physical or conceptual models

Possible contexts:

- planets orbiting the Sun
- gravitational forces between and within our galaxy and universe
- comets that are visible from Earth at regular intervals
- meteor showers
- Chelyabinsk meteor explosion over Russia
- Skylab orbiting Earth and then falling out of orbit

Content and evidence to be included: information/descriptions about different celestial bodies or events

Types of student responses that need to be supported: creating, completing, and/or improving models of motions of objects within the solar system and galaxy; describing and interpreting these models with the focus on gravity's effects on motion

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.ESS1.2:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Describe the components and/or system that are shown/need to be shown by the model. [What is the system shown by this model?]	Distractors may contain misinterpretations of the model and its components, particularly tied to misconceptions.
2	**MC**	Identify relationships between inputs and outputs of a model. [Based on the model, which statement describes the relationship between gravity and motion of the asteroid?]	Distractors may contain statements describing an incorrect relationship.
3	**MC**	Use the model to predict the effects of gravity on a celestial body.	Distractors may contain incorrect predictions of the motion of a celestial body, particularly tied to misconceptions.
4	**MC**	Complete the model to demonstrate the underlying concept about the motion of the solar system.	Distractors may include illustrations that incorrectly model the motion of planets within the solar system.
5	**MC**	Revise the model to demonstrate the underlying patterns in systems.	Distractors may include a misunderstanding of the patterns.
6	**MC**	Explain *how* the data fit/support the model (i.e., are evidence for the model). [How do the data collected in this investigation support the model?]	Distractors may include explanations that incorrectly relate the data to the model.
7	**MC**	Identify evidence that supports the model [Which evidence supports this model?]	Distractors may include evidence that is irrelevant or that can serve to reject the model.
8	**TEI**	Complete a model.	Drag-drop interaction Correct responses show a correct model. Partial credit would be given for responses that have parts of the model correct.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

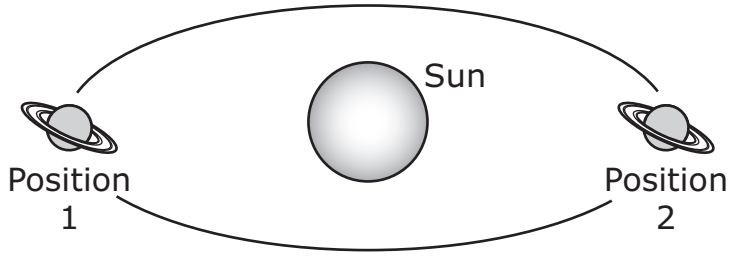
- The Milky Way galaxy is at the center of the universe.
- Earth and the solar system are at the center of the Milky Way.
- Celestial bodies are discrete bodies without pattern or without hierarchy.
- The solar system always existed in its current form.
- Some, but not all, celestial objects have gravity.

Use the information to answer the following questions.

A class visits a planetarium where students watch a presentation that models movements in the solar system. During the presentation, the students see the planet Saturn and one of its moons, Titan.

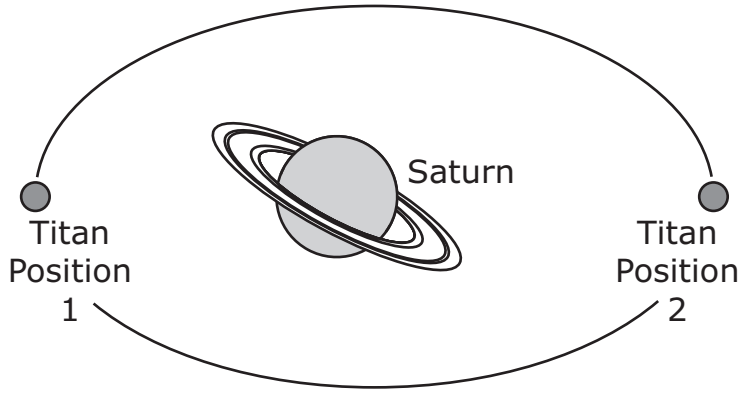
The students want to learn more about Saturn and Titan. They find models of Saturn's orbit and Titan's orbit. The models are shown.

Orbital Model of Saturn



not to scale

Orbital Model of Titan



not to scale

The students also find a table that shows the mass of each object, as shown.

