Test Specifications: Grade 5 Science - 2.0

Introduction

The Grade 5 Science Test Specifications provide an overview of the structure and content of the test. This overview includes a description of the test design as well as information on the types of items that will appear on the test. Also included is a test blueprint composed of a table identifying the range and distribution of items and points grouped by categories. The test specifications also provide specific guidelines for the development of all items used for the Grade 5 Science Test. This document is intended to be a resource not only for item writers and test designers, but for Ohio educators and other stakeholders who are interested in a deeper understanding of the test. The *Content Limits* and *Do Not Assess* sections identify boundaries for the content that will appear on the Grade 5 Science Test. The *Do Not Assess* section lists content that is either beyond the scope of the standard or which is pertinent to the standard but will not be explicitly tested in isolation. Do not assess does not necessarily mean do not instruct.

General Description of the Grade 5 Science Test

In 2018 Ohio adopted revised academic content standards for Grade 5 Science. A model curriculum based on these standards was adopted in 2019.

An achievement assessment that aligns to the revised standards and model curriculum is mandated by Ohio Revised code 3301.079. The assessment will be administered as a two-part test, in an online format, to measure progress toward the standards and to provide information to teachers and administrators. Test results are reported back to schools by June 30th.

Test Design

The structure of the Grade 5 Science Test will consist of two parts that will be given near the end of the academic year. Both parts of the test are fixed forms that are administered in an online format. The sequence and timing of the administration of Part 1 and Part 2 is determined by the district. After the student has completed both parts of the test, his or her scores will be combined to yield a comprehensive view of the student's progress.

Test Blueprint

The following test blueprint shows the content statements assessed in each reporting category and the distribution of points.

Grade 5 Science Test Blueprint

Reporting Category	Topic	Points	Total Points on Form	Approximate Percent of Test
Earth Science	5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics. 5.ESS.2: The sun is one of many stars that exist in the universe 5.ESS.3: Most of the cycles and patterns of motion between Earth and the sun are predictable.	15-17	54-56	25-32%
Life Science	5.LS.1: Organisms perform a variety of roles in an ecosystem. 5.LS.2: All of the processes that take place within organisms require energy.	19-21		32-40%
Physical Science	5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount to force exerted. 5.PS.2: Light and sound are forms of energy that behave in predictable ways.	19-21		32-40%

Cognitive Demands	Approximate Portion of Test
Designing Technological/ Engineering Solutions Using Science Concepts (T)	**0-15 %**
Demonstrating Science Knowledge (D)	**10-25%**
Interpreting and Communicating Science Concepts (C)	**30-50%**
Recalling Accurate Science (R)	**25-40%**

Cognitive Demands: Expectations for Learning

Cognitive Demand	Description	Approximate Portion of Test
Designing Technological/ Engineering Solutions Using Science Concepts (T)	Requires student to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives and/or integrate and synthesize scientific information.	0-15%
Demonstrating Science Knowledge (D)	Requires student to use scientific practices and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments (Slightly altered from National Science Education Standards)	10-25%
Interpreting and Communicating Science Concepts (C)	Requires student to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experience using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.	30-50%
Recalling Accurate Science (R)	Requires student to provide accurate statements about scientifically valid facts, concepts and relationships. Recall only requires students to provide a rote response, declarative knowledge or perform routine mathematical tasks. This cognitive demand refers to students' knowledge of science fact, information, concepts, tools, procedures (being able to describe how) and basic principles.	25-40%

Resources: Frameworks that were consulted in the development of the draft cognitive demands are listed below. Each links to a brief description of the framework.

NAEP: Science Framework for the 2015 National Assessment of Educational Progress(2015), https://www.nagb.gov/naep-frameworks/science/2015-science-framework.html

Revised Bloom's Taxonomy: See Anderson, et.al. A Taxonomy for Learning, Teaching and Assessing (2001), http://www.celt.iastate.edu/teaching/effective-teaching-practices/revised-blooms-taxonomy/.

TIMSS: TIMSS 2007 Assessment Frameworks (2005), https://timssandpirls.bc.edu/

Survey of Enacted Curriculum: Coding Procedures for Curriculum Content Analyses (2004), https://secure.wceruw.org/seconline/Reference/K12Taxonomy08.pdf

PISA: The PISA 2003 Assessment Domains (2003), http://www.oecd.org/education/school/programmeforinternationalstudentassessmentpisa/33694881.pdf

Ohio's Technology Standards: Ohio Academic Content Standards in Technology (2017), https://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Technology/Ohio-s-2003-Academic-Content-Standards-in-Technolo/The-2017-Ohio-Learning-Standards-in-Technology.pdf.aspx.

