

[BACK TO INDEX](#)[BACK TO K-8 INDEX](#)**MODEL CURRICULUM GRADE 5****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****Prior Concepts Related to Solar System**

**PreK-2:** The moon, sun and stars can be observed at different times of the day or night. The observable shape of the moon changes throughout the month, the sun's position in the sky changes in a single day and from day to day and the sun is the principal source of energy. Earth's atmosphere is discussed.

**Grades 3-4:** All objects are made of matter and light is a form of energy. Earth's surface is discussed and gravitational forces are introduced.

**Grade 5 Concepts**

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.**

**Future Application of Concepts**

**Grades 6-8:** The interior and exterior composition of Earth, Earth's unique atmosphere, light waves, electromagnetic waves, interactions between the Earth, moon and sun, and gravitational forces are explored in more depth.









**High School:** Galaxies, stars and the universe are studied in the physical sciences.

**EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS**

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

[BACK TO INDEX](#)[BACK TO K-8 INDEX](#)**VISIONS INTO PRACTICE: CLASSROOM EXAMPLES**

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

<b>DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS</b>	<b>DEMONSTRATING SCIENCE KNOWLEDGE</b>	<b>INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS</b>	<b>RECALLING ACCURATE SCIENCE</b>
<p>Choose a planet (other than Earth) and research and develop a plan to colonize the planet with humans. Evaluate current conditions and what would be needed to meet the basic requirements for humans to live on Mars.</p> <p>Critique the plan. Ask: <i>Is the plan feasible? What equipment is required?</i></p> <p>Make a final recommendation based on the research. Present recommendations to the class.</p>   	<p>Choose a major planet. Plan and build a scaled model that can demonstrate the planet size and rotation orbit in relationship to the sun and the Earth. Conduct the demonstration (with explanation) to the class.</p>  	<p>Make a table, chart or graphic that interprets the general characteristics of the major planets in the solar system. Use real data (current) to compare and contrast the findings.</p>	<p>Recognize that there are eight major planets in the solar system and they all orbit the sun.</p> <p>Recognize that other celestial bodies also orbit the sun. These can include dwarf planets, comets, asteroids, meteoroids and comets.</p>
		<p>Research the history of the exploration of the solar system or a recent space discovery. Make a timeline or write a report to interpret and clarify the major events, the tools and technology used, and the discoveries made. Share findings with the class.</p>  	<p>Identify a telescope as a tool that can be used to magnify the appearance of objects in the solar system.</p> 

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### INSTRUCTIONAL STRATEGIES AND RESOURCES

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Ensuring that relevant and up-to-date information about the solar system is important. **NASA's** website offers a good starting point with helpful resources, references, content-specific data for the solar system, recent research and discoveries to help teachers prepare to teach about the solar system.
- **Science News for Kids** is a resource that provides topics and current events that include new discoveries and research related to the solar system and space. These articles can help form classroom discussions and research ideas for students.
- The **University of Chicago** provides ideas and background for student projects related to the solar system and solar exploration. One project combines science and investigation through the role of a reporter. Students collaborate and learn about asking investigative questions. By presenting the science material in a different format, students of all ability levels can be engaged in learning.
- **NSTA** provides learning modules called **SciPacks** that are designed to increase teacher content knowledge through inquiry-based modules. This module addresses the Earth, moon and sun.
- It is important to incorporate inquiry and student investigation into learning about the solar system. Researching the existing conditions on different planets or in space and comparing them to the conditions that support life on Earth can help in understanding the history of Earth and the solar system. **Life on Mars** is an example of a student research idea that helps with understanding properties. Using real planetary **characteristics** and sizes can make the research authentic.
- Helping students understand the **distances** within the solar system and the size of the solar system can be difficult. Using student-made scaled models of the solar system (based on actual data) can develop that understanding.
- Information about **historic discoveries and events** as related to the solar system can be located at the NASA website.

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### COMMON MISCONCEPTIONS

- **Margarita–Grades 5-8** is a case study that outlines different ways of approaching science for ESL students (see below), available at <http://www.learner.org/resources/series21.html>.
- NASA lists common misconceptions for all ages about the sun and the Earth at <http://www-istp.gsfc.nasa.gov/istp/outreach/sunearthmiscons.html>.
- For examples of misconceptions that elementary students may have about the solar system and space (astronomy), and resources to address misconceptions through investigation, visit <http://amasci.com/miscon/opphys.html>.

