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## MODEL CURRICULUM GRADE 8

# EARTH AND SPACE SCIENCE (ESS)

**Topic: Physical Earth**

This topic focuses on the physical features of Earth and how they formed. This includes the interior of Earth, the rock record, plate tectonics and landforms.

### CONTENT STATEMENT

**The composition and properties of Earth's interior are identified by the behavior of seismic waves.**

The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate the layers of Earth's interior. Earth has an inner and outer core, an upper and lower mantle, and a crust.

The formation of the planet generated heat from gravitational energy and the decay of radioactive elements, which are still present today. Heat released from Earth's core drives convection currents throughout the mantle and the crust.

**Note: The thicknesses of each layer of Earth can vary and be transitional, rather than uniform and distinct as often depicted in textbooks.**

### CONTENT ELABORATION

**Prior Concepts Related to Earth's Interior**

**PreK-2:** Properties of materials can change due to heating or freezing. Forces change the motion of an object.

**Grades 3-5:** Matter exists in different states. Heating and cooling can change the state of matter. Heat is a form of energy. Energy can cause motion. Earth's surface is changed in many ways. Light changes direction when it moves from one medium to another; it can be reflected, refracted or absorbed.

**Grades 6-7:** Matter is made up of atoms. Igneous, metamorphic and sedimentary rocks form in different ways and in different environments. Magma from Earth's interior forms igneous rocks. Position and speed can be measured and graphed as a function of time. Matter and energy can be transferred through Earth's spheres. Energy can be transformed from one form to another. Thermal energy can be transferred through radiation, convection and conduction. Electromagnetic waves transfer energy when they interact with matter. Seismic and oceanic waves are found in PS grade 7.

**Grade 8 Concepts**

It is important to provide the background knowledge regarding how scientists know about the structure and composition of the interior of Earth (without being able to see it). Seismic data, graphics, charts, digital displays and cross sections must be used to study Earth's interior. Actual data from the refraction and reflection of seismic waves can be used to demonstrate how scientists have determined the different layers of Earth's interior. New discoveries and technological advances relating to understanding Earth's interior also play an important role in this content.

Earth and other planets in the solar system formed as heavier elements coalesced in their centers. Planetary differentiation is a process in which more dense materials of a planet sink to the center, while less dense materials stay on the surface. A major period of planetary differentiation occurred approximately 4.6 billion years ago (College Board Standards for College Success, 2009).

In addition to the composition of Earth's interior, the history of the formation of Earth and the relationship of energy transfer, transformation and convection currents within the mantle and crust are essential in understanding sources of energy.

**Future Application of Concepts**

**High School:** Waves (all types), gravitational energy, energy transformation and transfer, and radioactivity are studied in greater detail. In addition, Earth's formation and the formation of the solar system are used as the formation of the universe is introduced.

### 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 |
|---|---|---|---|
| Design and build a model of an earthquake-resistant structure (e.g., bridge, building, home). Draw a blueprint of the plan or design. Provide data to validate the choice of design. Test results using a shake table or another quantifiable measuring device. | Design and build a simple seismograph that can measure movement of Earth's lithosphere. | Using real seismic data (wave velocities), create or interpret a cross section of Earth. Explain the change of appearance in the section as the rock type or consistency of the rock changes. | Identify the different composition and consistency of each layer of Earth's interior (inner and outer core, upper and lower mantle, crust). |

## 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.

- Building a working seismograph can be a way of combining design and engineering with understanding earthquakes and waves within science. Relating earthquakes to actual movements of the Earth can be difficult if the student has not actually experienced it. Using a seismograph and interpreting seismic data from working seismographs can help demonstrate the movement. **Teach Engineering** resources include information on building a seismograph. There also are specific resources to the engineering and design process and how to use them with eighth-grade students. Other examples of building a **seismograph** are available online. It is important to allow the student to test and experiment with the instrument to develop an understanding of how it measures Earth movement.
- The **USGS** provides helpful background data that connects the structure of Earth to plate tectonics. There also are links provided to show real-time seismic data (including data for the state of Ohio) and interactive seismic maps that can be manipulated.
- Another way to engage and interest students in the study of the structure of Earth and seismic activity is through specific case studies and research (e.g., the **Denali Fault Earthquake of 2002**). Showing the actual seismic waves as they travel can help students see the actual results of a real earthquake. This is helpful for all students, but may be especially helpful for students that are more visual or have difficulty developing concepts from text.

## COMMON MISCONCEPTIONS

- A common student misconception is that only California or Alaska experiences earthquakes. Researching and examining actual seismic events that occur in Ohio or surrounding areas can dispel this misconception. The USGS provides seismic data for all 50 states, including real-time data, at **http://earthquake.usgs.gov/earthquakes/states/?old=top_states.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**.
- 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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## 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.*

A Harvard case study on improving the teaching of science in real classrooms is available at **http://www.learner.org/resources/series21.html?pop=yes&pid=1050**. Nancy, an eighth-grade teacher, encourages students to work and think more on their own in her science class. This encourages true scientific inquiry and investigation at the student level.

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## MODEL CURRICULUM GRADE 8

## EARTH AND SPACE SCIENCE (ESS)

**Topic: Physical Earth**

This topic focuses on the physical features of Earth and how they formed. This includes the interior of Earth, the rock record, plate tectonics and landforms.