Interaction Types

Ohio's State Tests are composed of several interaction types. Currently, there are ten interaction types that may appear on a science computer-based assessment:

Interaction Types	Description
Equation Item (EQ)	The student is presented with a keypad that includes a variety of mathematical symbols that can be used to create a response. Responses may be in the form of a number, variable, expression, or equation, as appropriate to the test item. The student enters their response in the response box which may be on a line by itself or embedded in a sentence or phrase. For paper-based assessments, this interaction type may be replaced with a modified version of the item that can be scanned and scored electronically or the student may be given an answer box to write their answer.
Gap Match Item (GM)	Given a set of options (e.g., numbers, words, phrases, or sentences) the student hovers over the options which then highlight, indicating that the option is selectable. The student can then click on the object, hold down the mouse button, and drag it to an answer area, indicated by a dotted box, in a graphic, table, or paragraph. For paper-based assessments, the options are associated with a letter, and students write a letter for their response in each response area.
Grid Item (GI)	The student may select numbers, words, phrases, or images to display their response. The student may also use the drag-and-drop feature to place objects into a response area. This interaction type may also require the student to use the point, line, or arrow tools to create a response on a graph or gridded area. For paper-based assessments, the student may be given the response space to draw their answer, or this interaction type may be replaced with another interaction type that assesses the same standard at the same level of difficulty and can be scanned and scored electronically.
Hot Text Item (HT)	**Selectable Hot Text -** Given a set of options (e.g., phrases, sentences, or numbers) the student hovers over the options which then highlight, indicating that the text is selectable ("hot"). The student can then click on an option to select it as their response. For paper-based assessments, a "selectable" hot text item is modified so that it can be scanned and scored electronically. The student fills in a circle to indicate the correct response. **Drag-and-Drop Hot Text -** Given a set of options (e.g., numbers, words, phrases, or sentences) the student hovers over the options, which then highlight, indicating that the option is selectable ("hot"). The student can then click on the object, hold down the mouse button, and drag it to a graphic, table, or paragraph. For paper-based assessments, the options are associated with a letter, and students write a letter for their response in each response area

Inline Choice Item (IC)	Given a sentence, paragraph, or table, the student clicks a blank box embedded within a sentence or table which reveals a drop-down menu containing options for completing a sentence or table. The student then selects an option from the drop-down menu to respond. For paper-based assessments, the interaction is modified so that it can be scanned and scored electronically. The student fills in a circle to indicate the correct response.
Matching Item (MI)	Given column and row headers in a table format, the student checks a box to indicate if information from a column header matches information from a row header. For paper-based assessments, the interaction is modified so that it can be scanned and scored electronically. The student fills in a circle to indicate the correct response.
Multiple Choice Item (MC)	The student selects one correct answer from four options. For paper-based assessments, the student fills in a circle to indicate the correct response.
Multi Select Item (MS)	The student is directed to either select an indicated number of correct answers or to select all of the correct answers. Students in grades 3-5 always select an indicated number of correct answers; students in grades 6-8 select an indicated number of correct answers on 50% of the items and select all on 50% of the items; and students taking high school end-of-course tests are always directed to select all correct answers. These items are different from multiple choice items and require the student to select 2 or more correct answers. For paper-based assessments, the student fills in circles to indicate the correct responses.
Simulation Item (Sim)	Given a set of instructions, the student may interact with any of the following controls to generate data: radio buttons, drop-down menus, slide bars, or selecting a number by clicking arrows. Once the student has set the parameters, they click the start button to begin the simulation and generate a data set. Once the student has enough data, they may answer questions about the data using a different interaction type. For paper-based assessments, this interaction will be replaced with another interaction type that assesses the same standard at the same level of difficulty and can be scanned and scored electronically.
Table Item (TI)	The student types numeric values into a given table. The student may complete the entire table or portions of the table depending on what is being asked. For paper-based assessments, the student writes their responses in the blank boxes of the table.

Note: The examples provided are not necessarily science related but inform students how to interact with the different item types.

For paper-based assessments (including those for students with an IEP or 504 plan that specifies a paper-based accommodation), the items may be modified so that they can be scanned and scored electronically or hand-scored.

Stimulus Types

A simulation stimulus consists of the following:

- An interactive graphic interface that presents a set of interactive stimulus materials or simulates an investigative experiment, physical situation, or an aspect of the inquiry process. The graphics may be static or contain animation. Information is displayed in the form of dynamic illustrations or maps, statistical tables, texts, charts, or graphs. Data “inputs” can be adjusted by the students, depending on the requirements of the scenario or the associated items, and the graphics adjust themselves to account for the new inputs.
- When a simulation is used as part of a task, the simulation is accompanied by one or more items of various types. The simulation functions as an interactive stimulus that provides information for the student to reflect on, analyze or synthesize with other knowledge into a cognitively demanding set of answers. This can be used to simulate an aspect of scientific inquiry.