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### DIVERSE LEARNERS

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at [this site](#). Resources based on the Universal Design for Learning principles are available at [www.cast.org](http://www.cast.org).

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### CLASSROOM PORTALS

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[BACK TO INDEX](#)[BACK TO K-8 INDEX](#)**MODEL CURRICULUM GRADE 5****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****Prior Concepts Related to Sun**

**PreK-2:** The sun can be observed at different times of the day or night. The sun's position in the sky changes in a single day and from day to day. The sun is the principal source of energy.

**Grades 3-4:** All objects are made of matter. Heat and light are forms of energy. Gravitational forces are introduced.

**Grade 5 Concepts**

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.

**Future Application of Concepts**

**Grades 6-8:** Earth's unique atmosphere, light waves, electromagnetic waves, interactions between the Earth, moon and sun (including the phases of the moon and tides), and gravitational forces are explored in more depth.

**High School:** Galaxies, stars and the universe are studied in the Physical Sciences.

**EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS**

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

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**DESIGNING TECHNOLOGICAL/ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS**

Solar energy collection is most effective in areas that receive direct sunlight for long periods of time. Research areas on Earth that receive direct sunlight (can use information and data from the model suggested for Demonstrating Science Knowledge). Critique different zones of the Earth. Evaluate the data and make a recommendation (using the scientific data) to locate a solar energy facility. Share and defend the recommendation with the class.

**DEMONSTRATING SCIENCE KNOWLEDGE**

Choose a major planet. Plan and build a scaled model that can demonstrate the planet size and rotation orbit in relationship to the sun and the Earth. Conduct the demonstration (with explanation) to the class.

**INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS**

Differentiate between the sun and a red dwarf or blue giant star. Make a table or chart to represent the comparison.

**RECALLING ACCURATE SCIENCE**

Identify the sun as a medium-sized star and the only star in the solar system.

Recall that there are many other stars in the universe and they are different sizes, but the sun appears larger because it is closer to the Earth.

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- **NASA** provides background data about the sun (including recent discoveries, research and photos) to help teachers prepare for teaching about the sun.
- **NSTA** provides learning modules called **SciPacks** that are designed to increase teacher content knowledge through inquiry-based modules. This module addresses the sun as a star.
- It can be difficult for fourth-grade students to understand the size and scale of the solar system. Setting up scaled models (e.g., making the classroom into the solar system using actual distance data) or investigating the solar system by setting up a **planetarium** can increase understanding. It is important to use student inquiry and investigation in developing the models.
- New technology and discoveries are important to include in learning about the sun and the solar system. Projects such as NASA's **Solar Orbiter** or the **Solar Probe Plus** can be used in classroom discussions to engage student interest and ensure that new findings are part of the curriculum.
- **Mission Science** provides games and activities for students that can supplement what is being learned in the classroom and generate interest. The computer games are interactive and based on accurate science.

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### COMMON MISCONCEPTIONS

- NASA lists common misconceptions for all ages about the sun and the Earth at <http://www-istp.gsfc.nasa.gov/istp/outreach/sunearthmiscons.html>.
- For examples of misconceptions that elementary students may have about the solar system and space (astronomy), and resources to address misconceptions through investigation, visit <http://amasci.com/miscon/opphys.html>.

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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****Prior Concepts Related to Earth, Sun and Moon**

**PreK-2:** The sun and moon can be observed at different times of the day or night. The sun's position in the sky changes in a single day and from day to day. The observable shape of the moon changes throughout the month. The sun is the principal source of energy.

**Grades 3-4:** All objects are made of matter. Heat and light are forms of energy. Gravitational forces are introduced.

**Grade 5 Concepts**

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.

**Future Application of Concepts**

**Grades 6-8:** Earth's unique atmosphere, light waves, electromagnetic waves, interactions between the Earth, moon and sun (including the phases of the moon and tides), climate studies, and gravitational forces are explored in more depth.