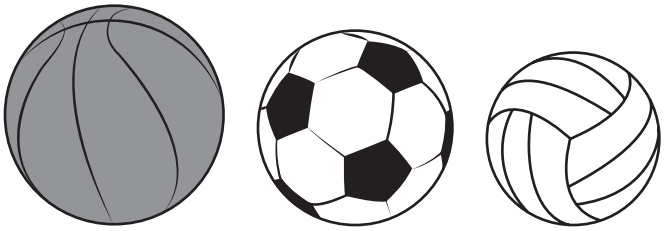
Mass of Three Objects in the Solar System

Object	Mass	Average Distance from the Sun	Average Distance from Saturn
Saturn	5.7×10^{26} kg	1.4×10^{9} km	N/A
Sun	2.0×10^{30} kg	N/A	1.4×10^{9} km
Titan	1.3×10^{23} kg	1.4×10^{9} km	1.2×10^{6} km

1 The students want to make a model to compare the size of the three objects in the table.

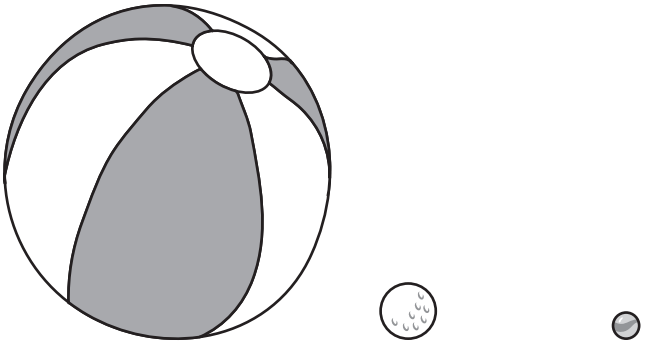
According to the data, which model **best** shows the difference in sizes of the objects?

A



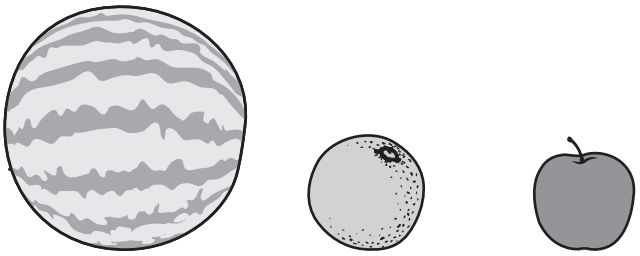
Sun Saturn Titan

B



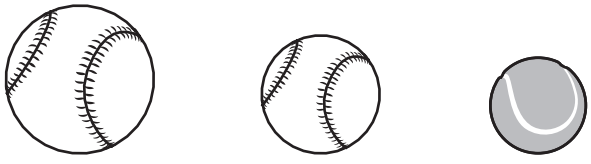
Sun Saturn Titan

C



Sun Saturn Titan

D



Sun Saturn Titan

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

Cognitive Complexity:
SEP: High
DCI: Low
CCC: Medium
Overall Cognitive Complexity: Moderate Support

Distractor Rationale:
A. All three objects are roughly the same size, which does not reflect the large differences in the sizes of the Sun, Saturn, and Titan.
B. Correct. This comparison does the best job of showing the size difference between all the objects. The Sun is 12 times larger than Saturn and 277 times larger than Titan.
C. Although the watermelon is bigger than the orange, it is not enough larger to accurately reflect the difference in sizes between the Sun and Saturn. Also, the apple is almost the same size as the orange so a much smaller fruit should have been chosen.
D. The three balls do go down in size, however, there is not much difference between the softball, baseball, and tennis ball. This does not do the best job of showing the big differences in the sizes of the Sun, Saturn, and Titan.

2 A student claims that according to the models, Titan only orbits Saturn and Saturn only orbits the Sun.

Which statement **best** evaluates the student's claim?

A The student is correct because only Saturn is shown orbiting the Sun in the model.

B The student is correct because all moons orbit planets and Titan is classified as a moon.

C The student is incorrect because all objects in the solar system orbit the Sun because it has the largest mass.

D The student is incorrect because Saturn has less mass than the Sun which causes Titan to only orbit the Sun.