### CONTENT STATEMENT

**Earth's crust consists of major and minor tectonic plates that move relative to each other.**

Historical data and observations such as fossil distribution, paleomagnetism, continental drift and sea-floor spreading contributed to the theory of plate tectonics. The rigid tectonic plates move with the molten rock and magma beneath them in the upper mantle.

Convection currents in the crust and upper mantle cause the movement of the plates. The energy that forms convection currents comes from deep within the Earth.

There are three main types of plate boundaries: divergent, convergent and transform. Each type of boundary results in specific motion and causes events (such as earthquakes or volcanic activity) or features (such as mountains or trenches) that are indicative of the type of boundary.

### CONTENT ELABORATION

**Prior Concepts Related to Forces, Movement and Igneous Environments**

**PreK-2:** Properties of materials can change. Pushing and pulling can affect the motion of an object.

**Grades 3-5:** Forces change the motion of an object. Rocks have specific characteristics. Heat is a form of energy. Energy can be conserved. Earth's surface has specific characteristics. Heat results when materials rub against each other. Gravitational force and magnetism also are studied.

**Grades 6-7:** Rocks have characteristics that are related to the environment in which they form. Thermal energy is a measure of the motion of the atoms and molecules in a substance. Energy can be transformed, transferred and conserved. Thermal energy can be transferred through radiation, convection and conduction.

**Grade 8 Concepts**

The historical data related to the present plate tectonic theory must include continental "puzzle-like-fit" noticed as early as Magellan and by other mapmakers and explorers, paleontological data, paleoclimate data, paleomagnetic data, continental drift (Wegener), convection theory (Holmes) and sea floor spreading (Hess, Deitz). Contemporary data must be introduced, including seismic data, GPS/GIS data (documenting plate movement and rates of movement), robotic studies of the sea floor and further exploration of Earth's interior.

Physical world maps, cross sections, models (virtual or 3D) and data must be used to identify plate boundaries, movement at the boundary and the resulting feature or event. The relationship between heat from Earth's core, convection in the magma and plate movement should be explored. World distribution of tectonic activity of possible interest should be investigated (e.g., Ring of Fire, San Andreas Fault, Mid-Atlantic Ridge, Mariana Trench, Hawaiian Islands, New Madrid Fault System).

Volcanic activity, earthquakes, tsunamis, geysers, hot springs, faults, oceanic vents, island arcs, hot spots and rift valleys should all be included in the identification of plates and plate boundaries. Plate boundary identification (converging, diverging, transform) must be based on the resulting features or events. The focus must be on the cause of plate movement, the type and direction of plate movement and the result of the plate movement, not on memorizing plate names.

**Future Application of Concepts**

**High School:** Thermal energy, gravitational energy, radioactive decay and energy transfer are studied. In the grades 11/12 Physical Geology course, further studies of plate tectonics, seismology and volcanism are found.

### EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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|---|---|---|---|
| Research, design and construct a model of an earthquake-resistant structure (e.g., bridge, building, home). Draw a blueprint of the plan or design. Provide data to validate the choice of design. Test results using a shake table or another quantifiable measuring device with the class.  | Research the most recent measurements of North America.<br>Using this data and the movement of North America throughout geologic time, predict where North America will be in 600 million years or more. Create a model to demonstrate that movement.  | Differentiate between plate tectonics and continental drift. | Describe the general history of plate tectonics, including the early observations, discoveries and ideas that combined, that eventually lead to the modern theory of plate tectonics. |
| | Investigate, using **magnetic data** from new technology and the rock record, the pattern of reversing magnetism within Earth's core. Generate a chart or graph to represent findings. Using historical data, predict a time range for when the next reversal could occur.<br>Share findings with the class and be prepared to discuss what impact the reversal could have for humans.  | Using a world map, mark the **locations** of all earthquakes and volcanoes that are recorded each week for one month (or longer). Use a different color or pattern so that earthquakes and volcanoes can be differentiated. Outline the boundaries of where the concentrations are located.<br>Compare/contrast this map with a map of plate boundaries. Ask: ***What types of boundaries are found in the volcano areas? What types are found in earthquake areas?*** Discuss findings with the class. | Identify the standard geologic features or events that occur at each of the boundaries (e.g., oceanic trenches are formed at converging plate boundaries, oceanic ridges form at diverging plate boundaries). |

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## INSTRUCTIONAL STRATEGIES AND RESOURCES

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- To grasp plate movement fully, students must investigate Earth's history using real data and maps. Maps constructed using scientific evidence, such as Earth's **magnetism** and sea floor spreading, can be helpful. Interpreting paleomagnetic data for different geologic periods demonstrates how scientists determine plate movement over time.
- Another way to show plate movement and emphasize the evidence from the geologic record is to use technology and **virtual field trips**. Seeing the impact and movement of the plates firsthand can help with understanding the dynamic and changing features of Earth.
- Showing each geologic time period and the location of the major plates through time can help illustrate the ever-changing surface of Earth. Comparing **tectonic maps** from the earliest time period to present day and then predicting where the plates will be in the future can deepen the understanding of these processes.
- **NSTA** provides learning modules called ***SciPacks*** that are designed to increase teacher content knowledge through inquiry-based modules. This module addresses Plate Tectonics.
- Constructing geologic maps from actual data allows students to document evidence in a unique way. Maps can be compared and be used to discuss the changes that occur in specific locations. The **National Association of Geoscience Teachers** provides inquiry-based activities and resources for constructing geologic maps to demonstrate plate tectonics.
- The **USGS** provides helpful background data to understand the relationship between the structure of Earth and plate tectonics.