Other stimulus types associated with discrete items or tasks may include but not limited to:

- Document excerpts and other texts
- Images and illustrations
- Graphs
- Charts
- Data tables
- Maps
- Timelines

Item Specifications: Grade 5 Science Test

Nature of Science One goal of science education is to help students become scientifically literate citizens that are able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.	
Categories	**3-5**
Scientific Inquiry, Practice and Applications All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.	● Observe and ask questions about the world that can be answered through scientific investigations. ● Design and conduct scientific investigations using appropriate safety techniques. ● Use appropriate mathematics, tools, and techniques to gather data and information. ● Develop and communicate descriptions, models, explanations, and predictions. ● Think critically and ask questions about the observations and explanations of others. ● Communicate scientific procedures and explanations. ● Apply knowledge of science content to real-world challenges.
Science is a Way of Knowing Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.	● Science is both a body of knowledge and processes to discover new knowledge. ● Science is a way of knowing about the world around us based on evidence from experimentation and observations. ● Science assumes that objects and events occur in consistent patterns that are understandable through measurement and observation.
Science is a Human Endeavor Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, disabilities, family backgrounds and incomes.	● People from many generations and nations contribute to science knowledge. ● People of all cultures, genders, and backgrounds can pursue a career in science. ● Scientists often work in teams. ● Science affects everyday life. ● Science requires creativity and imagination.
Scientific Knowledge is Open to Revision in Light of New Evidence Science is not static. Science is constantly changing as we acquire more knowledge.	● Science develops theories based on a body of scientific evidence. ● Science explanations can change based on new scientific evidence.

Item Specifications: Grade 5 Science Test

Topic: Cycles and Patterns in the Solar System

This topic focuses on the characteristics, cycles and patterns in the solar system and within the universe.

Content Statement

5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics.

The distance from the sun, size, composition and movement of each planet are unique. Planets revolve around the sun in elliptical orbits. Some of the planets have moons and/or debris that orbit them. Comets, asteroids, dwarf planets and meteoroids also orbit the sun.

Content Elaboration:

Planets in the solar system orbit the sun. Some of the planets have one or more orbiting moons. Earth is a planet that has a moon. The moon orbits Earth. Gravitational forces between the sun and its planets cause the planets to orbit the sun. Gravitational forces between a planet and its moon(s) cause the moon(s) to orbit the planet. If no forces were present, planets and moons would continue their motion toward outer space without changes in speed or direction. However, gravitational forces between the sun and each planet continuously changes the planet's direction so it remains in orbit. In the same way, gravitational forces between each moon and its planet continuously changes the moon's direction so it remains in orbit.

Asteroids are rocky bodies that orbit the sun in nearly circular orbits but are too small to be classified as planets. Comets are a mixture of ices (e.g., water, methane, carbon monoxide, carbon dioxide, ammonia) and dust, and have highly elliptical orbits. A meteor appears when a particle or chunk of metallic or stony matter called a meteoroid enters Earth's atmosphere from outer space. Meteors that pass through the atmosphere and impact Earth's surface are called meteorites.

General information regarding planetary positions, orbital patterns, planetary composition and recent discoveries and projects (e.g., missions to Mars) are included in this content. Tools and technology are an essential part of understanding the workings within the solar system.

Content Limits:

- The orbital path of planets, moons, and celestial bodies due to gravitational attraction;
- Earth orbits the sun in a nearly circular path;
- General characteristics of planets such as location in the solar system, size, movement, composition, and temperature;
- General information about asteroids, meteoroids, comets, and dwarf planets such as composition, relative size, and orbits;
- Tools and technology needed to study the solar system including Earth (e.g., telescopes, satellites, probes);
- Functionality of the parts of tools and technology needed to study the solar system including Earth (e.g., camera, antenna, soil sampler);
- Differences between planets (inner and outer), dwarf planets, and other celestial bodies.
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Labeling or naming specific planets;
- Distinguishing between meteoroids, meteors, and meteorites;
- Values of size, temperature, atmospheric composition, distance from the sun of planets;
- Descriptions/drawings of the phases of the moon;
- Mass-distance relationship of gravitational force;
- History of the solar system;
- The term “elliptical” (shape of orbit will be assessed visually).