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

Cognitive Complexity:
SEP: Medium
DCI: Medium
CCC: Medium
Overall Cognitive Complexity: Moderate Support

Distractor Rationale:
A. The student making the claim has not taken into account the limitations of the model or that the model is only showing one interaction.
B. Although moons do orbit planets, they also orbit the Sun as the planet orbits the Sun
C. Correct. All objects in the solar system orbit the Sun, even if they orbit another object because the Sun's mass is so large that all objects within the solar system orbit its mass.
D. Saturn does have less mass than the Sun, but Saturn is closer to the Sun which is why it orbits Saturn as well as the Sun.

This question has two parts. Be sure to answer both parts of the question.

3 Which sentence **best** compares the gravitational force between the pairs of objects?

A The gravitational force between Titan and Saturn is greater than the gravitational force between Titan and the Sun because of the masses of the interacting objects.

B The gravitational force between Titan and Saturn is greater than the gravitational force between Titan and the Sun because of the distances between the interacting objects.

C The gravitational force between Titan and Saturn is less than the gravitational force between Titan and the Sun because of the masses of the interacting objects.

D The gravitational force between Titan and Saturn is less than the gravitational force between Titan and the Sun because of the distances between the interacting objects.

Which sentence **best** compares the gravitational force between the pairs of objects?

A The gravitational force between the Sun and Saturn is greater than the gravitational force between the Sun and Titan because of the masses of the interacting objects.

B The gravitational force between the Sun and Saturn is greater than the gravitational force between the Sun and Titan because of the distances between the interacting objects.

C The gravitational force between the Sun and Saturn is less than the gravitational force between the Sun and Titan because of the masses of the interacting objects.

D The gravitational force between the Sun and Saturn is less than the gravitational forces between the Sun and Titan because of the distances between the interacting objects.

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

Cognitive Complexity:
SEP: Low
DCI: Medium
CCC: Medium
Overall Cognitive Complexity: Moderate Support

Distractor Rationale:

A. The table shows that the combined masses of Titan and Saturn are smaller than the combined masses of Titan and the Sun.

B. Correct. The orbital model shows that Titan orbits Saturn, which shows that the gravitational force between them is stronger. The decreased distance is why the gravitational force is stronger even though the table shows that the mass of the Sun is much larger than the mass of Saturn.

C. The orbital model shows that Titan orbits Saturn, meaning that the gravitational attraction is greater than the gravitational attraction of the Sun and Titan. The table shows that the combined masses of Titan and Saturn are smaller than the combined masses of Titan and the Sun.

D. The orbital model shows that Titan orbits Saturn, meaning that the gravitational attraction is greater than the gravitational attraction of the Sun and Titan.

A. Correct. The data table shows that the average distance between Titan and Saturn to the Sun is the same. Because Saturn has more mass, there will be more gravitational attraction between Saturn and the Sun than Titan and the Sun.

B. Distance between the interacting objects is not different according to the data table, so the reasoning behind the greater gravitational force is incorrect.

C. Since Saturn and Titan are the same distance from the Sun, the masses of the interacting objects will have the effect on the difference in the gravitational forces. Gravitational force increases with mass, so Saturn and the Sun will have a greater gravitational force between them.

D. Distance between the interacting objects is not different according to the data table, so the reasoning behind the greater gravitational force is incorrect. Since Saturn and Titan are the same distance from the Sun, the masses of the interacting objects will have the effect on the difference in the gravitational forces. Gravitational force increases with mass, so Saturn and the Sun will have a greater gravitational force between them.

Earth's Place in the Universe: 8.ESS1.3

back to "Item Specifications by Performance Expectation"

8.ESS1.3. Analyze and interpret data to determine scale properties of objects in the solar system.*

OAS-S 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.

OAS-S Assessment Boundary:

Assessment emphasis is on data analysis of properties of the planets and should not include recalling facts about the planets and other solar system bodies.

Science & Engineering Practice:	Disciplinary Core Idea:	Crosscutting Concept:
Analyzing and Interpreting Data • Analyze and interpret data to determine similarities and differences in findings.	**ESS1.B: Earth and the Solar System** • The solar system consists of the Sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the Sun by its gravitational pull on them. **ETS1: 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.	**Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

In Lay Terms:

Objects in the solar system are vastly different in size and scale. The size and scale of the objects in the solar system can be analyzed and interpreted from data collected from various sources.