## COMMON MISCONCEPTIONS

- Misconceptions regarding Earth Science, including those dealing with plate tectonics and Earth history, can be determined through a professional "gallery walk." Discussing the conclusions and findings can be a very useful way to determine possible misconceptions that exist for the class and address them. Carleton College offers a gallery walk website at **http://serc.carleton.edu/introgeo/gallerywalk/misconceptions.html**.

The Journal of Geoscience Education contains an article (Visual Abilities and Misconceptions about Plate Tectonics), Sept. 2005, outlining the use of student drawings to identify misconceptions at **http://d32ogoqmya1dw8.cloudfront.net/files/nagt/jge/abstracts/Sibley_v53p471.pdf**.

- 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

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## MODEL CURRICULUM GRADE 8

# EARTH AND SPACE SCIENCE (ESS)

**Topic: Physical Earth**

This topic focuses on the physical features of Earth and how they formed. This includes the interior of Earth, the rock record, plate tectonics and landforms.

### CONTENT STATEMENT

**A combination of constructive and destructive geologic processes formed Earth's surface.**

Earth's surface is formed from a variety of different geologic processes, including but not limited to plate tectonics.

**Note: The introduction of Earth's surface is found in ESS grade 4.**

### CONTENT ELABORATION

**Prior Concepts Related to Earth's Surface**

**PreK-2:** Water can be found in many forms and locations. Wind is moving air.

**Grades 3-5:** Characteristics of rocks and soil, weathering, deposition, erosion, landforms, mass wasting and weather events (e.g., flooding) are studied.

**Grades 6-7:** Igneous, metamorphic and sedimentary formation, interactions between Earth systems, and patterns of erosion and deposition are studied.

**Grade 8 Concepts**

The interactions between the hydrosphere and lithosphere are studied as they relate to erosional events (e.g., flooding, mass wasting). The characteristics of rocks and soil, the climate, location, topography and geologic process are studied.

Distinguishing between major geologic processes (e.g., tectonic activity, erosion, deposition) and the resulting feature on the surface of Earth is the focus of this content statement. It is important to build on what was included in the elementary grades (recognizing features), enabling students to describe conditions for formation. Topographic, physical and aerial maps, cross-sections, field trips and virtual settings are methods of demonstrating the structure and formation of each type of feature. The use of technology (remote sensing, satellite data, LANDSAT) can be used to access real-time photographs and graphics related to landforms and features.

Factors that affect the patterns and features associated with streams and floodplains (e.g., discharge rates, gradients, velocity, erosion, deposition), glaciers (e.g., moraines, outwash, tills, erratic, kettles, eskers), tectonic activity (should include the features listed in the content statement above), coastlines, flooding and deserts should be studied.

**Future Application of Concepts**

**High School:** Gravitational forces and movement of matter are explored. In the grades 11/12 Physical Geology course, glaciation, sedimentation, stream evolution, seismology, volcanics, bathymetry and further information about weathering, erosion and deposition are included.

### EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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

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## VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

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|---|---|---|---|
| Research a specific area with active geologic processes or events. Develop a plan to harness the available energy (e.g., heat from magma, water movement) from the process. Build a working model using specific data from the location, including the geologic record, that can be used to evaluate the efficiency of the type of energy chosen. Present findings, recommendations and model to the class. | Research the most recent measurements of North America. Using this data and the movement of North America throughout geologic time, predict where North America will be in 600 million years or more. Create a model to demonstrate that movement. | Put together a **model** of karst topography enabling a 3-D view of a cave or sinkhole. Research the processes that must occur to form karst topography. Communicate the research in writing or orally. | Identify examples of destructive geologic processes (e.g., flooding, mass wasting, volcanic activity, glacial movement, earthquakes, tsunamis. |

## INSTRUCTIONAL STRATEGIES AND RESOURCES

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- Constructing geologic maps from actual data allows students to document evidence in a unique way. Maps can be compared and used to discuss the changes that occur in specific locations. The **National Association of Geoscience Teachers** provides inquiry-based activities and resources for constructing geologic maps to demonstrate plate tectonics.
- The **USGS** provides helpful background data to understand constructive and destructive Earth processes as related to plate tectonics.
- Students should be able to look at topographic maps, geologic maps and aerial photographs to identify constructive and destructive features found in Ohio, the United States and other areas of the world. Comparing and contrasting the features and the processes that created the features increase the depth of student understanding. **ODNR** demonstrates the dynamic surface of Earth through interactive and geologic maps specific to Ohio. There are many other resources that help support the teaching of geology using surficial maps to view the changing, dynamic surface of the Earth.
- The relationship between plate movement and the interior of Earth should be demonstrated through a variety of different resources (e.g., maps, photographs, virtual experiences, film clips of constructive and destructive processes, study of **Earth systems**). The Digital Library for Earth Systems Education offers resources from a number of sources (e.g., *National Geographic*, government agencies, scientific agencies). An **inquiry example** can show how to integrate the study of plate tectonics, seismic waves and earthquakes with constructive and destructive processes.