Stimulus Attributes:

- Diagrams or visual representations of a moon’s orbit around a planet;
- Diagrams, charts, and data depicting planetary positions and orbital patterns;
- Charts comparing/contrasting characteristics of major planets, dwarf planets, and other celestial bodies in the solar system;
- Data, charts, diagrams, simulations, scenarios, or images from solar system investigations;
- Tools used in solar system exploration;
- Recent discoveries and projects (e.g., mission to Mars);
- Primary sources related to solar system exploration.

Response Attributes: Response options may include, but are not limited to, the following:

- Comparing/contrasting planets, moons, asteroids, meteoroids, comets and dwarf planets based on characteristics;
- Relating orbital paths of planets, celestial bodies and moons to gravitational attraction;
- Planning an investigation using the appropriate tools and scientific practices to study a component of the solar system;
- Comparing the orbits of planets, moons, asteroids, meteoroids, and comets;
- Creating a model to demonstrate position and paths of celestial bodies in the solar system;
- Using data about the compositions of planets to indicate distance from the sun;
- Using data to compare properties of planets, moons, dwarf planets, asteroids, meteoroids, and comets;
- Evaluating the appropriateness of different tools to collect data in a given scenario;
- Comparing and contrasting tools for collecting information about the solar system;
- Planning an investigation to study a component of the solar system using appropriate tools and scientific practices.

Distractors may include, but are not limited to, the following common misconceptions:

- Earth is the center of the solar system.
- The sun orbits Earth.
- Gravity only exists on Earth.
- Planetary orbits are highly elliptical.
- Only planets have an atmosphere.

Topic: Cycles and Patterns in the Solar System

This topic focuses on the characteristics, cycles and patterns in the solar system and within the universe.

Content Statement

5.ESS.2: The sun is one of many stars that exist in the universe.

The sun appears to be the largest star in the sky because it is the closest star to Earth. Some stars are larger than the sun and some stars are smaller than the sun.

Content Elaboration:

The sun is the closest star to Earth. Scaled models (3-D or virtual) and graphics can be used to show the vast difference in size between the sun and Earth. The sun is a medium-sized star and is the only star in our solar system. There are many other stars of different sizes in the universe. Because they are so far away, they do not appear as large as the sun. Stars appear in patterns called constellations, which can be used for navigation.

General facts about the size and composition of the sun are introduced. Details (e.g., age of the sun, specific composition, temperature values) are above grade level. The emphasis should be on general characteristics of stars and beginning to understand the size and distance of the sun in relationship to Earth and other planets.

Current and new discoveries related to the sun and other stars are included.

Content Limits:

- Other stars are much farther away from Earth than the sun, which causes them to appear much smaller;
- The size and composition of stars, including the sun;
- Size of the sun relative to sizes and distances in the solar system (e.g., Earth is much smaller than the sun);
- The sun is the only star in the solar system;
- The use of constellations for navigation;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Star classification;
- Life stages of stars;
- Age, specific composition, or temperature values of sun/stars;
- Light waves;
- Names of constellations.

Stimulus Attributes:

- Scaled models (virtual) and graphics to show the difference in size between the sun and Earth, or the distance between the Earth/sun and Earth/other stars;
- Graphics and charts comparing/contrasting characteristics (distance from Earth, size, relative brightness) of different stars or the same star from different points of view;
- Description of current or recent discoveries related to stars and the sun;
- Data, charts, diagrams, simulations, scenarios, or images from stars;
- Primary sources related to stars.

Response Attributes: Response options may include, but are not limited to, the following:

- Finding the relationship between the distance of a star and its apparent size in the sky;
- Creating a model showing distance or size of the sun/Earth or sun/other stars.

Distractors may include, but are not limited to, the following common misconceptions:

- The sun is not a star.
- The sun is bigger and brighter than other stars.
- The sun is the only star that has a solar system.
- The sun has a solid surface.

Topic: Cycles and Patterns in the Solar System

This topic focuses on the characteristics, cycles and patterns in the solar system and within the universe.

Content Statement

5.ESS.3: Most of the cycles and patterns of motion between Earth and the sun are predictable.

Earth's revolution around the sun takes approximately 365 days. Earth completes one rotation on its axis in a 24-hour period, producing day and night. This rotation makes the sun, stars and moon appear to change position in the sky.

Note: *Moon phases should not be the focus.*

Content Elaboration:

In a day Earth rotates once on its axis, which is tilted at a 23.5° angle. Earth's rotation causes the apparent position of the sun, moon and stars to move in the sky from east to west. Some stars are visible from all parts of Earth, some stars can only be seen from the northern hemisphere and some stars can only be seen from the southern hemisphere. Stars located directly above the north and south poles do not appear to move. A well-known example of this is the North Star**.** The effects of Earth's tilt are not the focus at this level. Direct and indirect sunlight, the reason hours of daylight change throughout the year and the role of Earth's tilt in changing seasons are reserved for grade 7.