**High School:** Galaxies, stars and the universe are studied in the Physical Sciences.

**EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS**





This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

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### VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

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DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
<p>Solar energy collection is most effective in areas that receive direct sunlight for long periods of time. Research specific locations on Earth that receive direct sunlight. Evaluate the data and make a recommendation (using the scientific data) to locate a solar energy facility. Share and defend the recommendation with the class.</p> 	<p>Using a simple model, investigate the positions of the sun, moon and Earth to detect and test the reasons why the moon and sun appear to change position in the sky and the phases of the moon.</p>  <p><b>Note: The names of the phases are not the emphasis at this grade level. The emphasis is on observational differences. Names of phases are found in grade 7.</b></p>	<p>Represent the sun, moon and Earth and their orbits graphically and to scale. Use actual data and measurements for the representation.</p> 	<p>Recognize that the rotation of Earth on its axis produces day and night, which is why the sun, stars and moon appear to change position in the sky.</p> 

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- **The National Atlas** mapping project provides maps that show areas within the United States that are effective in generating solar energy. This can be a starting resource for the Designing Solutions section listed in the classroom examples.
- Using **specific data** to determine the actual distances and sizes of objects within the solar system is an important part of understanding Earth's role in the solar system. The characteristics of the Earth and the relationship of the rotation and orbit of Earth and the seasons are all related to the cycles within the solar system.
- Modeling the movement within the solar system and the resultant **moon and moon phases** is important in understanding the processes required. Names of the lunar phases are not the emphasis; the processes and positions of the sun, Earth and moon during the phases should be the focus.
- Collecting background information about how direct sunlight is actually measured and using the direct sunlight data to understand weather and solar energy are important. **NASA** provides information for the teacher about how direct sunlight measurements are collected.

### COMMON MISCONCEPTIONS

- *Beyond Penguins* and Polar Bears is an online magazine for K-5 teachers. Misconceptions about why there are seasons are common at this age (e.g., the Earth is closer to the sun in the summer and that is why it is so hot). For a list of common misconceptions and ways to address them, visit <http://beyondpenguins.ndsl.org/issue/column.php?date=May2008&departmentid=professional&columnid=professional!science&test>.
- NASA lists common misconceptions for all ages about the sun and the Earth at <http://www-istp.gsfc.nasa.gov/istp/outreach/sunearthmiscons.html>.
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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****Prior Concepts Related to Behavior, Growth and Changes**

**PreK-2:** Plants get energy from sunlight. Animals get energy from plants and other animals. Living things cause changes on Earth.

**Grade 5 Concepts**

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.**

**Future Application of Concepts**

**Grades 6-8:** The importance of biodiversity within an ecosystem is explored.

**High School:** The concepts of evolution and biodiversity are explored.

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<p>Design and build a self-sustaining ecosystem (e.g., terrarium, bottle biology). Considerations for the ecosystem include the size of the container, the location to create the proper temperature, light and humidity, and organisms that will support one another.</p> 	<p>Investigate change in an established model of an ecosystem over time (e.g., terrarium, aquarium). Answer: <i>What would happen with removal or introduction of one kind of living thing (e.g., one species of producers not all producers)?</i></p> <p>Design experiments to observe what actually happens when one species is changed.</p>  <p><b>Note: At this grade, species can be defined by using Ernst Mayer's definition of "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups." Students will not be assessed on the definition of species at this grade level.</b></p>	<p>Compare the roles of producers, consumers and decomposers and explain how they work together within an ecosystem.</p> 	<p>Given a list of organisms and a description of their interactions within an environment, classify them as producers, consumers, decomposers or by type of symbiotic relationships (mutualism, commensalism and parasitism).</p> 

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- Conduct a field study involving a hands-on investigation of a rotting log in a temperate forest. Examine the relationships among organisms (e.g., decomposers, green plants, insects, worms) found in the soil.
- Based on observations of the local environment, build a food web describing each organism's role and impact within the food web.
- NSTA offers a content-rich segment for ecosystem study. **Coral Reef Ecosystems: Interdependence** develops understanding of the interactions and energy flow between organisms in a food web.
- ODNR-Division of Wildlife's **A to Z Species Guide** has photos, information, tracks and sounds of Ohio's wild animals. The guide also includes the diet of organisms.
- **Project Wild** was developed through a joint effort of the Western Association of Fish and Wildlife Agencies and the Council for Environmental Education. This program helps students learn basic concepts about wild animals, their needs and importance and their relationships to people and the environment. The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the **ODNR Website**. The following activities are helpful in teaching this content. **Quick Frozen Critters**—Through a game of freeze tag, students will become part of a predator/prey interaction. **What's for Dinner**—Students list and analyze sources of food to illustrate that all animals, including people, depend on plants as a food source. **Surprise Terrarium**—students create a classroom terrarium to illustrate animal behavior. **Good Buddies**—students research pairs of animals, play a card game, and classify the pairs of animals according to the three major forms of symbiotic relationships. **Designing a Habitat (Aquatic WILD)**—Students design a habitat suitable for aquatic wildlife to survive.