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## COMMON MISCONCEPTIONS

- 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/**.
- NSTA provides recommendations for specific publications that are designed to address strategy in the K-8 classroom to support teaching science to all students in the classroom. Helpful in starting to work with inquiry to reach and engage all students, the recommendations can be found at **http://www.nsta.org/recommends/ViewProduct.aspx?ProductID=18466**.

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## MODEL CURRICULUM GRADE 8

# EARTH AND SPACE SCIENCE (ESS)

**Topic: Physical Earth**

This topic focuses on the physical features of Earth and how they formed. This includes the interior of Earth, the rock record, plate tectonics and landforms.

### CONTENT STATEMENT

**Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.**

Earth is approximately 4.6 billion years old. Earth history is based on observations of the geologic record and the understanding that processes observed at present day are similar to those that occurred in the past (uniformitarianism). There are different methods to determine relative and absolute age of some rock layers in the geologic record. Within a sequence of undisturbed sedimentary rocks, the oldest rocks are at the bottom (superposition). The geologic record can help identify past environmental and climate conditions.

**Note: Environmental and climate conditions also can be documented through the cryosphere as seen through ice cores.**

### CONTENT ELABORATION

**Prior Concepts Related to Rocks and Fossils**

**PreK-2:** Some living things that once lived on Earth no longer exist because their needs were not met.

**Grades 3-5:** Rocks have characteristics and form in different ways. Earth's surface changes. Most types of organisms that have lived on Earth no longer exist. Fossils provide a point of comparison between the types of organisms that lived long ago and those living today. Rocks can change size and shape due to weathering, water and wind. Ice can physically remove and carry rock, soil and sediment.

**Grades 6-7:** Igneous, metamorphic and sedimentary rocks form in different ways. Each type of rock can provide information about the environment in which it was formed.

**Grade 8 Concepts**

The representation of the age of the Earth must include a graphic demonstration of the immensity of geologic time, as this is a very difficult concept to grasp. The different methods used to determine the age of the Earth are an important factor in this concept. In elementary grades, fossils are used to compare what once lived to what lives now, but the concept of Earth's age and the age of the fossils were not included (the concept of billions or millions of years was not age-appropriate). In grade 8, the concept of index fossils is a way to build toward understanding relative dating. Superposition, crosscutting relationships and index fossils play an important role in determining relative age. Radiometric dating plays an important role in absolute age. The inclusion of new advances and studies (mainly due to developing technological advances) is important in learning about the geologic record.

Uniformitarianism can be an important key in understanding how scientists have interpreted the environmental conditions that existed throughout Earth's history. Fossil evidence also can indicate specific environments and climate conditions that help interpret the geologic record. Relating Earth's climate history to present-day climate issues should include evidence from ice core sampling as well as evidence from the geologic record.

Using actual data to generate geologic maps of local or statewide formations can connect to the real world. Field studies or geologic research (can be virtual/digital) can help identify local formations and interpret the environment that existed at the time of the formation. Analyzing and interpreting the data to draw conclusions about geologic history is an important part of this content statement.

**Note: This content is closely connected to LS grade 8 content pertaining to diversity of species as documented in the fossil record, tracing changes evident in the fossil record and relating this content to evolution.**

**Future Application of Concepts**

**High School:** The age of Earth is further explored through learning about the evolution and extinction of species throughout Earth's history. In grades 11/12 Physical Geology, the interpretations of sections of the rock record and geologic time periods are explored.

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## EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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| Research a specific area with active geologic processes or events. Evaluate the different possible types of energy available at the event or location. Develop a plan to harness the available energy (e.g., heat from magma, water movement) from the process. Build a working model using specific data from the location, including the geologic record. Present findings, recommendations and model to the class. | Using technology, investigate the geologic record **virtually** to collect data and conduct scientific investigations through 60-70 million years of geologic time. Analyze data and document all changes verified by the data. Discuss conclusions and findings with the entire class. | Choose a specific geologic time period and location on Earth that has geologic rock record data. Represent the geologic time period graphically (using technology or manually). Include specific formation information. Share the final product with the class. | Describe the methods used by scientists to determine that the age of Earth is approximately 4.6 billion years. |
| | | | Recognize the immensity of the geologic time scale. |

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- The **USGS** provides helpful background data to understand the relationship between the structure of Earth, the history of Earth and plate tectonics. Students often struggle with the immense scale of Earth's history, so using relative and absolute time data to construct timelines can be helpful. It is important to use actual **geologic time** data and ensure that absolute time is fully explained. Timeline activities (e.g., using a football field for the timeline with an inch equaling one million years) may enhance class discussions.
- Relating the geologic record to Ohio is another strategy that can increase student engagement. Allow students to interpret Ohio's geologic history by combining field observations, bedrock geology maps and scientific research and data. **ODNR** offers a number of references and resources to help interpret Ohio geologic history.
- In addition to the geologic record, **ice cores** can be used to determine environmental conditions that existed at the time of formation. Actual ice-core data should be used. Interpretations of the data can support student ideas and discussions. Virtual field experiences and film clips can add to student interest.

