Test Specifications: Grade 5 Science

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. A test blueprint is included, composed of a table identifying the range and distribution of items and points, grouped into various categories. The 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.

General Description of the Grade 5 Science Test

In 2010 Ohio adopted new rigorous academic content standards for Grade 5 Science. A model curriculum based on these new standards was adopted in 2011.

An achievement assessment that aligns to the new standards and model curriculum is mandated by Ohio Revised Code 3301.079. The assessment will be administered as a two-part summative exam, 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 year. There are two parts in order to provide flexibility in test administration for school districts. Both parts of the test are fixed forms that are administered in an online format. In addition to technology-enhanced items, the test will also contain constructed-response items that require the student to type or make a response into the computer interface. 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 the points.

Grade 5 Science Test Blueprint

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

Description of Item and Stimulus Types

Item Types

Item types are divided into four categories: multiple-choice, enhanced selected-response, machine-scored constructed response and human-scored.

A **multiple-choice** item may consist of the following:

- a brief statement that orients students to the context of the question;
- a stimulus (document, data table, graphic, etc.) on which the question is based;
- a question or prompt;
- a set of answer choices (most often four) that allows students to select one option in response to the question.

An **enhanced selected-response** item may consist of the following:

- a brief statement that orients students to the context of the question;
- a stimulus (document, data table, graphic, etc.) on which the question is based;
- a question or prompt;
- a set of answer choices that allows students to select multiple options in response to one question, matching options together to classify information, selecting evidence supporting an initial answer choice, or a very structured graphic-response interface.
- Enhanced selected-response items allow students to demonstrate deeper understanding than multiple-choice items by having multiple parts or multiple correct answers.

A **machine-scored constructed-response** item may consist of the following:

- a brief statement that orients students to the context of the question;
- a stimulus (document, data table, graphic, etc.) on which the question is based;
- a prompt;
- a graphic-response, text/numeric entry, or simulation interface.
    - A graphic-response interface allows students to manipulate objects to create a response to the question. The graphic-response interface may be a map, a chart or graph, a picture, a diagram, or an interactive simulation on which the students must draw or position objects correctly.
- Machine-scored constructed-response items offer the students a great degree of freedom to create their own response. These items allow students to demonstrate deeper understanding than multiple-choice or enhanced selected-response items by requiring students to construct their own response instead of selecting their answer from a given set of choices. These items are scored based on an item-specific rubric.

A **human-scored constructed-response** item consists of the following:

- a brief statement that orients students to the context of the questions (optional);
- one or more stimuli (documents, graphics, data displays, etc.) to which the questions refer (optional);
- a question or set of questions that require a detailed written response or responses. The responses are scored by trained scorers according to a rubric or set of rubrics that address multiple dimensions in students' work.

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, 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:

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

Item Specifications: Grade 5 Science

Earth and Space Science (ESS)

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: 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 and meteoroids orbit the sun.

Note: The shape of Earth's orbit is nearly circular (also true for other planets). Many graphics that illustrate the orbit overemphasize the elliptical shape, leading to the misconception regarding seasonal change being related to how close Earth is to the sun. The discussion of planet characteristics should be at an introductory level for this grade.

Content Elaboration:

Eight major planets in the solar system orbit the sun. Some of the planets have a moon or moons that orbit them. Earth is a planet that has a moon that orbits it. The planets' orbits are because of their gravitational attraction to the sun. Moons orbit around planets because of their gravitational attraction to the planets.

Asteroids are metallic, rocky bodies that orbit the sun but are too small to be classified as a planet. A meteor appears when a particle or chunk of metallic or stony matter called a meteoroid enters Earth's atmosphere from outer space. Comets are a mixture of ices (both water and frozen gases) that are not part of a planet. Pluto is classified as a dwarf planet (definition from http://www.nasa.gov).

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.

Note: Additional information about gravity is found in PS grade 5.

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 distance from the sun, 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);
- Differences between planets (inner and outer), dwarf planets, and other celestial bodies.

Do Not Assess:

- Labeling or naming specific planets;
- Values of size, temperature, atmospheric composition, distance from the sun to 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 photos from solar system investigations;
- Recent discoveries and projects (e.g., mission to Mars).

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.

Earth and Space Science (ESS)

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: 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 the Earth. Scaled models (3-D or virtual) and graphics can be used to show the vast difference in size between the sun and the 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. Stars appear in patterns called constellations, which can be used for navigation. Because they are so far away, they do not appear as large as the sun.

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 the Earth and other planets.

Current and new discoveries related to stars and the sun must be 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 (made of gas) 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.

Do Not Assess:

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

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.
  - Other stars are not suns for solar systems.
  - The sun has a solid surface.

