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Grade 7

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: ORDER AND ORGANIZATION

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be described by simple principles. These principles are related to the properties or interactions within and between systems.

SCIENCE INQUIRY AND APPLICATION

- During the years of grades 5-8, all students must use the following scientific processes, with appropriate **laboratory safety techniques**, to construct their knowledge and understanding in all science content areas:
- Identify questions that can be answered through scientific investigations;
- Design and conduct a **scientific investigation**;
- Use appropriate mathematics, tools and techniques to gather data and information;
- Analyze and interpret data;
- Develop descriptions, models, explanations and predictions;
- Think critically and logically to connect evidence and explanations;
- Recognize and analyze alternative explanations and predictions; and
- Communicate scientific procedures and explanations.

STRANDS

Strand Connections: Systems can exchange energy and/or matter when interactions occur within systems and between systems. Systems cycle matter and energy in observable and predictable patterns.

EARTH AND SPACE SCIENCE (ESS)	PHYSICAL SCIENCE (PS)	LIFE SCIENCE (LS)
Topic: Cycles and Patterns of Earth and the Moon This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.	**Topic: Conservation of Mass and Energy** This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy.	**Topic: Cycles of Matter and Flow of Energy** This topic focuses on the impact of matter and energy transfer within the biotic component of ecosystems.

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CONDENSED CONTENT STATEMENTS

- The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere.
- Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns.
- The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere.
- The relative patterns of motion and positions of the Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon.
- The properties of matter are determined by the arrangement of atoms.
- Energy can be transformed or transferred but is never lost.
- Energy can be transferred through a variety of ways.
- Matter is transferred continuously between one organism to another and between organisms and their physical environments.
- In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.

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MODEL CURRICULUM GRADE 7

EARTH AND SPACE SCIENCE (ESS)

Topic: Cycles and Patterns of Earth and the Moon

This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.

CONTENT STATEMENT

The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere.

Thermal energy is transferred as water changes state throughout the cycle. The cycling of water in the atmosphere is an important part of weather patterns on Earth. The rate at which water flows through soil and rock is dependent upon the porosity and permeability of the soil or rock.

Note: Contamination can occur within any step of the hydrologic cycle. Ground water is easily contaminated as pollution present in the soil or spilled on the ground surface moves into the ground water and impacts numerous water sources.

CONTENT ELABORATION

Prior Concepts Related to Hydrologic Cycle

PreK-2: Water is observed through weather. Water is in the atmosphere. Water can be a solid, a gas and a liquid.

Grades 3-5: Water is present in soil. Water is a non-living resource. Properties of the different states of water, how water can change the surface of Earth, and how water is a factor in some weather-related events (e.g., flooding, droughts) are discussed.

Grade 6: The changes in the state of water are related to motion of atoms (changes in energy). Water flows through rock and soil (porosity and permeability).

Grade 7 Concepts

The different pieces of the hydrologic cycle (e.g., properties of water, changes of state, relationships of water to weather, effects of water on Earth's surface) from the elementary grades are formally combined in grade 7 and applied to the components of the hydrologic cycle.

The movement of water through the spheres of Earth is known as the hydrologic cycle. As water changes state and energy is transferred, it cycles from one sphere into another (e.g., water transfers from the hydrosphere to the atmosphere when evaporation occurs). Ground water and surface water quality are important components of the hydrologic cycle. The porosity and permeability of the rock and/or soil (grade 6) can affect the rate at which the water flows. The pattern of the cycling illustrates the relationship between water, energy and weather.

The movement of water in the cycle also can move contamination through each of the spheres. Relating water flow to geographic and topographic landforms and/or features leads to an understanding of where water flows and how it moves through the different spheres. Topographic and aerial maps (can be virtual) can be used to identify drainage patterns and watersheds that contribute to the cycling of water. Lab investigations or technology can be used to simulate different segments of the hydrologic cycle.

Future Application of Concepts

Grade 8: The relationship between the hydrosphere, atmosphere and lithosphere are studied as they relate to weathering and erosion.

High School: The hydrologic cycle is a component of biology as it relates to ecosystems and the diversity of life.

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.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Produce and test solutions for reducing acid rain, erosion and/or surface runoff rates in specific regions (e.g., urban, agricultural, construction). Present findings/plan to school administrators or local government.	Design and conduct a scientific investigation to measure and analyze surface-water discharge rates.	Using GPS/GIS programs, topographic maps and/or aerial maps, identify regions where surface water run-off and/or acid rain could impact ground or surface water quality. Illustrate the results graphically.	Describe the movement of water through all four spheres of Earth (lithosphere, hydrosphere, atmosphere, biosphere).
Develop, test and evaluate plans outlining a specific method to reduce storm water flow at a specific site in the local community (e.g., a housing construction project, the school parking lot). Present findings/plans to school administrators or local government.	Build a model to represent a cross-section of Earth's surface (soil, rock, surface, ground water) that can enable investigation of multiple water pathways. Explain and demonstrate to the class.	Research and investigate an area in Ohio that exhibits a unique water contamination problem (e.g., acid mine drainage in southeastern Ohio, mercury contamination in Lake Erie). Document recent discoveries, case studies, clean-up technologies or field investigations that are occurring. Present findings to the class.	Identify the changes in thermal energy as water changes state in the hydrologic cycle.
	Investigate and use different methods and tools that measure water flow and water quality, and evaluate which methods and tools are most effective for the desired outcome.	Research and evaluate the effectiveness of different tools, models and methods to collect ground water and surface water data (e.g., rate of flow, direction of movement, types of contamination). Present recommendations orally, graphically or in writing.	Recognize that the sun is the source of energy that drives the hydrologic cycle.

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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.

- Ground water is often overlooked or minimalized in the teaching of the hydrologic cycle. It is important to discuss and demonstrate the distribution of Earth's water to show that there is more ground water than surface water. The **National Ground Water Association** offers information, data and resources to support teachers in teaching all aspects of ground water.
- The **USGS** provides resources, data, information, books and maps that relate to Earth's resources and the hydrologic cycle.
- Contamination can be introduced at all steps of the hydrologic cycle. This relationship is important to begin to show how contamination migrates and travels between Earth's spheres. The Ohio **EPA** provides background and resource information related to water and water contamination issues related to the hydrologic cycle. It also includes helpful environmental education resources. Other related programs include **Project Wet** and ODNR's **Division of Soil and Water Resources**.
- iTunes provides free ***Science Quest*** video clip downloads that address current discoveries pertaining to water, research and events. These can generate topics of interest, research ideas and discussion points for the class.
- Using recent discoveries and technology are ways to interest and engage students by connecting to real events that are directly related to water contamination and water shortage problems. **Satellite imagery** can show specific contamination issues that are relevant to Ohio (e.g., algae contamination within drinking water supplies) and can be used for research and comparative studies in the classroom.
- **Healthy Water, Healthy People** offers ideas and resources for teaching all aspects of water and water contamination issues. Ideas for field monitoring and research projects, as well as investigative projects for students, are found within the program. Teacher training is included.
- Connecting the hydrologic cycle (and other biogeochemical cycles) with everyday life and experiences is essential since many resources and references regarding cycles within Earth systems are very abstract and difficult to apply to the real world. Choosing local issues that involve water and conducting field studies and research about the movement of water and/or contamination can lead to deeper understanding of how the cycles work (e.g., researching acid mine drainage problems in southeastern Ohio. The **Monday Creek** website provides research and data for southeastern Ohio and acid mine drainage cleanup efforts. There are other resources listed on the site to assist in student research.