## COMMON MISCONCEPTIONS

- Understanding the age of the Earth (4.6 billion years) can be difficult to grasp. This **activity** helps demonstrate the time scale in a visual and active way using a football field as the "scale." The activity can be modified to include important events and fossils for North America or Ohio to generate student interest.
- NASA lists common misconceptions for all ages about the sun and the Earth at **http://www-istp.gsfc.nasa.gov/istp/outreach/sunearthmiscons.html**.
- 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 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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## VISIONS INTO PRACTICE: CLASSROOM EXAMPLES

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|---|---|---|---|
| Research cloning in the food industry. Select one practice and determine whether or not it is an environmentally healthy practice. Justify your position with scientific evidence. | Examine offspring in plants that are produced sexually. Note and record variations that appear. Determine how the variations may help an organism to survive if the environment should change (e.g., warmer or cooler temperatures, increase or decrease in precipitation). | Explain why genetic variation is a survival advantage. | Describe the features of sexual and asexual reproduction related to the transfer of genetic information from parent to offspring. |

## INSTRUCTIONAL STRATEGIES AND RESOURCES

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- The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the **ODNR Website**. In *Bottleneck Genes*, students simulate the gene-pool analysis of an animal population and all the factors that affect it, including genetic diversity, environmental change, and limiting factors.

## COMMON MISCONCEPTIONS

- **Weber State University** provides a list for misconceptions in biology. Scroll down to Standard IV to address misconceptions about reproduction.

## DIVERSE LEARNERS

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## MODEL CURRICULUM GRADE 8

# LIFE SCIENCE (LS)

**Topic: Species and Reproduction**

This topic focuses on continuation of the species.

### CONTENT STATEMENT

**Diversity of species occurs through gradual processes over many generations. Fossil records provide evidence that changes have occurred in number and types of species.**

Fossils provide important evidence of how life and environmental conditions have changed.

Changes in environmental conditions can affect how beneficial a trait will be for the survival and reproductive success of an organism or an entire species.

Throughout Earth's history, extinction of a species has occurred when the environment changes and the individual organisms of that species do not have the traits necessary to survive and reproduce in the changed environment. Most species (approximately 99 percent) that have lived on Earth are now extinct.

**Note: Population genetics and the ability to use statistical mathematics to predict changes in a gene pool are reserved for grade 10.**

### CONTENT ELABORATION

**Prior Concepts Related to Species and Reproduction**

**PreK-2:** Living things have physical traits that enable them to live in different environments. Some kinds of individuals that once lived on Earth have completely disappeared, although they may be something like others that are alive today.

**Grades 3-5:** Fossils provide a point of comparison between the types of organisms that lived long ago and those existing today.

**Grades 6-7:** In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic conditions.

**Grade 8 Concepts**

The fossil record documents the variation in a species that may have resulted from changes in the environment. The fossil record is contained within the geologic record (ESS grade 8). Combining data from the geologic record and the fossil record, **Earth's living history** can be interpreted. Data and evidence from the fossil record must be used to develop further the concepts of extinction, biodiversity and the **diversity of species**.

Diversity can result from sexual reproduction. The sorting and combination of genes results in different genetic combinations, which allow offspring to be similar to, yet different from, their parents and each other. (This statement must be connected to the grade 8 Life Science content statement on reproduction and Mendelian Genetics.) These variations may allow for survival of individuals when the environment changes. Diversity in a species increases the likelihood that some individuals will have characteristics suitable to survive under changed conditions.

Evidence from geologic and fossil records can be used to infer what the environment was like at the time of deposition, The variations that exist in organisms can accumulate over many generations, so organisms can be very different in appearance and behavior from their distant ancestors.

**Note 1: Molecular clocks are not appropriate at this grade level.**

**Note 2: The term "transitional form" should be used to describe parts of the fossil record that are incomplete.**

### 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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| Research a genetically modified organism (e.g., Bt corn) and make a<br><br>Recommendation whether or not it is harmful to the environment. Provide peer-reviewed scientific evidence to support your answer. Evaluate the validity of the scientific claims made by both proponents and opponents of using genetically modified organisms for food. | Conduct a field study on a specific population of plants or animals in a local area. Examine members of that population and record variations in physical characteristics that can be seen (e.g., height, coloration, number of flowers). Predict which traits are more beneficial for survival in the population's current environment. Predict what variations may result in higher survival rates should the environment change (e.g., became warmer, colder, windy). | Create a timeline that illustrates the relative ages of fossils of a particular organism in sedimentary rock layers. | Describe how to determine the relative age of fossils found in sedimentary rock. |
| | | Graph data that indicates how the biodiversity in a particular biome or continent have changed over time. | |
| | | Examine organisms that are found in a variety of environments and others that have very specific habitats. Compare and contrast the ability of an organism to survive under different environmental conditions. | |
| | | Explain why variation within a population can be advantageous for a population of organisms. | |

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- The Annenberg Media series *Essential Science for Teachers:* **Life Science: Session 5** provides information on how children can learn about the variations of living things and offers classroom footage to illustrate implementation. Conduct an investigation to study adaptations of organisms and how they affect survival in a particular environment. **Bottle biology** offers a methodology for this investigation.
- The **Missouri Botanical Garden** helps students explore the world's biomes and their organisms. When students choose a biome or ecosystem, they discover a wide variety of information on plants, animals and their habitats.
- The Annenberg Media series *Essential Science for Teachers:* **Life Science: Session 6** provides information about how children can learn about the variations of living things that lead to evolution. It focuses on the development of a species.
- *Project Wild* was developed through a joint effort of the Western Association of Fish and Wildlife Agencies and the Council for Environmental Education. This program helps students learn basic concepts about wild animals, their needs and importance and their relationships to people and the environment. The activity guides are available to educators free of charge when they attend a workshop. Information about upcoming workshops are available on the **ODNR Website**. In *Bottleneck Genes*, students simulate the gene-pool analysis of an animal population and all the factors that affect it, including genetic diversity, environmental change, and limiting factors. In *Here Today, Gone Tomorrow*, students explore endangered species and the reasons why they are endangered.
- **Guide to Using Animals in the Classroom** by the Ohio Department of Natural Resources provides guidance, explains legally which organisms may be collected and limited advice on use of animals in the classroom.
- ODNR-Division of Wildlife's **A to Z Species Guide** has photos, information, tracks and sounds of Ohio's wild animals.