Earth and Space Science (ESS)

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: Most of the cycles and patterns of motion between the Earth and 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. Earth's axis is tilted at an angle of 23.5°. This tilt, along with Earth's revolution around the sun, affects the amount of direct sunlight that the Earth receives in a single day and throughout the year. The average daily temperature is related to the amount of direct sunlight received. Changes in average temperature throughout the year are identified as seasons.

Note 1: The amount of direct sunlight that Earth receives is related to the altitude of the sun, which affects the angle of the sun's rays, and the amount of time the sun is above the horizon each day.

Note 2: Different regions around the world have seasonal changes that are not based solely on average temperature (e.g., rainy season, dry season, monsoon season).

Content Elaboration:

Models, interactive websites and investigations are required to illustrate the predictable patterns and cycles that lead to the understanding of day and night, seasons, years and the amount of direct sunlight Earth receives. Three-dimensional models should be used to demonstrate that the tilt of Earth's axis is related to the amount of direct sunlight received and seasonal temperature changes.

Seasonal change should be expanded in grade 5 to include regions of the world that experience specific seasonal weather patterns and natural weather hazards (e.g., hurricane season, monsoon season, rainy season, dry season). This builds upon making observations of the seasons throughout the school year in the earlier grades and prepares students for understanding the difference between weather and climate.

Content Limits:

- Cycles and patterns on Earth including the seasons, day and night, and the motion of the sun in the sky;
- The cause of cycles and patterns such as day and night, a year, and seasons;
- Seasonal weather patterns in specific regions (including hurricane, monsoon, and rainy or dry seasons) are predictable, and due to the yearly solar cycle;
- Earth's tilt and revolution as related to direct sunlight and seasons;
- Relationships between direct sunlight and temperature, the angle/altitude of the sun and amount of direct sunlight.

Do Not Assess:

- Phases of the moon;
- Specific atmospheric causes of seasonal weather patterns;
- Causes of eclipses or tides.

Stimulus Attributes:

- Diagrams, charts, and tables depicting the cycles (rotation and revolution) of the Earth in the solar system;
- Diagrams, charts, and tables depicting the tilt of the Earth in relationship to the sun;
- Charts and tables with data regarding average temperatures as they relate to the amount of direct sunlight;
- Global maps illustrating seasonal weather patterns and angle of sunlight.

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 seasons based on Earth's tilt and revolution around the sun;
- Relating using data the average temperature, seasons, and the angle of sunlight;
- Creating a model to demonstrate Earth's orbit around the sun and time (a year);
- Using diagrams and models to predict the position of the Earth and sun at various stages in the yearly cycle;
- Interpreting data (length of day, temperature) to determine seasonal changes and/or seasonal weather patterns;
- Interpreting a model of Earth and the sun and how it relates to seasons;
- Explaining how to create a model of Earth and the sun that shows the seasons;

- Using a model/graphic to explain why the sun or moon appears to move across the sky;
- Using data and evidence to make a conclusion about how the position of Earth and the sun relates to seasons and explain how the evidence supports this conclusion.

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

- Common misconceptions:
    - The sun moves instead of Earth moving.
    - Seasons caused by proximity to the sun.
    - The seasons are the same everywhere on Earth.
    - Night and day are the same everywhere on Earth.

Life Science (LS)

Topic: Interconnections within Ecosystems

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

Content Statement: 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 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 resemble 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. See the next content statement for details on grade-appropriate food webs.

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 must be conducted and include considerations of the effects of remediation programs, species loss and the introduction of new species on the local environment.

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." Assessments will not include the definition of species.

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 (e.g., symbiotic) of organisms within an ecosystem;
- Impact on the ecosystem as species are introduced or removed (e.g., endangered or threatened species, invasive species).

Do Not Assess:

- Specific information about the process of photosynthesis (do not assess the steps, chemical reactions, reactants, or products; the concept that energy from the sun is converted to food is the focus);
- 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;
- Definitions 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.

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;
- Using data and evidence to form conclusions about the roles of organisms within a given ecosystem and explain how the evidence supports the conclusions;
- Planning an investigation based on data from a real-world scenario to determine the impact of the introduction of an invasive species on the population of a local species.

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.

Life Science (LS)

Topic: Interconnections within Ecosystems

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

Content Statement: All of the processes that take place within organisms require energy.

For ecosystems, the major source of energy is sunlight.

Energy entering ecosystems as sunlight is transferred and transformed by producers into energy that organisms use through the process of photosynthesis. That energy then passes from organism to organism as illustrated in food webs.

In most ecosystems, energy derived from the sun is transferred and transformed into energy that organisms use by the process of photosynthesis in plants and other photosynthetic organisms.

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 photosynthetic organisms to consumers (herbivores, omnivores to 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.