Career Connection

Students will research or investigate an actual environmental event (e.g., a specific release of a toxin or contaminant) and determine how it impacted each of Earth's spheres. Students will identify a body of water that has been flagged as an environmental hazard. They will identify careers needed to assist in analyzing the problem, developing a solution, and acting to resolve the issue. Students will identify which organizations and agencies to consult, how they will mobilize the necessary resources, and their specific role in the project.

COMMON MISCONCEPTIONS

- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at **http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html**.
- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at **http://science.nasa.gov/big-questions/**.

DIVERSE LEARNERS

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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**.

Teachers need to sign up to use this free site. The case studies *Dotty–Grade 7* and *Erien, Year Two–Grade 7* provide examples of how to use technology in the science classroom and develop higher-level thinking for science students.

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MODEL CURRICULUM GRADE 7

EARTH AND SPACE SCIENCE (ESS)

Topic: Cycles and Patterns of Earth and the Moon

This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.

CONTENT STATEMENT

Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns.

The sun is the major source of energy for wind, air and ocean currents and the hydrologic cycle. As thermal energy transfers occur in the atmosphere and ocean, currents form. Large bodies of water can influence weather and climate. The jet stream is an example of an atmospheric current and the Gulf Stream is an example of an oceanic current. Ocean currents are influenced by factors other than thermal energy, such as water density, mineral content (such as salinity), ocean floor topography and Earth's rotation. All of these factors delineate global climate patterns on Earth.

Note: This content statement is related to LS grade 7 (biomes). Regional temperature and precipitation contribute to the identification of climatic zones.

CONTENT ELABORATION

Prior Concepts Related to Energy Transfers, Atmosphere and Hydrosphere

PreK-2: Water is observed through weather. Water is in the atmosphere. Water can be a solid, a gas and a liquid.

Grades 3-5: Water is present in soil. Water is a non-living resource. Properties of the different states of water, how water can change the surface of Earth, and how water is a factor in some weather-related events (e.g., flooding, droughts) are discussed.

Grade 6: The changes in the state of water are related to motion of atoms. Atoms take up space and have mass. Changes of state occur due to the amount of motion of atoms and molecules and density.

Grade 7 Concepts

The earlier concepts of weather and the physical properties of air and water and their changes are expanded in grade 7 to the relationship of atmospheric and oceanic currents and climate. Current and climate patterns on a global level should be studied using a variety of maps, models and technology (e.g., remote sensing, satellite images, LANDSAT).

The causes of moving currents in the atmosphere and ocean must be connected to thermal energy, density, pressure, composition and topographic/geographic influences (e.g., continental mountains, ocean ridges). Studies also should include **specific current patterns** in both the atmosphere and the ocean that are mapped and documented through data. Contemporary studies regarding global climate must be based on **facts and evidence**.

This content statement is connected to the LS grade 7 content pertaining to biomes and the climatic zones of Earth.

Future Application of Concepts

Grade 8: In grade 8, global climate is expanded though the investigation of **climate change** that occurred throughout Earth's history (as evidenced through the rock record and more recently though ice cores).

High School: Gravity, density, gases and properties of air and water are found in Physical Sciences. In the 11/12 grade Physical Geology and Environmental Science courses, climate change is explored in greater depth.

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.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Investigate water using drifter and student-built buoys.			
Buoys are used by scientists to collect water data on a continual basis or to collect data in areas where sampling may be difficult. Drifter buoys are ocean buoys that are equipped with sensors that can **transmit data** (e.g., water temperature, air temperature, location) via satellites.			
Based on the interpretation and analysis of **drifter buoy data** (Demonstrating Science Knowledge), develop a list of criteria (including cost) for successful buoy deployment and life span. Design, build and test a buoy that can sample water temperatures or another water-quality test (e.g., pH, turbidity levels) of a local lake, pond, pool or stream. **Deploy the buoy** and collect/ analyze data. **Compare** and discuss results with the class. Find **additional information about buoys** under Instructional Strategies and Resources.	Analyze **real-time drifter buoy data** to determine the pattern of the Gulf Stream. Compare the present pattern with documented seasonal patterns over a five-year period. Using quantifiable data, outline factors that contribute to the changing patterns and influence the Gulf Stream. Additional buoy data is available at **NOAA Drifter Buoy Program**.	Adopt a drifter buoy (**NOAA**), record its movement and record water-temperature data over time. Represent the **oceanic data** on a graph or chart to assist in the analysis and interpretation found under Demonstrating Science Knowledge.	Identify the factors that contribute to the global climate.
Investigate the velocity of ocean and atmospheric currents.			
The movement of ocean and atmospheric currents directly influence climate. Changes in velocity (speed and direction) can be measured and used to predict climate pattern changes.			
Using the analytical data from Demonstrating Science Knowledge, evaluate and map the fastest and most effective route to travel from Spain to Florida. Document all scientific data, data analysis and steps in the evaluation process (everything that supports the chosen route).	Using Adopt a Buoy data (**NOAA**), calculate the average buoy velocities at specific segments of the year. Predict where ocean current patterns change and may result in climate changes (based on the data). ***How does this relate to* Jet Stream *patterns and changes?*** Present findings to the class and be prepared to defend the predictions using evidence and data.	Record drifter-buoy **velocity** data in a graph or chart. Use the velocity data to make a simple map showing the general patterns of the Gulf Stream. Research the documented patterns of the **Jet Stream.**	Identify the general patterns of the Jet Stream and the Gulf Stream using a world map.

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INSTRUCTIONAL STRATEGIES AND RESOURCES

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- **NOAA** provides an opportunity for students to track free-floating buoys (linked via GPS/Satellite systems) to actually see the movement of oceanic currents over time. The buoys also collect surface temperature and barometric pressure data that relate to climate and weather changes. Training CDs are available to assist and support **teachers** in the implementation of the real-time buoy data.
- Have students build their own buoys out of **everyday materials** (e.g., PVC piping) to collect data from local water systems (e.g., streams, ponds, lakes, pools). Test and **deploy** the buoys. NOAA offers information about **student-built buoys**. Research Ohio water-quality buoy data, such as **real-time Lake Erie data** from moored **buoy stations**. The stations are monitored daily, which enables students to compare and analyze data on a long-term basis. Buoy building also offers a strong **connection to STEM** education.
- Building large ships or models and then evaluating the design using research and investigation can generate interest for many students. Hosting a culminating contest or participating in regional contests can further engage students in learning about ship design and effectiveness. Competitions at the middle school level for **large boat** events and **combinations** of large and small boat competitions can help in planning.
- Building a **Remotely Operated Vehicle** to collect specified data within a marine environment allows students to explore the engineering field while supporting scientific concepts and investigations directly related to deep and shallow oceanic currents, tides, waves and new scientific discoveries.
- Integrate the previously listed investigations with both physical science and life science for grade 7 so students see connections between the content. For PS, measure and calculate the **velocity** of the Gulf Stream at varying intervals over a period of time using real-time buoy data. For LS, calculate the ocean productivity level (**biomass**) for specific areas within the Gulf Stream. Analyze the data to determine the **relationships** between water temperatures, amounts of living organisms and types of living organisms present.
- Integrate the previously listed investigations with other content areas (e.g., Mathematics, English Language Arts, Social Studies, World Languages, Fine Arts) using the *Eye of Integration*. This demonstrates the interconnectedness of STEM fields and other middle school content areas, ensuring that real-world connections are made through different lenses.