## COMMON MISCONCEPTIONS

- **AAAS' Benchmarks 2061 Online, Chapter 15**, 5f, *Evolution of Life*, states many students believe that environmental conditions are responsible for changes in traits or that organisms develop new traits because they need them to survive.

## DIVERSE LEARNERS

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## CLASSROOM PORTALS

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## MODEL CURRICULUM GRADE 8

## LIFE SCIENCE (LS)

**Topic: Species and Reproduction**

This topic focuses on continuation of the species.

### CONTENT STATEMENT

**Reproduction is necessary for the continuation of every species.**

Every organism alive today comes from a long line of ancestors who reproduced successfully every generation. Reproduction is the transfer of genetic information from one generation to the next. It can occur with mixing of genes from two individuals (sexual reproduction). It can occur with the transfer of genes from one individual to the next generation (asexual reproduction). The ability to reproduce defines living things.

### CONTENT ELABORATION

**Prior Concepts Related to Species and Reproduction**

**Grades 3-5:** Individual organisms inherit many traits from their parents indicating a reliable way to transfer information from one generation to the next.

**Grades 6-7:** Modern Cell Theory states cells come from pre-existing cells.

**Grade 8 Concepts**

An individual organism does not live forever. Reproduction is necessary for the continuation of every species. Most organisms reproduce either sexually or asexually. Some organisms are capable of both. In asexual reproduction, all genes come from a single parent, which usually means the offspring are genetically identical to their parent, allowing genetic continuity. Mitosis was investigated in grade 6. The end products of mitotic and meiotic cell divisions are compared as they relate to asexual and sexual reproduction. It is important that both mitosis and meiosis are addressed in preparation for future study of Mendelian genetics and embryology.

In sexual reproduction, a single specialized cell from a female (egg) merges with a specialized cell from a male (sperm). Typically, half of the genes come from each parent. The fertilized cell, carrying genetic information from each parent, multiplies to form the complete organism. The same genetic information is copied in each cell of the new organism. In sexual reproduction, new combinations of traits are produced which may increase or decrease an organism's chances for survival. Investigations and experimentation (3-D or virtual) must be used to compare offspring to parents in sexual and asexual reproduction.

**Future Application of Concepts**

**High School:** The details and importance of gamete formation are studied.

### EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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| Research cloning in the food industry. Select one practice and determine whether or not it is an environmentally healthy practice. Justify your position with scientific evidence. | Examine offspring in plants that are produced sexually. Note and record variations that appear. Determine how the variations may help an organism to survive if the environment should change (e.g., warmer or cooler temperatures, increase or decrease in precipitation). | Explain why genetic variation is a survival advantage. | Describe the features of sexual and asexual reproduction related to the transfer of genetic information from parent to offspring. |

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## COMMON MISCONCEPTIONS

- **Weber State University** provides a list for misconceptions in biology. Scroll down to Standard IV to address misconceptions about reproduction.

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## MODEL CURRICULUM GRADE 8

## LIFE SCIENCE (LS)

**Topic: Species and Reproduction**

This topic focuses on continuation of the species.

### CONTENT STATEMENT

**The characteristics of an organism are a result of inherited traits received from parent(s).**

Expression of all traits is determined by genes and environmental factors to varying degrees. Many genes influence more than one trait, and many traits are influenced by more than one gene.

During reproduction, genetic information (DNA) is transmitted between parent and offspring. In asexual reproduction, the lone parent contributes DNA to the offspring. In sexual reproduction, both parents contribute DNA to the offspring.

**Note 1: The focus should be the link between DNA and traits without being explicit about the mechanisms involved.**

**Note 2: The ways in which bacteria reproduce is beyond the scope of this content statement.**

**Note 3: The molecular structure of DNA is not appropriate at this grade level.**

### CONTENT ELABORATION

**Prior Concepts Related to Species and Reproduction**

**PreK-2:** Offspring tend to look their parents.

**Grades 3-5:** Individual organisms inherit many traits from their parents indicating a reliable way to transfer information from one generation to the next.

**Grades 6-7:** Modern Cell Theory states cells come from pre-existing cells.

**Grade 8 Concepts**

The traits of one or two parents are passed on to the next generation through reproduction. Traits are determined by instructions encoded in deoxyribonucleic acid (DNA), which forms genes. Genes have different forms called alleles. Introduce the principles of Mendelian genetics by reviewing Mendel's work. Mendel's two laws provide the theoretical base for future study of modern genetics. Mendel's first law, the Law of Segregation, and his second law, the Law of Independent Assortment, should be demonstrated and illustrated in a variety of organisms. The concepts of dominant and recessive genes are appropriate at this grade level. Codominant traits such as roan color in horses and cows may be useful to provide further validation of the theory and to help dispel some misconceptions. Pedigree analysis is appropriate for this grade level when limited to dominant, recessive or codominance of one trait. The Law of Independent Assortment should only be explored in simple cases of dominance and recessive traits. Chi-square and dihybrid crosses are reserved for high school.