Satellite imaging, remote sensing or other digital-research formats can be used to help visualize what happens in an ecosystem when new producers (e.g., Tamarisk plants) are introduced into 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.

Do Not Assess:

- Specific information about the process of photosynthesis (do not assess the steps, chemical reactions, reactants, or products; the concept that energy from the sun is converted to food is the focus);
- 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.

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;
- Using data from an ecosystem, make a conclusion about the change of energy flow in that ecosystem when organisms are introduced or removed and explaining how evidence supports the conclusion.

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

- Common misconceptions:
    - Food is the major source of energy.

- Energy flow is not cyclical.
- Larger organisms always consume smaller organisms.
- Plants get energy from the ground or water.

Physical Science (PS)

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: 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).

Earth pulls down on all objects with a gravitational force. Weight is a measure of the gravitational force between an object and the Earth.

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

Note: Gravity and magnetism are introduced (through observation) in PS grade 2.

*While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level. In Ohio, students will not be assessed on the differences between mass and weight until Grade 6.

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 same direction of an object's motion, the speed will increase. If a force is applied in the opposite direction of an object's motion, the speed will decrease. Generally, the greater the force acting on an object, the greater the change in motion. Generally, the more mass* an object has, the less influence a given force will have on its motion. If no forces act on an object, 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, the object will remain at rest.

Movement is measured by speed (how fast or slow the movement is). Speed is measured by time and distance traveled (how long it took the object to go a specific distance). Speed is calculated by dividing distance by time. Speed must be investigated through testing and experimentation. Real-world settings are recommended for the investigations when possible. Virtual investigations and simulations also can be used to demonstrate speed.

An object that moves with constant speed travels the same distance in each successive unit of time. In the same amount of time, a faster object moves a greater distance than a slower object. When an object is speeding up, the distance it travels increases with each successive unit of time. When an object is slowing down, the distance it travels decreases with each successive unit of time.

Speed must be explored and tested through investigations (3-D or virtual) inside and outside of the classroom. Video technology can be used to stop movement and measure changes at different steps in the investigations.

Note 1: This content can be taught in conjunction with the following ESS content: Everything on or anywhere near Earth is pulled toward Earth's center by gravitational force. Weight is a measure of this force. The planets are kept in orbit due to their gravitational attraction for the sun.

Note 2: While concepts are related to Newton's second law, remain conceptual at this grade. Knowing the name of the law 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 of speed 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 a force to start moving;
- An object moving at constant speed has no change in speed or direction if no force is acting on it.

Do Not Assess:

- Identification or definition of forces such as gravity, friction, magnetic force, push and pull;
- Momentum;
- Term inertia or references to Newton's Laws by name or number;
- Difference between mass and weight;
- Definition of mass;
- Mass and weight independently;
- 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;
- Balanced or unbalanced forces.

Stimulus Attributes:

- Distance and time data tables;
- Diagrams or pictures of moving objects;
- Realistic scenarios showing how the force acting on an object, and its mass/weight, affects its 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 three 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;
- Designing an investigation that determines how the mass/weight of an object (or amount of force acting on an object) affects how the motion of an object changes;
- Designing a solution to an engineering problem involving speed, force, and/or mass/weight.

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.

Physical Science (PS)

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: 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 also can 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 striking 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. Experiment with prisms and magnifying lenses to observe the refraction of light.

Visible light may 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.

Pitch can be changed 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. 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 (reflected) or engage in some combination of these possibilities.

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

Note: Students are not responsible for knowing the additive rules for color mixing of light other than the fact that white light is a mixture of many colors. The wave nature of sound and light are not introduced at this level nor are parts of the electromagnetic spectrum other than visible light. At this grade, how sound travels through the medium is not appropriate as atoms and molecules are not introduced until grade 6.

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);
- How 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;
- 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.

Do Not Assess:

- The additive rules for color mixing of light;
- The wave nature of sound and 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;
- Ray diagrams involving concave/convex lenses or mirrors;
- Prediction of the direction of refraction at a medium boundary;
- The order of colors in the visible spectrum.

Stimulus Attributes:

- Examples of light absorption, reflection, refraction, and passing through a medium (e.g., mirrors, pigments, filters, lenses);
- Examples of sound absorption, reflection (echo), and passing through a medium;
- Simple ray diagrams (e.g., mirrors or refraction at 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).

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;
- Performing 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 the hypothesis that sound travels in all directions;
- Providing evidence to support that light travels in straight lines.
- Designing an engineering solution to a real-world scenario involving light absorption, reflection and heat;
- Planning an investigation to determine relationships between the surface properties, color, intensity, duration, or angle of incidence of absorbed light and change in temperature.

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 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.