COMMON MISCONCEPTIONS

- Students may have misinformation and misconceptions that pertain to climate change. To address this, it is important to provide scientific evidence of climate change throughout Earth's history (found in grade 8 ES) and current data to document temperature changes (surface and oceanic). Data and other resources to help with teaching climate change can be found on EPA's website at **http://www.epa.gov/climatechange/index.html**.
- **NASA** provides lists of common misconceptions that pertain to Earth and the patterns and cycles on Earth. By teaching students through Earth systems and allowing exploration of the interconnectedness of the systems, students can become aware of the role climate has played throughout Earth's history.
- Carleton College provides geology-specific assessment techniques that can identify misconceptions, lists of common Earth science misconceptions and resources to correct misconceptions at **http://serc.carleton.edu/NAGTWorkshops/teaching_methods/conceptests/index.html**.
- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at **http://science.nasa.gov/big-questions/**.

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MODEL CURRICULUM GRADE 7

EARTH AND SPACE SCIENCE (ESS)

Topic: Cycles and Patterns of Earth and the Moon

This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.

CONTENT STATEMENT

The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere.

The atmosphere is held to the Earth by the force of gravity. There are defined layers of the atmosphere that have specific properties, such as temperature, chemical composition and physical characteristics. Gases in the atmosphere include nitrogen, oxygen, water vapor, carbon dioxide and other trace gases. Biogeochemical cycles illustrate the movement of specific elements or molecules (such as carbon or nitrogen) through the lithosphere, biosphere, hydrosphere and atmosphere.

Note: The emphasis is on why the atmosphere has defined layers, not on naming the layers.

CONTENT ELABORATION

Prior Concepts Related to Atmosphere

PreK-2: Wind is felt as moving air, wind speed and direction can be measured, sunlight warms air, the atmosphere is air, air has properties, transfer of energy causes air movement, and water is present in air.

Grades 3-5: Air is a non-living resource that can be used for energy, air can be contaminated, wind can change the surface of Earth, and Earth is a planet that has an atmosphere.

Grade 6: Atoms take up space, have mass and are in constant motion. Elements, molecules and compounds (and their properties) are discussed. Changes of state occur due to the amount of motion of atoms and molecules.

Grade 7 Concepts

The properties and composition of the layers of Earth's atmosphere are studied, as they are essential in understanding atmospheric current, climate and biogeochemical cycles, which are seventh-grade concepts.

Understanding the interactions between Earth's spheres (Earth Systems Science) and how specific elements and/or molecules move between them should be emphasized. This study must include standard greenhouse gases (including water vapor), ozone (in the atmosphere and at Earth's surface), and natural events/human activities that can change the properties of the atmosphere. Contemporary issues and technological advances should be included within this concept. Real-time scientific data pertaining to air quality and properties of air must be incorporated into the study of atmospheric properties and air quality.

Future Application of Concepts

Grade 8: Changes in environmental and climate conditions (including atmospheric changes) as evidenced in the rock record and contemporary studies of ice cores are studied.

High School: Gravity, density, gases and properties of air are found in the Physical Science course. In grade 11/12 Physical Geology and Environmental Science courses, the atmosphere, Clean Air Act and climate change are explored further.

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.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Develop a method of testing and evaluating the best material to use in a physical filtration mask used by humans that are exposed to particulate matter (e.g., mold, dust, soil, ash). Compile and analyze test methods and data. Present final recommendations (based on the scientific evidence) to the class.	Plan and implement an investigation to collect and test ground levels of ozone or carbon monoxide in a local area. Compare results to statewide data. Determine the existing factors that contribute to these levels. Explain and defend the investigation and the results to an authentic audience.	Using **ozone data** from the stratospheric level, generate a graph that illustrates the changes in the ozone over a specific period of years.	Identify the general properties of the different layers of the atmosphere. Recognize human-made and natural factors that can change the properties of the atmosphere.
	Plan and implement an investigation to test the relationship between air pressure, elevation and temperature. Determine where to find reliable datasets that can be used to verify the hypothesis. Analyze the data and make a final determination. Write a final analysis and conclusion to share with the class.	Research and document the types of everyday activities that generate the highest and lowest amount of air pollution. Compare the results with the class.	Identify the different gases that are present in Earth's atmosphere. Trace the different biogeochemical cycles through each of Earth's spheres.

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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 Ohio **EPA's Division of Air Pollution Control** provides resources, data and information pertaining to air and air pollution. The home page of this site also offers environmental education resources that can be used in the classroom.
- To understand fully the properties of the atmosphere and the different layers, a connection between density and chemical properties must be provided. This is found in PS grade 6. Interpreting **actual data** to identify the different layers of the atmosphere can help in this connection between physical and chemical properties of the atmosphere. **Background data** to help support the teaching of the atmosphere should include chemistry, composition, temperature, pressure and density.
- Learning about air quality and air-quality issues within the United States and within Ohio can increase awareness of the importance of conserving air as a resource. **NOAA** provides air-quality information and actual data that can be used in the classroom. **AirOhio** is another helpful site that concentrates on the air quality within Ohio and offers a database that houses regional monitoring data for specific air-quality parameters.

COMMON MISCONCEPTIONS

- Students may have misinformation and misconceptions that pertain to climate change. To address this, it is important to provide evidence of climate change throughout Earth's history and current data to document temperature changes (surface and oceanic). Data and other resources to help with teaching climate change can be found on EPA's website at **http://www.epa.gov/climatechange/index.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**.
- Offered by NASA, Mission: Science provides games and activities for students that can supplement what is being learned in the classroom. Interactive computer games based on accurate science can be used to generate interest and support classroom work. Find it at **http://missionscience.nasa.gov/**.
- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at **http://science.nasa.gov/big-questions/**.

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MODEL CURRICULUM GRADE 7

EARTH AND SPACE SCIENCE (ESS)

Topic: Cycles and Patterns of Earth and the Moon

This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.

CONTENT STATEMENT

The relative patterns of motion and positions of the Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon.

The moon's orbit and its change of position relative to the Earth and sun result in different parts of the moon being visible from Earth (phases of the moon).

A solar eclipse is when Earth moves into the shadow of the moon (during a new moon). A lunar eclipse is when the moon moves into the shadow of Earth (during a full moon).

Gravitational force between the Earth and the moon causes daily oceanic tides. When the gravitational forces from the sun and moon align (at new and full moons) spring tides occur. When the gravitational forces of the sun and moon are perpendicular (at first and last quarter moons), neap tides occur.

CONTENT ELABORATION

Prior Concepts Related to Moon, Earth and Sun

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. The sun is the principal source of energy.

Grades 3-5: Earth's atmosphere, introduction to gravitational forces, orbits of planets and moons within the solar system, predictable cycles and patterns of motion between the Earth and sun, and the fact that Earth's axis is tilted are explored.

Grade 6: Objects and substances in motion have kinetic energy. Objects and substances can store energy as a result of its position (gravitational potential energy).

Grade 7 Concepts

The role of gravitational forces and tides are introduced in relationship to the position of the Earth, moon and sun. Models and simulations (can be 3-D or virtual) must be used to demonstrate the changing positions of the moon and Earth (as they orbit the sun) and lunar/solar eclipses, daily tides, neap and spring tides, and the phases of the moon. Earth and its solar system are part of the Milky Way galaxy, which are part of the universe.

The emphasis should not be on naming the phases of the moon or tides, but in understanding why the phases of the moon or tides are cyclical and predictable. Advances in science knowledge regarding patterns and movement in the solar system are included in this content statement.