### Career Connection

When examining factors that impact white-tailed deer population in Ohio, students will determine the implications for a community when the population decreases or increases. After students determine the implications for a community, students will identify careers directly or indirectly impacted in addressing the issues. This conversation will offer an opportunity to discuss how ecosystems can impact an economy. Environmental circumstances dictate demands and influence the necessity of certain careers.

### COMMON MISCONCEPTIONS

- The Annenberg Media series **Essential Science for Teachers** can be used to provide greater insight to misconceptions children hold about living things and energy. Classroom videos and lessons are provided to help students avoid these misconceptions.
- **AAAS' Benchmarks 2061 Online, Chapter 15, 5e, Flow of Matter and Energy**, Plant and Animal Nutrition, outlines children's misconceptions about energy in relationship to producers and consumers.

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- Many **Project Wild** activities feature Universal Design for Learning principals by providing multiple means of concept representation; means of physically interacting with materials; and multiple means of engagement, including collaboration and communication. **Quick Frozen Critters**—Through a game of freeze tag, students will become part of a predator/prey interaction. **What's for Dinner**—Students list and analyze sources of food to illustrate that all animals, including people, depend on plants as a food source. **Surprise Terrarium**—students create a classroom terrarium to illustrate animal behavior. **Good Buddies**—students research pairs of animals, play a card game, and classify the pairs of animals according to the three major forms of symbiotic relationships. **Designing a Habitat (Aquatic WILD)**—Students design a habitat suitable for aquatic wildlife to survive.

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**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****Prior Concepts Related to Behavior, Growth and Changes**

**PreK-2:** Living things have basic needs, which are met by obtaining materials from physical environments.

**Grade 5 Concepts**

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.

**Future Application of Concepts**

**Grades 6-8:** Concepts will build for an understanding of the interdependencies and interrelationships of organisms that are required to build stability in an ecosystem.

**High School:** Photosynthesis will be introduced.

**Note: The chemical details of photosynthesis will be addressed in grade 10. This is just an introduction of the process, not the details of the process.**

**EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS**





This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

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### VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

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<p>Design and build a self-sustaining ecosystem (e.g., terrarium, bottle biology). Considerations for the ecosystem include the size of the container, the location to create the proper temperature, light and humidity, and organisms that will support one another.</p> 	<p>Investigate change in an established model of an ecosystem over time (e.g., terrarium, aquarium). Answer: <i>What would happen if one factor of the environment changes (e.g., temperature increased or decreased, higher intensity of sunlight)?</i> Design experiments to observe what actually happens when one environmental factor is changed.</p> 	<p>Explain ways that humans can improve the health of ecosystems (e.g., recycling wastes, establishing rain gardens, planting native species).</p>  <p><b>Note: At this grade, species can be defined by using Ernst Mayer's definition of "groups of actually or potentially interbreeding natural populations, which are reproductively isolated from other such groups." Students will not be assessed on the definition of species at this grade level.</b></p>	<p>Given a list of common organisms and a description of their environmental interactions, draw a food web using arrows to illustrate the flow of energy. Properly identify the producers and consumers.</p> 

### INSTRUCTIONAL STRATEGIES AND RESOURCES

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- Given an ecosystem, create an illustration to explain the flow of energy within that system (food web, food chain). For example, as part of research on an endangered species, the species' energy relationships could be documented in a food web. The focus at this stage is on what eats what in various environments, not the chemical processes of energy transformation and transfer. ODNR-Division of Wildlife's [A to Z Species Guide](#) has photos, and information, including diet, of Ohio's wild animals.
- The Annenberg Media series *Essential Science for Teachers: Life Science: Session 7* provides information about populations of organisms that live and interact together. The focus is on the process of energy flow between producers, consumers and decomposers.
- Project Wild* was developed through a joint effort of the Western Association of Fish and Wildlife Agencies and the Council for Environmental Education. This program helps students learn basic concepts about wild animals, their needs and importance and their relationships to people and the environment. The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the [ODNR Website](#). In *Move Over Rover* students play a game where they have to identify characteristic animals found in several ecosystems, match those animals to the environments in which they live and identify food chains and food webs within the ecosystems. In *Surprise Terrarium (Wild)* and *Designing a Habitat (Aquatic Wild)* students design and build habitats for animals.