Shadows change throughout the day due to the apparent movement of the sun. This content can be linked with content from 5.PS.2.

As Earth orbits the sun, different stars and constellations are visible during different portions of the year. Stars located in the same direction as the sun are not visible because the sun is so bright compared to the other stars. Stars located in the direction opposite from the sun are seen during nighttime hours. As Earth moves in its orbit around the sun, various sections of the sky are visible during nighttime hours. This allows different stars to be seen at different times of the year.

Models, interactive websites and investigations are used to illustrate the predictable patterns and cycles that lead to the understanding of rotation (day and night) and revolution (years).

Content Limits:

- Cycles and patterns on Earth including day and night and the motion of the sun in the sky;
- The cause of cycles and patterns such as day and night and a year;
- Changes in shadows throughout the day;
- Cause of movement of constellations/stars and from east to west;
- Variable visibility of stars/constellations based on location;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Phases of the moon;
- Causes of eclipses or tides;
- Causes of seasons;
- Direct and indirect sunlight.

Stimulus Attributes:

- Diagrams, images, charts, and tables depicting the cycles (rotation and revolution) of the Earth in the solar system;
- Diagrams, images, charts, and tables depicting the tilt of the Earth in relationship to the sun;
- Diagrams, images, charts and tables depicting the apparent movement of sun, moon, stars and constellations;
- Diagram, images, charts and tables of shadow lengths and directions;
- Primary sources related to Earth and sun.

Response Attributes:

Response options may include, but are not limited to, the following:

- Creating a model to demonstrate that Earth's rotation on its axis produces night and day in a 24-hour period;
- Creating a model to demonstrate Earth's orbit around the sun;
- Using diagrams and models to predict the position of the Earth and sun and stars at various stages in the yearly cycle;
- Using a model/graphic to explain why the sun, stars or moon appear to move across the sky;
- Using diagrams and models to predict the position of shadows.

Distractors may include, but are not limited to, the following common misconceptions:

- The sun and stars revolve around the Earth.
- Night and day are the same everywhere on Earth.
- Shadows will appear the same all day and year long.

Topic: Light, Sound and Motion

This topic focuses on the forces that affect motion. This includes the relationship between the change in speed of an object, the amount of force applied and the mass of the object. Light and sound are explored as forms of energy that move in predictable ways, depending on the matter through which they move.

Content Statement

5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.

Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t).

Any change in speed of an object requires a force and is affected by the mass of the object and the amount of force applied.

Note 1: *Differentiating between mass and weight is not necessary at this grade level.*

Content Elaboration:

The motion of an object can change by speeding up, slowing down or changing direction. Forces cause changes in motion. If a force is applied in the direction of an object's motion, the speed will increase. If a force is applied in the direction opposite an object's motion, the speed will decrease. The greater the force acting on an object, the greater the change in motion. The greater the mass of an object, the less influence a force will have on its motion. If no force acts on an object (or the forces are balanced), the object does not change its motion and moves at constant speed in a given direction. If an object is not moving and no force acts on it (or the forces are balanced), the object will remain at rest.

A force is described by its strength and the direction that it pushes or pulls an object. More than one force can act on an object at a time. At this grade level, only consider two forces acting on an object either horizontally or vertically. When two forces act on an object, their combined effect influences the motion of that object. The effect forces have on an object depends not only on the forces' strengths, but also on their directions. If the forces have equal strengths, but act in opposite directions, the object's motion will not change, and the forces are considered balanced. A stationary object subject to balanced forces will remain stationary. A moving object subject to balanced forces will continue moving in the same direction at the same speed. Unbalanced forces will cause change in the motion of an object. A stationary object subject to unbalanced forces will move in the direction of the larger force. Inquiry activities should be used to develop student understanding of the effects of forces on the motion of objects.

Movement is a change in position. Speed is a measurement of how fast or slow this change takes place. In the same amount of time, a faster object moves a greater distance than a slower object. Speed is calculated by dividing distance traveled by elapsed time. An object that moves with constant speed travels the same distance in each successive unit of time. When an object is speeding up, the distance it travels increases with each successive unit of time. Speed should be investigated through testing and experimentation. When possible, real-world settings are recommended for the investigations. Virtual investigations, simulations and freeze-frame video also can be used to explore concepts of speed.