Future Application of Concepts

Grade 8: Gravitational forces, frame of reference, forces have magnitude and direction, and gravitational potential energy are explored.

High School: Patterns of motion within the solar system are expanded to the universe. The Big Bang theory and origin of the universe are explored. Forces and motion are investigated at depth.

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.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Research the availability of tidal-generated power facilities. Outline the requirements and output. Critique and analyze all collected data. Using tidal and current requirements (and other physical requirements, such as ocean depth, geographic location), make a determination of a recommended location for maximum effectiveness within the United States.	Design and conduct an experiment using 3-D modeling, drawing or technology to represent the factors that must exist for a full or partial solar or lunar eclipse. Use actual data to create the model. Present with detailed explanation to the class.	Make a chart or graph that illustrates moon phases, Earth's rotation, sun position and resulting tidal data for one month. Include specific data about Spring and Neap tides. Use actual data to document the graphic representation.	Recognize the relationship between gravity and tidal movement. Recognize the different phases of the moon.

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.

- Teaching concepts of tides and eclipses must involve student-centered modeling and exploration. These topics can be abstract, even if they have been observed. Developing modeling strategies and research-based investigations can lead to a deeper understanding of the processes involved in different eclipses and tidal patterns. **NASA** provides examples, data and resources to assist in teaching about tides and eclipses using models.
- Allowing students to observe and document changes in tides or lunar phases and then recreating the observation in the classroom can be useful in teaching patterns and cycles within the solar system. Often virtual **demonstrations** (repeated as needed) can help students that may be struggling in understanding the relationship of gravity and neap/spring tides or other cycles and patterns.
- **Griffith Observatory** provides background data and information pertaining to lunar phases, eclipses and celestial bodies.

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**.
- NASA provides a list of overarching Earth Science questions that address many of the common misconceptions at this grade level. There are resources and information that help address questions that center on Earth Systems Science at **http://science.nasa.gov/big-questions/**.

DIVERSE LEARNERS

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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**. Teachers need to sign up to use this free site. The case studies *Dotty–Grade 7* and *Erien, Year Two–Grade 7* provide examples of how to use technology in the science classroom and develop higher-level thinking for science students.

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MODEL CURRICULUM GRADE 7

LIFE SCIENCE (LS)

Topic: Cycles of Matter and Flow of Energy

This topic focuses on the impact of matter and energy transfer within the biotic component of ecosystems.

CONTENT STATEMENT

Matter is transferred continuously between one organism to another and between organisms and their physical environments.

Plants use the energy in light to make sugars out of carbon dioxide and water (photosynthesis). These materials can be used and immediately stored for later use. Organisms that eat plants break down plant structures to produce the materials and energy they need to survive. Then they are consumed by other organisms.

Energy can transform from one form to another in living things. Animals get energy from oxidizing food, releasing some of its energy as heat.

The total amount of matter and energy remains constant, even though its form and location change.

Note 1: Chemical reactions are presented as the rearrangement of atoms in molecules.

Note 2: Chemical reactions in terms of subatomic structures of atoms are not appropriate.

CONTENT ELABORATION

Prior Concepts Related to Cycles of Matter and Flow of Energy

Grades 3-5: Populations of organisms can be categorized by how they acquire energy. Food webs can be used to identify the relationships among organisms. 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.

Grade 6: Atomic Molecular Theory, Cell Theory and the function of cell organelles, including mitochondria and chloroplast, are studied.

Grade 7 Concepts

The basic concepts for matter and energy flow were introduced in grades 3-5. The grades 3-5 concepts are expanded to include a comparison of photosynthesis and cellular respiration.

The use of light energy to make food is called photosynthesis. The breakdown of food to release the stored energy is called respiration. General formulas are appropriate at this grade level, because atoms and molecules are taught in grade 6. Details of both processes are not grade appropriate. In grade 6, cellular organelles are introduced. It is appropriate to reinforce that the chloroplast (the plant cell organelle that contains chlorophyll) captures the sun's energy to begin the process of converting the energy from the sun into sugars and sugar polymers, such as starch.

As matter is cycled within the environment, it promotes sustainability. The emphasis is not on food webs, but on the transfer of matter and energy between organisms. The total amount of matter and energy remains constant in an ecosystem, even though the form and location undergo continual change. The concept of conservation of matter (introduced in PS grade 4) and conservation of energy are applied to ecosystems. An energy pyramid graphic can illustrate the flow of energy. At each stage in the transfer of energy within an ecosystem, some energy is stored in newly synthesized molecules and some energy is lost into the environment as heat produced by the chemical processes in cells. The elements that make up the molecules of living things are continuously recycled. Energy rich molecules that are passed from organism to organism are eventually recycled by decomposers back into mineral nutrients usable by plants.

New discoveries, technology and research must be used to connect the concept of energy transfer and transformation within the ecosystem and between ecosystems. For example, the use of biomass as an alternative energy source for the local area can focus on different types of biomass, competition between human food crops and biomass crops, and biomass vs. other types of alternatives to fossil-fuels energy.

Future Application of Concepts

High School: The chemical flow of energy during reactions will be explored as the molecular structure of molecules is studied.

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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
Ethanol, a plant product, is used in place of fossil fuels. Evaluate the pros and cons of using biomass products such as ethanol vs. traditional fossil fuels. Include in the evaluation anticipated real-world effects for production and usage of biomass products vs. traditional fossil fuels.	Plan and conduct an investigation to determine what factors impact photosynthesis in plants that live in aquatic environments (Elodea).	Distinguish between photosynthesis and respiration and illustrate how the two processes are connected. Create a chart that compares the reactants and products of both processes.	Identify the cellular structures primarily responsible for photosynthesis and respiration.

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 Annenberg Media series *Essential Science for Teachers:* **Life Science: Session 8** provides examples of material cycling in an ecosystem while illustrating the difference between the flow of energy and the cycling of materials.

COMMON MISCONCEPTIONS

- **Weber State University** provides a list for misconceptions in biology. Scroll down to Standard I to address misconceptions about energy flow in an ecosystem.

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**.

CLASSROOM PORTALS

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MODEL CURRICULUM GRADE 7

LIFE SCIENCE (LS)

Topic: Cycles of Matter and Flow of Energy

This topic focuses on the impact of matter and energy transfer within the biotic component of ecosystems.

CONTENT STATEMENT

In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.

Biomes are regional ecosystems characterized by distinct types of organisms that have developed under specific soil and climatic conditions.

The variety of physical (abiotic) conditions that exists on Earth gives rise to diverse environments (biomes) and allows for the existence of a wide variety of organisms (biodiversity).

Ecosystems are dynamic in nature; the number and types of species fluctuate over time. Disruptions, deliberate or inadvertent, to the physical (abiotic) or biological (biotic) components of an ecosystem impact the composition of an ecosystem.

Note: Predator-prey and producer-consumer relations are addressed in grade 5.

CONTENT ELABORATION

Prior Concepts Related to Forces, Movement and Igneous Environments

PreK-2: Plants and animals have traits that improve their chances of living in different environments. Living things have basic needs, which are met by obtaining materials from the physical environment.

Grades 3-5: Populations of organisms can be categorized by how they acquire energy. Food webs can be used to identify the relationships among organisms. 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.