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### COMMON MISCONCEPTIONS

- **Beyond Penguins and Polar Bears** is an online magazine for K-5 teachers that provides information for misconceptions about plants and how they acquire energy.
- The Annenberg Media series **Essential Science for Teachers** can be used to provide greater insight to misconceptions children hold about living things and energy. Classroom videos and lessons are provided to help students avoid these misconceptions.
- **AAAS' Benchmarks 2061 Online, Chapter 15**, 5e, *Flow of Matter and Energy*, Plant and Animal Nutrition, outlines children's misconceptions about energy in relationship to producers and consumers.

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### DIVERSE LEARNERS

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at [this site](#). Resources based on the Universal Design for Learning principles are available at [www.cast.org](http://www.cast.org).

- Many *Project Wild* activities feature Universal Design for Learning principals by providing multiple means of concept representation; means of physically interacting with materials; and multiple means of engagement, including collaboration and communication. In *Move Over Rover* students play a game where they have to identify characteristic animals found in several ecosystems, match those animals to the environments in which they live and identify food chains and food webs within the ecosystems. In *Surprise Terrarium* (Wild) and *Designing a Habitat* (Aquatic Wild) students design and build habitats for animals.

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### CLASSROOM PORTALS

*These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.*

A series of case studies of K-8 science classrooms by the Smithsonian and Harvard University can be found at <http://www.learner.org/resources/series21.html>. The case studies called *Sarah—Grade 5*, *Tom—Grade 5*, and *Erien, Year One—Grade 5* provide examples of developing meaningful science assessments, learning core science concepts and using effective questioning techniques for scientific inquiry.



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## MODEL CURRICULUM GRADE 5

### 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 1: 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

##### Prior Concepts Related to Force and Motion

**PreK-2:** Motion is described as a change in position. Forces are introduced as pushes and pulls. Forces are needed to change the motion of objects. Greater force on an object results in a greater change of motion.

**Grades 3-4:** Forces in nature are responsible for water movement, wind movement and movement of sediment through the process of erosion (ESS).

##### Grade 5 Concepts:

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.**

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**Grades 6-8:** *Force and Motion* involve both magnitude and direction. Two equal forces in opposite directions can give a net force of zero. Position vs. time and speed vs. time graphs are used to represent motion. Fields are introduced for forces that act over a distance.

**High School:** Newton's second law is used to solve mathematical problems in one and two dimensions.

\*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.

**EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS**

This section provides definitions for Ohio's science cognitive demands, which are intrinsically related to current understandings and research about how people learn. They provide a structure for teachers and assessment developers to reflect on plans for teaching science, to monitor observable evidence of student learning, and to develop summative assessment of student learning of science.

**VISIONS INTO PRACTICE: CLASSROOM EXAMPLES**

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
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**Investigate changes in motion.**

Plan and implement a scientific experiment that determines how the mass\* of an object (or amount of force acting on an object) affects how the motion of an object changes.

Analyze the data to determine trends.

Formulate a conclusion.



Represent the data graphically.



Recognize that increasing the force acting on an object will result in greater changes in motion.

Recognize that objects with greater mass\* will change their motion less than objects with less mass\*.

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**Design a way to determine speed from an airplane.**

Design a system by which police officers could make observations from an airplane to determine the speed of a car. Give an example of how the speed could be calculated from the measurements.



Clarify specifically how data will be measured and how it will be used to determine the speed of the car.



Recall the mathematical relationship between distance, time and speed.

Identify what factors must be measured to determine speed.

Predict what will happen to the motion of an object. Provide the speed and direction of motion and a force diagram on the object. Explain the prediction.



Compare and rank the relative change in motion for three objects of different masses that experience the same force.



Identify three ways the motion of an object can be changed (e.g., speed up, slow down, change direction).

Identify two factors that influence the amount of change in motion of an object.

\*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.

**INSTRUCTIONAL STRATEGIES AND RESOURCES**

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- **Forces and movement**, an interactive simulation from BBC Schools, gives students the chance to try different forces and weights to see how the movement of a car is changed.