Note 2: *While concepts are related to Newton's first and second laws, they should remain conceptual at this grade. Knowing the names of the laws is not required. Memorizing and reciting words to describe Newton's second law is not appropriate.*

Note 3: *Although mathematics is applied to the concept of speed at this grade level, its use should support deeper understanding of the concept and not be taught as the primary definition of speed.*

Content Limits:

- Effects of relative mass/weight and force (amount and direction) on an object's change in motion;
- Measurements of motion involving speed, distance and time;
- Objects at rest require an unbalanced force to start moving;
- An object moving at constant speed has no change in speed or direction if no force is acting on it or if the forces acting on it are balanced;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Momentum;
- Term inertia or references to Newton's Laws by name or number;
- Difference between mass and weight;
- Definition of mass;
- The term velocity;
- The term acceleration or how to calculate it (the concept of speeding up and slowing down can be assessed);
- Explanations of why objects with different masses fall at the same rate in the absence of air resistance;
- Graphs of motion.

Stimulus Attributes:

- Distance and time data tables;
- Diagrams or images of moving objects;
- Realistic scenarios showing how the force(s) acting on an object, and its mass/weight, affects its motion.
- Primary sources of data related to forces in motion.

Response Attributes:

Response options may include, but are not limited to, the following:

- Predicting changes in motion due to variations in amounts of forces and/or mass/weight;
- Comparing the speed of objects given distance and time data;
- Drawing conclusions about motion based on data tables, or diagrams;
- Determining changes in motion when analyzing the directions of forces and motion;
- Measuring distance and time to determine the speed of an object;
- Comparing and ranking the relative change in motion for objects of different masses/weights that experience the same force;

- Predicting changes that take place when an object experiences differing magnitudes of forces and/or masses/weights;
- Drawing conclusions based on data and/or diagrams showing movement over time;
- Determining if two forces are balanced or unbalanced.

Distractors may include, but are not limited to, the following common misconceptions:

- Force is required to keep an object in motion.
- Gravity only acts on falling objects.
- Forces always cause a change in motion.

Topic: Light, Sound and Motion

This topic focuses on the forces that affect motion. This includes the relationship between the change in speed of an object, the amount of force applied and the mass of the object. Light and sound are explored as forms of energy that move in predictable ways, depending on the matter through which they move.

Content Statement

5.PS.2: Light and sound are forms of energy that behave in predictable ways.

Light travels and maintains its direction until it interacts with an object or moves from one medium to another and then it can be reflected, refracted or absorbed.

Sound is produced by vibrating objects and requires a medium through which to travel. The rate of vibration is related to the pitch of the sound.

Note: *At this grade level, the discussion of light and sound should be based on observable behavior. Waves are introduced at the middle school level.*

Content Elaboration:

Light can travel through some materials, such as glass or water. Light can also travel through empty space, like from the sun to Earth. When light travels from one location to another, it goes in a straight line until it interacts with another object or material. When light strikes objects through which it cannot pass, shadows are formed. As light reaches a new material, it can be absorbed, refracted, reflected or can continue to travel through the new material; one of these interactions may occur or many may occur simultaneously, depending on the material.

Light can be absorbed by objects, causing them to warm. How much an object's temperature increases depends on the material of the object, the intensity of and the angle at which the light strikes its surface, how long the light shines on the object and how much light is absorbed. Investigating and experimenting with temperature changes caused by light striking different surfaces can be virtual or in a lab setting.

When light passes from one material to another, it is often refracted at the boundary between the two materials and travels in a new direction through the new material (medium). For example, a magnifying lens bends light and focuses it toward a single point. A prism bends white light and separates the different colors of light. Prisms and magnifying lenses can be used to observe the refraction of light.

Visible light can be emitted from an object (like the sun) or reflected by an object (like a mirror or the moon). The reflected colors are the only colors visible when looking at an object. For example, a red apple looks red because the red light that hits the apple is reflected while the other colors are absorbed. The additive rules for color mixing of light, other than the fact that white light is a mixture of many colors, are reserved for later grades. The wave nature of sound and light are not introduced at this level nor are parts of the electromagnetic spectrum other than visible light.

Pitch can be altered by changing how fast an object vibrates. Objects that vibrate slowly produce low pitches; objects that vibrate quickly produce high pitches. Audible sound can only be detected within a certain range of pitches. Sound must travel through a material (medium) to move from one place to another. This medium may be a solid, liquid or gas. Sound travels at

different speeds through different media. At this grade, how sound travels through the medium is not appropriate as atoms and molecules are not introduced until grade 6.

Once sound is produced, it travels outward in all directions until it reaches a different medium. When it encounters this new medium, the sound can continue traveling through the new medium, become absorbed by the new medium, bounce back into the original medium (reflect) or engage in some combination of these possibilities.