Grade 7 Concepts

Biomes are defined by abiotic components of the environment – topography, soil types, precipitation, solar radiation and temperature. Comparing the different biomes found on Earth is the focus of this content statement. Examples of the Earth's biomes include aquatic (freshwater, brackish water and marine water), forest (tropical and temperate), desert (cold and hot), grassland, taiga and tundra. Biomes must be linked to climate zones on a global level by using a variety of maps, models and technology (e.g., remote sensing, satellite images, LANDSAT). This content statement is connected to the ESS middle school content pertaining to global climate patterns.

An ecosystem is composed of linked and fluctuating interactions between biotic and abiotic factors. Given adequate resources and an absence of disease or predators, populations of organisms in ecosystems increase at rapid rates. Finite resources and other factors limit population growth. As one population proliferates, it is held in check by one or more environmental factors (e.g., depletion of food or nesting sites, increased loss to predators, invasion by parasites). If a natural disaster such as a flood or fire occurs, the damaged ecosystem is likely to recover in a succession of stages that eventually results in a system similar to the original one.

Future Application of Concepts

High School: The evolutionary mechanisms that build unity and diversity are studied.

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.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Analyze or critique the impact of Ohio's wetland mitigation plans on a local community or the state as a whole. Include real-world data from the sites in the analysis or critique. Anticipate future trends on the flora and fauna in the ecosystem based upon the real-world data.	Monitor the local environment (e.g., stream, river, construction site) for the impact Ohio's wetland mitigation plans have on water quality (e.g., oxygen levels, pH, phosphorus levels, nitrogen levels) and how the plans will impact living organisms (e.g., algae, diatoms, mussels, insect larvae).	Trace and explain how matter and energy are transferred through an ecosystem.	Identify the biotic and abiotic elements of the major biomes and describe how they are connected.
		Research an endangered species and examine environmental conditions that may contribute to that organism's classification. Determine if any conservation efforts have been employed and document whether or not any efforts have been successful. Use evidence to support responses.	

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INSTRUCTIONAL STRATEGIES AND RESOURCES

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- Research a biome by monitoring changes in the biotic and abiotic factors of the ecosystem. Have students ask questions about how the habitat has changed over a given period of time (abiotic factors). Ask: ***How have those changes impacted living things?*** Select an organism and find data on the population. Determine what changes have occurred in that population and provide scientific reasons for those changes. Ask: ***What efforts have been employed to protect the population?*** **WWF** for a living planet has resources, data, reports and activities about the health of the world's biomes. **NSTA Sci-Links**, **Missouri Botanical Garden**, **Freshwater Ecoregions of the World** and the **World Wildlife Organization** provide information and data about the biomes of the world.
- The program **One Species at a Time** allows an audio tour of the wonders of nature by examining a variety of species around the world through stories. The Encyclopedia of Life and Atlantic Public Media developed this program.
- The Annenberg Media series **Habitable Planet** explores how changes in populations impact ecosystems. It also shows how data is collected in the field.
- **Colorado University** has information about how animal population data can be collected in the Arctic with unmanned aircraft.
- Conduct an interactive lab designed to **build your own ecosystem** and explore the interrelationships between biotic and abiotic factors and their changes.
- Play **interactive games** to help students become aware of the variety of organisms that exist in the world.
- The **Virtual Nature Trail at Penn State New Kensington** is an opportunity to observe photos of various species of plants interacting with one another and the environment and examine what changes result due to those interactions.
- *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**. Several *Project Wild* and *Project Wild Aquatic* activities support this content. ***How Many Bears Can Live in This Forest?*** - This activity explores how changes in an ecosystem impact the survival of an organism. ***Oh Deer!*** - This activity explores how fluctuations in an environment impact the survival of an organism. ***Planting Animals*** - This activity explores the positive and negative implications of" translocating" wildlife in an ecosystem. ***Checks and Balances*** — Students become managers of a herd of animals in a conceptual and discussion-based activity where they identify at least four factors that can affect the size of a wildlife population. ***Water Canaries (Aquatic WILD)*** - Students investigate a stream or pond to identify aquatic organisms and assess the relative quality of the stream or pond. ***Migration Headaches*** - Students portray migrating waterfowl and experience limiting factors along their migration paths.

COMMON MISCONCEPTIONS

- **Weber State University** provides a list for misconceptions in biology. Scroll down to Standard I to address misconceptions about interactions between organisms in an ecosystem.

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**.

- 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. ***How Many Bears Can Live in This Forest?*** - This activity explores how changes in an ecosystem impact the survival of an organism. ***Oh Deer!*** - This activity explores how fluctuations in an environment impact the survival of an organism. ***Planting Animals*** - This activity explores the positive and negative implications of" translocating" wildlife in an ecosystem. ***Checks and Balances*** — Students become managers of a herd of animals in a conceptual and discussion-based activity where they identify at least four factors that can affect the size of a wildlife population. ***Water Canaries (Aquatic WILD)*** - Students investigate a stream or pond to identify aquatic organisms and assess the relative quality of the stream or pond. ***Migration Headaches*** - Students portray migrating waterfowl and experience limiting factors along their migration paths.

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CLASSROOM PORTALS

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MODEL CURRICULUM GRADE 7

PHYSICAL SCIENCE (PS)

Topic: Conservation of Mass and Energy

This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy.

CONTENT STATEMENT

The properties of matter are determined by the arrangement of atoms.

Elements can be organized into families with similar properties, such as highly reactive metals, less-reactive metals, highly reactive nonmetals and some gases that are almost completely nonreactive.

Substances are classified according to their properties, such as metals and acids.

When substances interact to form new substances, the properties of the new substances may be very different from those of the old, but the amount of mass does not change.

Note 1: This is the conceptual introduction of the Periodic Table of Elements.

Note 2: Acids and bases are included in this topic; further detail will be provided in the Model Curriculum.

Note 3: It is important to emphasize that most changes in the properties of matter have some combination of chemical and physical change (at different levels).

CONTENT ELABORATION

Prior Concepts Related to Properties of Matter

PreK-2: Properties can be used to sort objects. Changes, including phase changes are explored.

Grades 3-5: Objects are composed of matter which has mass* and volume. Properties of solids, liquids and gases are explored. Phase changes are reversible and do not change the identity of the material. The total amount of matter and mass* remains the same when something changes.

Grade 6: All matter is made up of atoms that are in constant random motion. Elements, compounds and molecules are introduced. The properties of solids, liquids and gases, and changes of phase are explained by the motion and spacing of the particles.

*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.

Grade 7 Concepts:

Mixtures are materials composed of two or more substances that retain their separate atomic compositions, even when mixed (e.g., water and sugar can be mixed together thoroughly at the molecular level but the water particles and sugar particles remain separate).

Elements are organized into groups based on their properties (including melting and/or boiling points) and position on the periodic table. These groups include metals, non-metals and gases that are almost completely nonreactive. The nonreactive gases exist primarily as elements and do not react to form many compounds. Most metals are malleable, have high melting points, are usually solid at room temperature and are good conductors of heat and electricity. Nonmetals are poor conductors of heat and electricity, are usually gases at room temperature and, as solids, tend to be dull and brittle.

The pH scale has a range of 0-14 and is used to measure the acidity or alkalinity of a compound. At the seventh-grade level, pH tests must be conducted on a variety of substances. The properties of the compounds that are acidic (below 7 on the pH scale), neutral (7 on the pH scale) or basic (above 7 on the pH scale) must be compared and evaluated. Acidity and alkalinity values must be related and connected to the natural world, as pH values are used to measure water, soil and air quality (e.g., sulfuric acid in the atmosphere can form acidic precipitation which can impact the acidity of a stream and the living organisms in the stream). The discussion of hydroxide and hydrogen ions as they relate to the pH scale is reserved for high school and will not be assessed at the grade 7.