Earth's Place in the Universe: 8.ESS1.3

Cluster Clarifications:

- There is an emphasis 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, size of objects, and distance from the Sun.
- Examples of data include statistical information, drawings and photographs, and models.
- Students organize given data on solar system objects (e.g., surface features, object layers, orbital radii) from various instruments to allow for analysis and interpretation (e.g., transforming tabular data into pictures, diagrams, graphs, or physical models that illustrate changes in scale).
- Students describe that different representations illustrate different characteristics of objects in the solar system, including differences in scale.
- Students use quantitative analyses to describe similarities and differences among solar system objects by describing patterns in features of those objects at different scales, including (1) distance from the Sun, (2) diameter, (3) surface features (e.g., sizes of volcanoes), (4) structure, and (5) composition (e.g., ice versus rock versus gas).
- Students identify advances in solar system science made possible by improved engineering (e.g., knowledge of the evolution of the solar system from lunar exploration and space probes) and new developments in engineering made possible by advances in science (e.g., space-based telescopes from advances in optics and aerospace engineering).
- Students use the patterns they find in multiple types of data at varying scales to draw conclusions about the identifying characteristics of different categories of solar system objects (e.g., planets, meteors, asteroids, comets) based on their features, composition, and locations within the solar system. (For example, most asteroids are rocky bodies between Mars and Jupiter, while most comets reside in orbits farther from the Sun and are composed mostly of ice.)
- Students use patterns in data as evidence to describe how two objects may be similar when viewed at one scale (e.g., types of surface features) but may appear to be quite different when viewed at a different scale (e.g., diameter or number of natural satellites).
- Students 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.
- Students should be able to explain how improvements in technology have increased our knowledge of the solar system and the universe.
- Students should not have to know specifics about how certain technology functions.

Cluster Stimulus Attributes:

Typical stimulus elements:

- diagrams
- tables
- data sets
- graphs or text descriptions

Possible contexts:

- information collected from *Voyager 1* and *Voyager 2*
- development of new spacecraft for exploration
- patterns seen in the solar system (i.e., rock planets being closer to the Sun, temperature decreasing as distance from the Sun increases, length of year increasing with the increase in distance from the Sun)
- observations of the properties of planets

Content and evidence to be included: information/descriptions and/or data about celestial bodies

Types of student responses that need to be supported: completing data transformations, identifying patterns and conclusions from data, and making inferences about scale

Allowable Item Types:

- MC
- TEI

Model Item Descriptions for 8.ESS1.3:

#	Item Type	Model Stem (Items ask students to...)	Response Characteristics*
1	**MC**	Interpret/read data in tables, graphs, and diagrams about scale properties of objects in the solar system.	Distractors may include misinterpretations resulting from incorrect reading of the graph/table/diagram or other data points found in the stimulus.
2	**MC**	Describe simple patterns and trends in tables, graphs, and diagrams.	Distractors may include responses indicating incorrect understanding of trends and patterns.
3	**MC**	Describe the data needed to support a given conclusion.	Distractors may include irrelevant data, data that are less useful in supporting the conclusion, or data that actually refute/reject the conclusion.
4	**MC**	Explain how specific data support a given conclusion.	Distractors may include explanations that misinterpret the pattern seen in the data.
5	**MC**	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.	Distractors may include incorrect patterns or a misunderstanding of the scale of the objects.
6	**MC**	Organize given data on solar system objects from various Earth- and space-based instruments.	Distractors may include misinterpretations of data or incorrect analysis/understanding of patterns in the data.
7	**MC**	Describe how different representations illustrate different characteristics of objects in the solar system, including differences in scale.	Distractors may include a misunderstanding of the scale of the universe.
8	**MC**	Use models to determine time, space, and energy phenomena ranging from the very small to the very large.	Distractors may include incorrect interpretations of the model or a misunderstanding of the scale.

Student Misconceptions:

*Response options can make use of Student Misconceptions (examples of scientifically incorrect assumptions) related to this performance expectation; references to misconceptions are listed below:

- A diagram of the solar system built to scale for distances from the Sun can also present the relative sizes of the planets and the Sun at the same scale.

APPENDIX: ALIGNMENT AND COGNITIVE COMPLEXITY EVALUATION TOOL

Alignment and Cognitive Complexity Evaluation Tool

Use this screener tool to evaluate the items independently and then the cluster overall.

Alignment to the dimensions

To what extent does the item require the student to engage with the dimension (low, medium, and high).
We first evaluate the SEP, CCC, and DCI individually as part of assigning a cognitive complexity ranking to the item. The below scale is used to evaluate individual dimensions. If an item is lacking a dimension (Oklahoma requires a minimum of two dimensions be present in any one item) indicate that with N/A in the box.