Light travels faster than sound. Technology, virtual simulations and models can help demonstrate the movement of light and sound. Experimentation, testing and investigation (3-D or virtual) are essential components of learning about light and sound properties.

Content Limits:

- Predictable movement of light through different media or empty space;
- Differences between objects that emit light (such as the sun) and objects that reflect light (such as an apple or the moon);
- Behavior of light when encountering a new medium (e.g., absorption, reflection, refraction, pass or travel through);
- Absorbed light causes objects to warm and the effects of the material, light intensity, angle, and time of exposure on the amount of heating;
- Color of objects as it relates to reflection and absorption of light;
- Predictable movement of sound as it travels outward from its source through different media;
- Relationships between the pitch of a sound and the vibration rate of an object;
- Behavior of sound when encountering a new medium (e.g., absorption, reflection, pass or travel through);
- Light travels (much) faster than sound;
- White light is the combination of all colors of light;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- The additive rules for color mixing of light;
- Values of the speed of light and sound in different media;
- The electromagnetic spectrum other than visible light;
- How sound travels through the medium at the molecular/atomic level (atoms and molecules are not introduced until Grade 6);
- Wave diagrams;
- Definitions of amplitude and wavelength;
- Prediction of the direction of refraction at a medium boundary;
- The order of colors in the visible spectrum.

Stimulus Attributes:

- Diagrams, images, charts or tables of light absorption, reflection, refraction, and passing through a medium (e.g., colors of light, mirrors, pigments, filters, lenses);
- Diagrams, images, charts or tables of sound absorption, reflection (echo), and passing through a medium;

- Simple ray diagrams (e.g., mirrors or refraction at a flat surface);
- Tables of sound data (speed in different substances);
- Temperature change data from light exposure with different intensities, angles, and/or times or on different surfaces (e.g. color, texture);
- Diagram, images, charts and tables of light sources and shadows;
- Diagram and images of instruments that produce sound;
- Primary sources documenting properties of light and sound.

Response Attributes:

Response options may include, but are not limited to, the following:

- Creating diagrams showing reflection, refraction and passing through a medium to illustrate light or sound phenomena (e.g., the color of objects, shadows, echoes);
- Comparing light and sound behaviors;
- Conducting an investigation to determine relationships between the surface properties, color, intensity, duration, or angle of incidence of absorbed light and change in temperature;
- Relating different pitches of sound to different rates of vibration (e.g. in stringed instruments);
- Planning an investigation to support a hypothesis about light or sound;
- Providing evidence to support that light travels in straight lines.

Distractors may include, but are not limited to, the following common misconceptions:

- Light is not needed to see.
- White is the absence of color.
- Color is due to emission not reflection.
- Color is not related to light.
- Sound travels fastest through air.
- Sound travels through space.
- Loudness and pitch are related.
- Sound can be created without material objects.
- Light rays can bend within a medium.

Topic: Interconnections within Ecosystems

This topic focuses on foundational knowledge of the structures and functions of ecosystems.

Content Statement

5.LS.1: Organisms perform a variety of roles in an ecosystem.
Populations of organisms can be categorized by how they acquire energy.

Food webs can be used to identify the relationships among producers, consumers and decomposers in an ecosystem.

Content Elaboration:
The content statements for fifth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's foundational theories: dynamic relationships within ecosystems. It is recommended that the content statements be combined and taught as a whole. For example, it is important that the ecological role of organisms is interwoven with a clear understanding that all living things require energy.

Plants and some microorganisms are producers. They are the foundation of the food web. Producers transform energy from the sun and make food through a process called photosynthesis. Animals get their energy by eating plants and other animals that eat plants. Animals are consumers and many form predator-prey relationships. Decomposers (primarily bacteria and fungi) are consumers that use waste materials and dead organisms for food. Decomposers also return nutrients to the ecosystem.

One way that ecosystem populations interact is centered on relationships for obtaining energy. Food webs are defined in many ways, including as a scheme of feeding relationships, which resembles a web. This web serves as a model for feeding relationships of member species within a biological community. Members of a species may occupy different positions during their lives. Food chains and webs are schematic representations of real-world interactions. For this grade level, it is enough to recognize that food webs represent an intertwining of food chains within the same biological community.

Organisms have symbiotic relationships in which individuals of one species are dependent upon individuals of another species for survival. Symbiotic relationships can be categorized as mutualism (where both species benefit), commensalism (where one species benefits and the other is unaffected), and parasitism (where one species benefits and the other is harmed).

Investigations of locally threatened or endangered species can be conducted and include considerations of the effects of remediation programs, species loss and the introduction of new species on the local ecosystem.