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Chemical and physical changes occur on a continuum and no distinct lines separate the two. In many cases when objects, substances or materials undergo change, there may be a combination of chemical and physical changes occurring. Under these standards, classifying specific changes as chemical or physical is not appropriate.

For any change in a closed system, the number and type of atoms stays the same, even if the atoms are rearranged. Therefore, the mass remains constant.

Note 1: Appropriate background knowledge such as graphics representing the atomic composition of the substances involved or descriptions of how the matter can be formed, decomposed or separated, should accompany questions asking to classify matter as an element, compound or mixture. The nature of chemical bonding is not appropriate at this grade.

Note 2: H^+ and OH^- ions as they relate to pH are found at the high school level.

Note 3: While mass is always conserved, this is not the case for volume. Mixing alcohol with water results in a volume that is less than the sum of the volumes. Boiling liquid results in a significant increase in volume.

Note 4: The idea of reversibility of changes is not a criterion for classifying changes as chemical or physical. Some changes cannot be reversed, like tearing paper. As students progress farther in chemistry, they will learn about equilibrium, which involves many chemical changes that are reversible. Dissolving an ionic substance is an example of a process that is not clearly chemical or physical since bonds are broken (Science: College Board Standards for College Success, 2009, page 125).

Future Application of Concepts

High School: Metalloids and pH calculations are introduced. Mixtures are classified as homogenous or heterogeneous. Trends in the properties and atomic structure of elements are related to the periodic table. The role of valence electrons in reactivity is explored, balanced chemical equations are written and stoichiometric problems are solved.

EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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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
Use empirical evidence to construct an argument and defend a position.			
Based on knowledge about the properties specific to certain types of material that can be used for packaging, design packaging (using various types of materials) for an egg that will allow it to drop from a considerable height without breaking. Organize and communicate resulting data in multiple formats. 	Bubbles have characteristic behaviors based on the arrangement of the atoms that determine their molecular structure. Investigate bubbles and the bonds that are behind their structure (e.g., what gives them longevity, why their shape is spherical, is it possible to create square bubbles). Record and organize data to communicate findings in multiple ways (e.g., graphically, orally, pictorially). 	Explain how the arrangement of atoms determines properties specific to a certain state of matter. 	Match the properties of a state of matter with the picture of a sample representative of a specific state of matter. 

INSTRUCTIONAL STRATEGIES AND RESOURCES

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- *Essential Science for Teachers* is a series of videos on demand produced by Annenberg. The segment **Physical Changes and Conservation of Matter** integrates high-quality content information with exemplary classroom practices that primarily address conservation of matter as it relates to change. The video shows that some physical changes are reversible. Please be advised that not all physical changes are reversible and that the differentiation of change as "chemical" or "physical" is inappropriate.
- *Essential Science for Teachers* is a series of videos on demand produced by Annenberg. The segment **Chemical Changes and Conservation of Matter** integrates high-quality content information with exemplary classroom practices that primarily address conservation of matter as it relates to change. The video shows that some chemical changes cannot be reversed. Please be advised that not all chemical changes are irreversible and that the differentiation of change as "chemical" or "physical" is inappropriate.
- **The Periodic Table of Videos** from the University of Nottingham contains short videos of all the elements. Videos include what the element looks like in elemental form, some of the reactions of the element and the uses for the element.

COMMON MISCONCEPTIONS

- Essential Science for Teachers is a series of videos on demand produced by Annenberg. The segment **Physical Changes and Conservation of Matter** addresses student misconceptions in student interviews. Classroom activities to address these misconceptions are shown. While most of the content is applicable and primarily addresses the conservation of matter as it relates to change, note that the differentiation of change as "chemical" or "physical" is inappropriate.
- Essential Science for Teachers is a series of videos on demand produced by Annenberg. The segment **Chemical Changes and Conservation of Matter** addresses student misconceptions in student interviews. Classroom activities to address these misconceptions are shown. While most of the content is applicable and primarily addresses the conservation of matter as it relates to change, note that the differentiation of change as "chemical" or "physical" is inappropriate.
- Many students think that all acids are corrosive. Students can use litmus paper to test common foods to discover that many of the things they eat are acids.
- **Particles are misrepresented** and undifferentiated in situations involving elements, compounds, mixtures, solutions and substances. There is frequent disregard for particle conservation and orderliness when describing changes of matter.

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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**.

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.

Erien, a new seventh-grade teacher, demonstrates strategies to develop higher-level thinking skills in her students in **this video on demand** produced by Annenberg. While the content in this video is not directly related to the content statement, the strategies shown can be applied to any content.

Dotty, a veteran teacher, demonstrates strategies to incorporate technology and societal connections into her science lessons for seventh-grade students in this video on demand produced by Annenberg. While the content in this video is not directly related to the content statement, the strategies shown can be applied to any content.

Rachel demonstrates strategies to increase participation among girls and minority students in her science classroom in this video on demand produced by Annenberg. While the content in this video is not directly related to the content statement, the strategies shown can be applied to any content.

Margarita demonstrates strategies for teaching high-quality science to non-English speaking students in grades 5-8 in this video on demand produced by Annenberg. While not all the content shown relates to this content statement, the strategies shown can be adapted to all science content.

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MODEL CURRICULUM GRADE 7

PHYSICAL SCIENCE (PS)

Topic: Conservation of Mass and Energy

This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy.

CONTENT STATEMENT

Energy can be transformed or transferred but is never lost.

When energy is transferred from one system to another, the quantity of energy before transfer equals the quantity of energy after transfer. When energy is transformed from one form to another, the total amount of energy remains the same.

Note: Further discussion of energy transformation is addressed at the high school level.

CONTENT ELABORATION

Prior Concepts Related to Energy Transfer

PreK-2: Sound is produced by vibrating objects. The sun is the principal source of energy and affects the warming or cooling of Earth (ESS). Weather changes occur due to changes in energy (ESS). Plants get energy from sunlight and animals get energy from plants and other animals (LS).

Grades 3-5: Objects with energy have the ability to cause change. Energy can transfer from one location or object to another and can be transformed from one form to another (e.g., light, sound, heat, electrical energy, magnetic energy. Earth's resources can be used for energy (ESS). Sunlight is transformed by producers into energy that organisms can use and pass from organism to organism (LS).

Grade 6: There are two forms of energy: kinetic and potential. Energy can transform from one form to another. Thermal energy is due to random motion of the particles of a substance.

Grade 7 Concepts:

A system is separated from its surroundings by either a physical or mental boundary. An isolated system is one that does not interact with its surroundings. Matter and energy cannot get into or out of an isolated system. Most systems on Earth are open systems. Matter and energy can be transferred into or out of an open system. If energy appears to be gained or lost, it has just transformed or transferred into a different system. Examples of systems include ecosystems, the atmosphere, the hydrosphere, the solar system and the human body.

When energy transfers to a large system, it may be difficult to measure the effects of the added energy. Dissipated energy (energy that is transformed into thermal energy and released into the surroundings) is difficult or impossible to recapture. Some systems dissipate less energy than others, leaving more energy to use.

Investigation, testing and experimentation must be used to explore energy transfers and transformations. Observing the quantifiable energy changes in a virtual environment is recommended at this introductory level, as these can be difficult to measure accurately.