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### COMMON MISCONCEPTIONS

- **Common misconceptions** about forces and motion at this grade level include:
  - Time can be measured without establishing the beginning of the interval.
  - The only natural motion is for an object to be at rest.
  - If an object is at rest, no forces are acting on the object.
  - Only animate objects can exert a force. Thus, if an object is at rest on a table, no forces are acting on it.
  - Force is a property of an object.
  - An object has force and when it runs out of force, it stops moving.
  - The motion of an object is always in the direction of the net force applied to the object.
  - Large objects exert a greater force than small objects.
  - A force is needed to keep an object moving with a constant speed.
- **Misconceptions in physical science** at this grade level include:
  - Any quantity can be measured as accurately as you want.
  - The only way to measure time is with a clock or a watch.
  - Time has an absolute beginning.
  - **Gravity only acts on things when they are falling.**
  - Only animate things (people, animals) exert forces; passive ones (tables, floors) do not exert forces.
  - A force applied by a hand (or other object), still acts on an object after the object leaves the hand.

### DIVERSE LEARNERS

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at [this site](#). Resources based on the Universal Design for Learning principles are available at [www.cast.org](http://www.cast.org).

### CLASSROOM PORTALS

*These are windows into the classroom through webcasts, podcasts or video clips to exemplify and model classroom methods of teaching science using inquiry.*

Donna demonstrates strategies for **working with a diverse group of students** in this video on demand produced by Annenberg. While the content shown does not relate to this content statement, the strategies shown can be adapted to all science content. Once you get to the Annenberg site, select number four, *Donna–Grade 5*.

Sarah demonstrates strategies for **promoting lasting and deep student understanding** in this video on demand produced by Annenberg. While the content shown does not relate to this content statement, the strategies shown can be adapted to all science content.

Tom, a new fifth-grade teacher, works with many special needs students in this video on demand produced by Annenberg. Tom is working to incorporate more **formative assessment** in his teaching and uses strategies such as storyboards and concept mapping to reach his diverse learners. While the content shown does not relate to this content statement, the strategies shown can be adapted to all science content.

Erien, a student teacher in a suburban fifth-grade classroom, is learning how to focus students with **questioning strategies** and manage classroom discussions in this video on demand produced by Annenberg. While the content shown does not align with this content statement, the strategies shown can be adapted to all science content.

[BACK TO INDEX](#)[BACK TO K-8 INDEX](#)**MODEL CURRICULUM GRADE 5****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.

\*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 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****Prior Concepts Related to Light and Sound**

**PreK-2:** Sound is related to vibrations (PS). The moon, sun and stars are visible at different times. The sun is the principal source of energy. Sunlight affects the warming and cooling of air, water and land (ESS).

**Grades 3-4:** Objects with energy can cause motion or create change. Energy can transfer between objects and locations. Light energy from the sun can cause plants to grow (LS).

**Grade 5 Concepts:**

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.

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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.

#### Future Application of Concepts

**Grades 6-8:** The atomic nature of matter is introduced and energy is classified as kinetic and potential. Waves are introduced. Energy transfer and transformation, and conservation of energy are explored further.

**High School:** The wave nature of light and sound is expanded upon including mathematical analysis of wavelength, frequency and speed, and the Doppler effect.

### EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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### VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

This section provides examples of tasks that students may perform; this includes guidance for developing classroom performance tasks. It is not an all-inclusive checklist of what should be done, but is a springboard for generating innovative ideas.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
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#### Investigate reflection.

Design a mirror system to use when building a periscope. <http://pbskids.org/zoom/activities/sci/periscope.html>

**Note:** Many different ideas for building the exterior structure of the periscope can be found at <http://www.sciencetomaker.org/periscope/index.html>. However, please note that in order to meet this cognitive demand, students must be able to experiment to determine the placement of the mirrors. Instructions on how the teacher can make inexpensive mirrors out of old CDs and DVDs can be found at <http://www.sciencetomaker.org/periscope/asmbICD.htm>

Plan and implement a scientific investigation to determine the ideal angle to place a reflective surface to bend light through a right angle.

Draw a picture of the periscope design and trace the path of light as it travels from the object to the eye.

Recognize that the angle that light approaches a reflective surface affects the direction in which the light is reflected.

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**Investigate refraction.**

Plan and implement a scientific experiment to investigate what happens when light enters a new medium (e.g., passing from air to water, passing from Jell-O® to air).

Pictorially represent the path light takes when traveling from one medium to another.

Recognize that refraction involves bending of light when passing into a new medium.

**Investigate the relationship between length and pitch.**

Design two different musical instruments, one using blowing and one using plucking, that can create the same three notes.