SEP (SCIENCE AND ENGINEERING PRACTICE)	
Questions to help determine how students' use of the SEP contributes to cognitive complexity/sense-making in the item: • How is the SEP being used to explore/understand the phenomenon? • How much scaffolding is provided for students to use the SEP? • Is the SEP used independently of any occurrence in the DCI or CCC? (No double counting)	
Low	• Students only need to use the SEP in a simple, straightforward way that is absent of or minimally uses sense-making • Large amounts of scaffolding are supplied to help the students apply the SEP • Isolated component of SEP is used
Medium	• Students must apply the SEP to make sense of the phenomenon • Typically some scaffolding is provided that helps students apply the SEP
High	• Students must apply the SEP to make sense of the phenomenon (e.g., synthesis to perform more connections. SEP elements are used in combination, such as having to combine data, produce a new graph or model as evidence, etc.) • Often little to no scaffolding is in place to help students apply the SEP • The SEP is used in sense-making that bridges across diverse contexts

DCI (DISCIPLINARY CORE IDEA)	
Questions to help determine how students' use of the DCI contributes to cognitive complexity/sense-making in the item: • How do the DCIs contribute to sense-making as the student engages with the phenomenon? • How much scaffolding is provided for students to use the DCI? • Is the DCI used independently of any occurrence in the SEP or CCC? (No double counting)	
Low	• Students use the DCI in a simple, straightforward way (e.g., little to no application or reasoning) • Often a large amount of scaffolding that helps students apply the DCI • Producing previously learned ideas and conceptual procedures in routine, well-practiced ways
Medium	• Students must apply or reason with DCI concepts to make sense of the phenomenon • Supported applications of science ideas in typical contexts • Some scaffolding that helps students apply the DCI

High	• Students must apply and connect DCI concepts in a sophisticated way to make sense of the phenomenon, e.g.,
	  ○ application of science ideas (often multiple ideas) in new ways or combinations
	  ○ knowledge transfer to construct new understanding, make sense of novel phenomena
	• Often little to no scaffolding that helps students apply the DCI
	• There is some uncertainty associated with the outcome of the scenario

CCC (CROSSCUTTING CONCEPT)	
Question to help determine how students' use of the CCC contributes to cognitive complexity/sense-making in the item: • How is the lens of the CCC used to understand the phenomenon? • How much scaffolding is provided for students to use the CCC? • Is the CCC used independently of any occurrence in the SEP or DCI? (No double counting)	
Low	• CCCs are implicitly part of the task, but they are not required in service of sense-making
Medium	• Students use the CCC in a general way (e.g., item includes and/or could have students use the general CCC concept) • Used for minimal sense making
High	• Students use the CCC in an in-depth way (e.g., drawing on the understandings of the CCC sub-bullet detail to make sense of the phenomenon) • Used in part or fully to bridge a gap in DCI knowledge and/or sense making

Stimulus Question
Can the questions of the task be answered without using information provided by the task scenario or context? **Yes ! or No**

Cognitive Complexity Table

Category	Description
Scripted	• Only one dimension is present, or two dimensions are present but only one is used in application or reasoning for sense-making. • Heavy scaffolding o Scripted "Cookbook instructions" • Little to no sense making
Moderate Support	• Multidimensional 2-3 dimensions are evident but only one is heavily used in sense-making while the other may be used minimally. • Moderate scaffolding o Students have to apply ideas and practices; however, they are often told which ones to engage with and supported in using them • Low to Medium degree of sense making

Low Support	• Multidimensional 2-3 dimensions are evident with at least 2 being necessary to use or reason within sense-making.
	• Minimal scaffolding
	  o Students are cued and guided to pursue certain lines of thinking, but have to make some decisions about how and what to engage
	• Medium to High degree of sense making
	  o High: Students must connect multiple pieces of information in a novel way

Doing (rarely achievable on summative assessments)	• The three dimensions are used together to engage in sense-making to a high degree throughout the task • Student-designed exploration of science • Limited to no scaffolding • Students work like scientists to use various scientific practices to be able to develop or deepen an understanding of a scientific idea or problem as they explore a phenomenon. In most cases if a student actually is engaged in 3 dimensions and has to develop the model or develop the explanation or develop the argument from raw data or information, they are being asked to do science.

Note: These descriptions are adapted from Achieve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