Note 1: This content statement does not deal with radiation, convection and conduction. That is addressed in the seventh-grade Physical Science content statement.

Note 2: ESS grade 7 is connected to this content statement regarding thermal energy. Thermal energy is transformed as water changes state throughout the water cycle. Thermal energy transferred in the ocean and atmosphere contributes to the formation of currents, which influence global climate patterns (ESS grade 7). Middle school LS also is connected to this statement as it relates to the transfer and transformation of energy within ecosystems.

Future Application of Concepts

Grade 8: Gravitational, chemical and elastic potential energy are explored.

High School: Waves are further explored as a method of transferring energy. Basic formulas are used to perform calculations with energy. Work is a method of and power is a rate of energy transfer.

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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
Investigate energy transformations in a roller coaster.			
Design and construct a roller coaster so that a marble will travel over a track that involves at least three hills. Apply the Law of Conservation of Energy to the roller coaster design.		Make a series of bar graphs that show kinetic energy, potential energy and thermal energy for eight different positions on the roller coaster. Place each set of bar graphs on a different index card for each position and shuffle the cards. Switch index cards and roller coaster designs with another group in the class. Organize the index cards in the correct order for the coaster.	Recognize that energy can change forms but the total amount of energy remains constant.
Investigate energy transformations through the design of a machine.			
Design and construct **a machine that performs a simple task in many steps**. Use materials that are lying around the classroom and the home. Test the machine as each additional component is added. Redesign to solve problems encountered during the testing. Record any problems encountered as well as the changes made to the machine to overcome these problems.		Use design software to make a labeled pictorial representation of the design. Explain the solutions to problems encountered during testing. Trace all the energy transformations that occur as the machine performs its task.	

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DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
	Investigate energy transformations for a skateboarder.		
	Plan and implement a scientific experiment to explore energy transformations for a skateboarder using the **Skate Park** simulation. The program can track changes in different types of energy over time. Analyze the data to determine patterns and trends. Formulate a conclusion about energy transformations. Share the results with the class. 	Summarize the experiment in writing. Graphically represent the energy of the skateboarder during a run. Use the results from different groups in the class to compare different designs to the energy graphs. Support the conclusion with experimental evidence. 	
		Explain why the energy from a teaspoon of hot water appears to have disappeared as it is placed into a gallon of room temperature water. 	Describe two ways that energy can leave a system so it may appear to disappear. 
		Explain where the energy of a swinging pendulum goes as it slows to an eventual stop. 	Recognize that energy or matter cannot enter or leave a closed system. 

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INSTRUCTIONAL STRATEGIES AND RESOURCES

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- **Career Corner** from EIA Kids has several articles that give information about different careers in energy.
- **Energy Skate Park**, an interactive simulation from PhET, demonstrates conservation of energy.
- **The Ultimate Roller Coaster Contest** from Discovery Education gives an idea for a design project that demonstrates energy transformation.
- **Rube Goldberg™ Invention** from PBS Kids gives ideas for design projects that accomplish a simple task using many steps and energy transfers.

COMMON MISCONCEPTIONS

Some students think that:

- **Energy is truly lost in many energy transformations**.
- *If energy is conserved, why are we running out of it?*
- Energy can be changed completely from one form to another (no energy losses).
- Things use up energy.
- Energy is a thing.
- The terms "energy" and "force" are interchangeable.
- Energy often disappears and is lost.
- Energy is a type of matter or substance that can flow like a liquid.
- Food and fuel are energy rather than sources of energy.
- **Transfer and Conversion of Energy** is one segment of *Science in Focus: Energy*, a series of videos on demand produced by Annenberg. This segment deals with energy transfers and transformations. The video series is designed to make teachers aware of common student misconceptions. While not all the concepts addressed are appropriate to be taught at this grade level, being aware of them can help avoid perpetuating common misconceptions.
- **Energy and Systems** is another segment of *Science in Focus: Energy*, a series of videos on demand produced by Annenberg. This segment deals with how energy that appears to be missing can be explained using the conservation of energy. The video series is designed to make teachers aware of common student misconceptions. While not all the concepts addressed are appropriate to be taught at this grade level, being aware of them can help avoid perpetuating common misconceptions.
- **Energy: Misconceptions and Teaching Models**, from the UK Department of Education, discusses different models of energy and the misconceptions that can be perpetuated by each model.

DIVERSE LEARNERS

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CLASSROOM PORTALS

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Rachel demonstrates strategies to increase participation among girls and minority students in her science classroom in this video on demand produced by Annenberg. While the content in this video is not directly related to the content statement, the strategies shown can be applied to any content.

Margarita demonstrates strategies for teaching high-quality science to non-English speaking students in grades 5-8 in this video on demand produced by Annenberg. While not all the content shown relates to this content statement, the strategies shown can be adapted to all science content.

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MODEL CURRICULUM GRADE 7

PHYSICAL SCIENCE (PS)

Topic: Conservation of Mass and Energy

This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy.

CONTENT STATEMENT

Energy can be transferred through a variety of ways.

Mechanical energy can be transferred when objects push or pull on each other over a distance.

Electromagnetic waves transfer energy when they interact with matter.

Thermal energy can be transferred through radiation, convection and conduction.

Electrical energy transfers when an electrical source is connected in a complete electrical circuit to an electrical device.

Note 1: Energy transfers should be experiential and observable. This builds upon PS grade 4 and is directly connected to ESS grade 7 (thermal energy transfers in the hydrologic cycle).

Note 2: Electricity can be measured through current, voltage and resistance. In addition, renewable energy systems should be included (such as wind, geothermal, water or solar).

Note 3: The types of waves used within this topic include seismic, oceanic, sound and light. Seismic waves also are found in ESS grade 8.

CONTENT ELABORATION

Prior Concepts Related to Energy Transfer

PreK-2: Temperature changes are observed. The sun is the principal source of energy. It affects the temperature of Earth (ESS) and supplies life's energy (LS).

Grades 3-5: Objects with energy have the ability to cause change. Electrical, heat, light and sound energy are explored. Earth's resources can be used for energy (ESS). Energy is transferred and transformed by organisms in ecosystems (LS).

Grade 6: Energy is identified as kinetic or potential and can transform from one form to another (gravitational, potential, kinetic, electrical, magnetic, heat, light, sound). Density depends on the mass and volume of a substance. Thermal energy is related to the motion of particles.

Grade 7 Concepts

Mechanical energy is transferred when a force acts between objects that move one of the objects some distance with or against the force. The amount of energy transferred increases as the strength of the force and/or the distance covered by object increases. This energy transfer (work) stops when the objects no longer exert forces on each other.

Vibrations cause wave-like disturbances that transfer energy from one place to another. Mechanical waves require a material (medium) in which to travel. The medium moves temporarily as the energy passes through it, but returns to its original undisturbed position. Mechanical waves are classified as transverse or longitudinal (compression) depending on the direction of movement of the medium.

Waves can be described by their speed, wavelength, amplitude and frequency. The energy of a mechanical wave depends upon the material, decreases with increasing wavelength, and increases with amplitude. The pitch of a sound wave increases with the frequency and the loudness increases with amplitude. While light and other electromagnetic waves do not require a medium and can travel through a vacuum, they can travel through some media, such as clear glass. A wave travels at a constant speed through a particular material as long as it is uniform (e.g., for water waves, having the same depth). The speed of the wave depends on the nature of the material (e.g., waves travel faster through solids than gases). For a particular uniform medium, as the frequency (f) of the wave is increased, the wavelength (λ) of the wave is decreased. The mathematical representation is $v_{wave}=\lambda f$.