Conduct a long-term investigation to analyze and compare characteristics passed on from parent to offspring through sexual and asexual reproduction. Ask questions about the phenotypes that appear in the resulting generations and what they infer about genotypes of the offspring.

**Note: Incomplete dominance is not suggested for this grade level to help avoid the misconception of "blending of traits." Codominance is encouraged because both traits are expressed in the resulting offspring.**

**Future Application of Concepts**

**High School:** The details and importance of gamete formation, the structure of DNA and modern genetics are studied.

### EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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| Designer dogs are developed to meet human needs. Investigate a number of breeds and explain the benefits and drawbacks of mixing the breeds. Make sure to examine several generations of dogs to determine the stability of the resulting hybrid. | Design and implement an investigation to predict the genotype and phenotypes of offspring between plants of known heritage (e.g., Wisconsin Fast Plants™) | Compare the exchange of genetic information during sexual and asexual reproduction. | Describe how genes, chromosomes and inherited traits are connected. |
| | | Given the genetic characteristics of the parents, use a Punnett square to predict the genetic outcome of the offspring produced. | Describe the characteristics and transfer of dominant and recessive traits. |

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## INSTRUCTIONAL STRATEGIES AND RESOURCES

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- **DNA from the Beginning** explores aspects of Mendel's genetic experiments with animations. The Law of Segregation, the Law of Independent Assortment and the Law of Dominance are explained.
- The University of Utah's Genetic Learning Center offers **Tour of the Basics**, a tutorial that contains animations to explain heredity and its components. For this content area, focus on *What is Heredity?* and *What is a Trait?* Some areas of this site go beyond the scope of this grade-level content.
- **Teachers' Domain: Reproduction and Genetics** is a two-session course that explores the cellular processes that organisms use to develop, reproduce and pass traits from one generation to the next.

### Career Connection

Students will research the roles of careers related to genetics, such as:

- Geneticists: expertise in the study of genetics.
- Veterinarian and Vet Techs: managing the health and wellness of animals, understanding animal reproductive behaviors and patterns.
- Biologists: study plants and animals and their environments.
- Medical and Animal Scientists: develop and improve products by conducting research and experiments.

Students will conduct career interviews, through a workplace visit or by telephone, to gather information that describes the real-work context of this classroom content.

## COMMON MISCONCEPTIONS

- **AAAS' Benchmarks 2061 Online, Chapter 15**, 5b, *Heredity*, highlights that students think sexual reproduction results in traits being inherited from only one parent (e.g., the mother or same-sex parent). They also may believe that there is a "blending of characteristics" in offspring.

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## MODEL CURRICULUM GRADE 8

## PHYSICAL SCIENCE (PS)

**Topic: Forces and Motion**

This topic focuses on forces and motion within, on and around the Earth and within the universe.

### CONTENT STATEMENT

**Forces between objects act when the objects are in direct contact or when they are not touching.**

Magnetic, electrical and gravitational forces can act at a distance.

**Note: Direct contact forces were addressed in the elementary grades.**

### CONTENT ELABORATION

**Prior Concepts Related to Forces**

**PreK-2:** Forces are pushes and pulls. Forces are required to change the motion of an object. Magnetic, gravitational and electrical forces act without touching.

**Grades 3-5:** The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted. The speed of an object is defined and calculated.

**Grades 6-7:** An object's motion can be described by its speed and the direction in which it is moving. An object's position and speed can be measured and graphed as a function of time.

*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 8 Concepts**

A field model can be used to explain how two objects can exert forces on each other without touching. An object is thought to have a region of influence, called a field, surrounding it. When a second object with an appropriate property is placed in this region, the field exerts a force on and can cause changes in the motion of the object.

Electric fields exist around objects with charge. If a second object with charge is placed in the field, the two objects experience electric forces that can attract or repel them, depending on the charges involved. Electric force weakens rapidly with increasing distance.

Magnetic fields exist around magnetic objects. If a second magnetic object is placed in the field, the two objects experience magnetic forces that can attract or repel them, depending on the objects involved. Magnetic force weakens rapidly with increasing distance. Magnetic field lines can be seen when iron filings are sprinkled around a magnet.

Gravitational fields exist around objects with mass. If a second object with mass is placed in the field, the two objects experience attractive gravitational forces toward each other. Gravitational force weakens rapidly with increasing distance.

Every object exerts a gravitational force on every other object with mass. These forces are hard to detect unless at least one of the objects is very massive (e.g., sun, planets). The gravitational force increases with the mass of the objects, decreases rapidly with increasing distance and points toward the center of objects. Weight is gravitational force and is often confused with mass. Weight is proportional to mass, but depends upon the gravitational field at a particular location. An object will have the same mass when it is on the moon as it does on Earth. However, the weight (force of gravity) will be different at these two locations.

Electricity is related to magnetism. In some circumstances, magnetic fields can produce electrical currents in conductors. Electric currents produce magnetic fields. Electromagnets are temporary magnets that lose their magnetism when the electric current is turned off. Building an electromagnet to investigate magnetic properties and fields can demonstrate this concept.