Note: *At this grade, species can be defined by using Ernst Mayer's definition "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups."*

Content Limits:

- The roles of living organisms are determined by how they acquire energy (e.g., producers, consumers and decomposers);
- Producers are the foundation of the food web;
- The roles and relationships of organisms within an ecosystem;
- Impact on the ecosystem as species are introduced or removed (e.g., endangered or threatened species, invasive species);
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Specific information about the process of photosynthesis (do not assess the steps, chemical reactions, reactants, or products other than the concept that energy from the sun is converted to a form useable to organisms);
- Energy pyramids (i.e., relative amounts of biomass at different trophic levels or the concept that useable energy is lost during energy transfers);
- Definition of species or population;
- Types of consumers (e.g., primary, tertiary).

Stimulus Attributes:

- Diagrams of food chains and webs;
- Charts with organism characteristics such as feeding habits;
- Real-world examples of symbiotic relationships;
- Data rich scenarios illustrating an established model of relationships between organisms in an ecosystem over time;
- Real-world scenarios involving species loss and/or introduction;
- Primary sources documenting changes and interactions in ecosystem.

Response Attributes:

Response options may include, but are not limited to, the following:

- Interpreting the roles and interactions of producers, consumers, and decomposers in a real-world context;
- Comparing the roles and relationships of organisms in a food chain or food web;
- Comparing symbiotic relationships;
- Using real-world interactions of organisms to interpret the relationships between organisms and how these relationships impact the ecosystem.
- Predicting the impact to ecosystems when organisms are introduced or removed.

Distractors may include, but are not limited to, the following common misconceptions:

- Organisms only eat one kind of food.
- All living things get energy from eating food.
- Organisms do not play a role in decomposition.

Topic: Interconnections within Ecosystems

This topic focuses on foundational knowledge of the structures and functions of ecosystems.

Content Statement

5.LS.2: All of the processes that take place within organisms require energy.

For most ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transformed by producers through the process of photosynthesis. That energy is used or stored by the producer and can be passed from organism to organism as illustrated in food webs.

Content Elaboration:

The content statements for fifth-grade life science are each partial components of a larger concept. The parts have been isolated to call attention to the depth of knowledge required to build to one of biology's foundational theories: dynamic relationships within ecosystems. It is recommended that the content statements be combined and taught as a whole. For example, it is important that the ecological role of organisms is interwoven with a clear understanding that all living things require energy. Virtual simulations and investigations can help demonstrate energy flow through the trophic levels.

Energy flows through an ecosystem in one direction, from the sun to photosynthetic organisms to consumers (herbivores, omnivores, carnivores) and decomposers. The exchange of energy that occurs in an ecosystem can be represented as a food web. The exchange of energy in an ecosystem is essential because all processes of life for all organisms require a continual supply of energy.

Direct and remote sensing (e.g., satellite imaging and other digital-research formats) can be used to help visualize what happens in an ecosystem when new producers, including invasive species, enter an ecosystem. The information gained should be used to determine the relationship between the producers and consumers within an ecosystem.

Content Limits:

- Energy necessary for life flows through an ecosystem in one direction.
- The sun is the primary source of energy for most ecosystems;
- Photosynthesis is the process in which sunlight is transformed by producers into energy;
- Energy is transferred and transformed in an ecosystem through interactions of organisms;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Specific information about the process of photosynthesis (do not assess the steps, chemical reactions, reactants or products other than the concept that energy from the sun is converted to a form useable by organisms);
- Conversion between different types of energy;
- Differences between energy transfer and energy transformation;
- Energy pyramids (i.e., relative amounts of biomass at different trophic levels or the concept that useable energy is lost during energy transfers);
- Definition of species or population.

Stimulus Attributes:

- Diagrams of food chains and webs;
- Charts and diagrams showing how feeding relationships relate to energy flows;
- Maps, satellite images and/or photographs that show types of organisms in an area and their relative abundance;
- Data-rich, real-world scenarios about the energy flow within an ecosystem;
- Primary sources that document changes in an ecosystem.

Response Attributes:

Response options may include, but are not limited to, the following:

- Interpreting the flow of energy between herbivores, omnivores and carnivores in a real-world scenario;
- Using data from an ecosystem to interpret the change of energy flow in an ecosystem when organisms are introduced or removed;
- Identifying sunlight as the major source of energy for most living things;
- Creating a food web illustrating the flow of energy based on a scenario;
- Providing evidence that the sun is the source of energy for most living things.

Distractors may include, but are not limited to, the following common misconceptions:

- Food is the original source of energy for all organisms.
- Energy flow is not cyclical.
- Energy is used up.
- Larger organisms always consume smaller organisms.
- Plants get energy from the ground or water.