For grade 7, investigation and experiments (3-D and virtual) must be used to connect energy transfer and waves to the natural world. Real data must be used, such as oceanic or seismic wave data or light and sound wave data.

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Heat is thermal energy transferred between objects and travels from a warm object to a cooler one, unless additional energy is used. Thermal energy can be transferred when moving atoms collide. This is called conduction. Thermal energy also can be transferred by means of thermal currents in air, water or other fluids. As fluids are heated, they expand, decreasing the density. Warmer material with less density rises, while cooler material with a greater density sinks, causing currents that transfer energy in a process called convection. Thermal energy also can be transformed into waves that radiate outward. This energy transferred by the waves can be transformed back into thermal energy when it strikes another material through a process called radiation. Technology (e.g., virtual simulations, satellite imagery, remote sensing, accessing real-time temperature data) can be used to demonstrate the transfer of thermal energy on the surface or interior of Earth and within the solar system.

An electric circuit exists when an energy source (e.g., battery, generator, solar cell) is connected to an electrical device (e.g., light bulb, motor) in a closed circuit. The energy source transfers energy to charges in the circuit. Charges flow through the circuit. Electric potential is a measure of the potential electrical energy of each charge. Differences in voltages can be measured with a voltmeter. The energy source does not create the charges; they were already present in the circuit. When the charges reach an electrical device, energy can be transformed into other forms of energy (light, sound, thermal or mechanical). The voltage drops after this energy transfer, but the charges continue to move through the circuit. In an open circuit, the charges stop flowing and energy is not transferred. Current is the rate of charge flow through conductors and can be measured with an ammeter. The degree to which current is opposed in a circuit is called resistance. Generally, for a particular energy source, the greater the resistance, the lower the current. The resistance through a wire depends upon the type of metal, the length of the wire and the diameter of the wire. Electrical devices can be connected in a series or as a parallel circuit. As the number of devices in a series loop increases, the current in the loop decreases. In a parallel circuit, the currents in each loop are the same as they would be if each loop were the only loop in the circuit. Testing and experimenting (3-D or virtually) with electrical circuits to evaluate the energy transfers, resistance, current and changes in voltage are required.

Note: The electromagnetic nature of electromagnetic radiation is not appropriate at this grade level nor are mathematical calculations of work or electricity.

Future Application of Concepts

Grade 8: Gravitational, chemical and elastic potential energy and seismic waves (ESS) are explored.

High School: Energy and work are explored mathematically.

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.

DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Investigate energy transformation by designing a candle wheel.			
Design and construct a candle wheel that will turn a maximum number of times in one minute. Test the designs from the class to determine the effectiveness of each one. Anticipate two applications in which the concepts addressed in this design could be used in the real world.	Analyze data to determine patterns and trends between design and effectiveness. Formulate a hypothesis about what design features are most effective.	Represent the design with a labeled picture constructed with design software. Orally present the design to the class, explaining how energy is transferred at each step. Compare the designs of different groups with the effectiveness of the designs. Use a particle model of matter to explain how energy can be transformed through convection.	Recognize that thermal energy can be converted to mechanical energy.
Investigate current in parallel and series circuits.			
	Plan and implement a scientific experiment to investigate the amount of electric current flowing through different positions of both series and parallel circuits. Analyze the data for series circuits to determine patterns and trends. Formulate a conclusion that states what happens to the flow of electric current in a series circuit. Analyze the data for parallel circuits to determine patterns and trends. Formulate a conclusion that states what happens to the flow of electric current in a parallel circuit.	Organize and clearly represent the data from the experiment. Compare the results for parallel and series circuits. Support conclusions with evidence from the experiments. Explain why the flow of current is the same at all parts of a series circuit.	Recognize that the flow of current is the same at all parts of a series circuit.

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DESIGNING TECHNOLOGICAL/ ENGINEERING SOLUTIONS USING SCIENCE CONCEPTS	DEMONSTRATING SCIENCE KNOWLEDGE	INTERPRETING AND COMMUNICATING SCIENCE CONCEPTS	RECALLING ACCURATE SCIENCE
Investigate current in parallel and series circuits.			
		Explain how thermal energy can transfer from one object to another by conduction.	Recognize that electrical energy in a circuit can be transferred into kinetic, thermal, light, sound and/or magnetic energy.
		Explain the motion of convection in liquids and gases.	Recall four different ways that energy can be transferred between two objects.

INSTRUCTIONAL STRATEGIES AND RESOURCES

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- **Circuit Construction Kit (DC only)** is an **interactive simulation** that allows students to build and test circuits.
- Schools in Ohio's AEP electric service territory can participate in the AEP Foundations' **AEGIS program**. Designed to engage girls in the sciences, a team of middle school girls and their teacher spend three days building the Energy Bike, learn leadership skills and conduct a presentation of the bike at school or within their community. The bike is retained by the team's school for use in the school's district.
- **Solar Cookers** from PBS Kids gives a few ideas of design projects to convert radiant energy into heat energy.

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COMMON MISCONCEPTIONS

- **Energy is a thing**.
- Energy is confined to some particular origin, such as what we get from food or what the electric company sells.
- The terms "energy" and "force" are interchangeable.
- From the non-scientific point of view, "work" is synonymous with "labor."
- It is hard to convince someone that more "work" is probably being done playing football for one hour than studying an hour for a quiz.
- **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.
- Sound waves are transverse waves (like water and light waves).
- Matter moves along with water waves as the waves move through a body of water.
- When waves interact with a solid surface, the waves are destroyed.
- In actual telephones, sounds (rather than electrical impulses) are carried through the wires.
- **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.
- Light is not necessarily conserved. It may disappear or be intensified.
- Gamma rays, X-rays, ultraviolet light, visible light, infrared light, microwaves and radio waves are all very different entities.
- Light fills the room as water fills a bathtub.
- The mechanisms between the light, the object and the eye are not recognized to produce vision.
- **Current flows from a battery** (or other source of electricity) to a light bulb (or other item that consumes electricity), but not from the light bulb to the battery.
- Current flows out of both terminals of a dry cell or both connections in an electrical outlet.
- Current flows around a complete circuit, but it is used by objects like light bulbs so less current returns than leaves the source of the electricity.
- All the charges that make up an electrical current are initially contained in the battery or generator that is the source of the electricity.
- Electricity is produced in the wall socket.
- Charges change into light when a lamp is turned on.
- Wires are hollow like a water hose and charges move inside the hollow space.
- Batteries have electricity inside them.
- **Heat is a substance.**
- Heat is not energy.
- Heat and cold are different, rather than being opposite ends of continuum.
- Objects of different temperatures that are in constant contact with each other or in contact with air at a different temperature do not necessarily move toward the same temperature.
- Heat only travels upward.
- Heat rises.
- Cold is thought to be transferred rather than heat.
- Some materials may be thought to be intrinsically warm (blankets) or cold (metals).
- Objects that keep things warm, such as a sweater or mittens, may be thought to be sources of heat.
- There is often confusion between forms of energy and sources of energy.

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- **Transfer and Conversion of Energy** is one segment of *Science in Focus: Energy*, a series of videos on demand produced by Annenberg. This segment deals with energy transfers and transformations. The video series is designed to make teachers aware of common student misconceptions. While, not all the concepts addressed are appropriate to be taught at this grade level, being aware of them can help avoid perpetuating common misconceptions.
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