Plan and implement a scientific investigation to investigate how the length of PVC tubing affects the pitch of the sound.

Summarize the data in a way that is clear and easy to understand.

Recognize that longer tubes produce lower pitches and shorter tubes produce higher pitches.

Verbally explain how the design of the instrument allows different pitches to be produced.

**Explore properties of light and sound.**

Design, construct and test a laser tag game prototype system that uses a system of mirrors and lenses to direct light through a simple maze to strike targets.

Draw a picture of a pencil half-submerged in a cup of water. Trace the path of light as it travels from a submerged part of the pencil to the eye. Use this picture to explain why the pencil appears to be bent or broken when placed in water.

Recall that increasing the rate of vibration can increase the pitch of a sound.



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### INSTRUCTIONAL STRATEGIES AND RESOURCES

This section provides additional support and information for educators. These are strategies for actively engaging students with the topic and for providing hands-on, minds-on observation and exploration of the topic, including authentic data resources for scientific inquiry, experimentation and problem-based tasks that incorporate technology and technological and engineering design. Resources selected are printed or Web-based materials that directly relate to the particular Content Statement. It is not intended to be a prescriptive list of lessons.

- The **Utah Education Network** shows how to construct lenses out of lemon Jell-O® that could be used for inquiry activities dealing with light for schools with limited resources.
  - How We See Things, an **interactive simulation** from BBC Schools, allows students to explore the path light takes with different orientations of mirrors. Students place mirrors in different locations with different orientations to alter the path of light to hit a target.
  - **Changing Sounds**, an interactive simulation from BBC Schools, demonstrates the differences between pitch and loudness and allows students to experiment with different ways to change the pitch and loudness of different types of sounds from a guitar.
  - **Light and Dark**, an interactive simulation from BBC Schools, allows students to experiment with the differences between objects that can be seen because they give off light and objects that can be seen because they reflect light.
  - **Seeing the Light** is an article from the December 2009 issue of Science and Children. It proposes that teaching the concepts of light from a photon model is more concrete for upper-elementary students than teaching from a wave model. It includes descriptions of how common light phenomena can be explained using a photon model.
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### COMMON MISCONCEPTIONS

- Many incorrectly think that sound travels best through air.
- Students have difficulty comprehending that there is no color if there is no light.
- **Students believe** that light just is and has no origin.
- Students believe that the addition of all colors of light yields black.
- **Common misconceptions about sound** pertaining to this content statement and grade level include:
  - Sounds can be produced without using any material objects.
  - Hitting an object harder changes the pitch of the sound produced.
  - Human voice sounds are produced by a large number of vocal cords that all produce different sounds.
  - Loudness and pitch of sounds are the same things.
  - You can see and hear a distinct event at the same moment.
  - Sounds can travel through empty space (a vacuum).
  - Sounds cannot travel through liquids and solids.
  - In wind instruments, the instrument itself vibrates (not the internal air column).
  - Music is strictly an art form; it has nothing to do with science.
  - In actual telephones, sounds (rather than electrical impulses) are carried through the wires.
  - Ultrasounds are extremely loud sounds.
  - Megaphones create sounds.
- **Common misconceptions about light** pertaining to this content statement and grade level include:
  - Light is associated only with a source and/or its instantaneous effects.
  - Light is not considered to exist independently in space.
  - Light is not conceived as moving from one point to another with a finite speed.
  - An object is seen whenever light shines on it, with no recognition that light must move between the object and the observer's eye.
  - A shadow is something that exists on its own.
  - Light pushes the shadow away from the object to a wall, the ground or other surface where the shadow lies.
  - Shadows are "dark reflections" of objects.
  - Lines drawn outward from a light bulb in a sketch represent the "glow" surrounding the bulb.
  - Light from a bulb only extends outward a certain distance and then stops. How far it extends depends on the brightness of the bulb.
  - Light is reflected away from shiny surfaces, but light is not reflected from other surfaces.
  - Light always passes straight through transparent material (without changing direction).
  - When an object is viewed through a transparent material, the object is seen exactly where it is located.
  - Light fills the room as water fills a bathtub.
  - No mechanism between the light, the object and the eye produces vision.

### DIVERSE LEARNERS

Strategies for meeting the needs of all learners including gifted students, English Language Learners (ELL) and students with disabilities can be found at [this site](#). Resources based on the Universal Design for Learning principles are available at [www.cast.org](http://www.cast.org).