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Generators convert mechanical energy into electrical energy and are used to produce electrical energy in power plants. Electric motors convert electrical energy into mechanical energy. Motors are in blenders and washing machines. Both motors and generators have magnets (or electromagnets) and a coil of wire that creates its own magnetic field when an electric current flows through it.

**Note 1: Magnetic poles are often confused with electric charges. It is important to emphasize the differences.**

**Note 2: Mathematics is not used to describe fields at this level.**

**Note 3: This content statement involves a basic introduction to the field model. Details about the field model are not required other than the idea that a field is a concept that is used to understand forces that act at a distance.**

### Future Application of Concepts

**High School:** The strength of the force between two charges is calculated using Coulomb's Law. Electromagnetic induction is applied to generator and motors. DC circuits are studied.

## EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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| | **Investigate the affect of charges and distance on electrical forces.** | | |
| | Using the simulation titled **Coulomb's Law,** plan and implement a scientific investigation to determine the relationship between either distance and force or charge and force for two charges.<br><br>Analyze the data to determine patterns and trends.<br><br>Formulate a conclusion about the relationship. | Represent the data graphically.<br><br>Support the conclusion with evidence from the simulation. | Recognize that the electrical force increases as the electrical charges increase.<br><br>Recognize that the electrical force decreases when the distance between the charges increases. |
| Design and build a prototype of a device that can be attached to a crane to lift and move cars made of iron. The force of attraction lifting the car must be able to be released to deposit the cars in the desired location.<br><br>Test the designs of different groups in the class to determine which design can lift the largest mass. | | Use the field model to explain why an apple will fall toward Earth. | Given a simple interaction between two objects that are not touching (e.g., a ball falling to the ground, a magnet and a steel cabinet, hair and a brush experiencing static), identify the objects involved in the interaction and give the direction of the force on each object.<br><br>Given a simple contact interaction between two objects, identify the objects involved and give the direction of the force on each object. |

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- **Coulomb's Law**, an interactive simulation from the State University of New York's Department of Chemistry, allows students to change the amount and distance between two charges and see the resulting change in electric force.
- Hand-cranked radios or cell-phone chargers are examples of items that include generators.

## COMMON MISCONCEPTIONS

- **Only animate objects can exert a force.**
- Force is a property of an object.
- An object has force and when it runs out of force, it stops moving.
- Large objects exert a greater force than small objects.
- There is no gravity in space.

## DIVERSE LEARNERS

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## CLASSROOM PORTALS

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**Audrey**, teaching eighth-grade science for the first time, demonstrates strategies to empower students to take responsibility for their own learning 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.

**Pat** demonstrates strategies to ensure that the science inquiry activities she does with her students lead to higher-level thinking and deeper understanding 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 8

# PHYSICAL SCIENCE (PS)

**Topic: Forces and Motion**

This topic focuses on forces and motion within, on and around the Earth and within the universe.

### CONTENT STATEMENT

**Forces have magnitude and direction.**

The motion of an object is always measured with respect to a reference point.

Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The net force acting on an object can change the object's direction and/or speed.

When the net force is greater than zero, the object's speed and/or direction will change.

When the net force is zero, the object remains at rest or continues to move at a constant speed in a straight line.

### CONTENT ELABORATION

**Prior Concepts Related to Forces**

**PreK-2:** Forces are introduced as pushes and pulls that can change the motion of objects. Forces are required to change the motion of an object. Greater force on a given object results in greater change of motion.

**Grades 3-5:** The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted.

**Grades 6-7:** An object's motion can be described by its speed and the direction in which it is moving. An object's position and speed can be measured and graphed as a function of time.

*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 8 Concepts**

Motion can be described in different ways by different observers (e.g., a pencil held in someone's hand may appear to be at rest, but to an observer in a car speeding by, the pencil may appear to be moving backward).

A force is described by its strength (magnitude) and in what direction it is acting. Many forces can act on a single object simultaneously. The forces acting on an object can be represented by arrows drawn on an isolated picture of the object (a force diagram). The direction of each arrow shows the direction of push or pull. When many forces act on an object, their combined effect is what influences the motion of that object. The sum of all the forces acting on an object depends not only on how strong the forces are, but also in what directions they act. Forces can cancel to a net force of zero if they are equal in strength and act in opposite directions. Such forces are said to be balanced. If all forces are balanced by equal forces in the opposite direction, the object will maintain its current motion (both speed and direction). This means if the object is stationary, it will remain stationary. If the object is moving, it will continue moving in the same direction and at the same speed. Such qualitative, intuitive understandings and descriptions of inertia must be developed through inquiry activities.

Kinetic friction is a force that occurs when two objects in contact interact by sliding past one another. Drag is a force that opposes the motion of an object when an object moves through a fluid (e.g., gas, liquid). Kinetic friction and drag affect the motion of objects and may even cause moving objects to slow to a stop unless another force is exerted in the direction of motion. This phenomenon leads to the misconception that objects require a sustained force to continue moving. Experimentation with objects that have limited friction (e.g., a puck on an air hockey table, dry ice on a surface) can address the misconception that objects with a net force of zero naturally slow down.

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If the forces are not balanced, the object's motion will change, either by speeding up, slowing down or changing direction. Qualitative, intuitive understandings of the influence of unbalanced forces on objects must be developed through inquiry investigations.

**Note 1: The concept of fields for objects that exert forces without touching is introduced at this grade level.**

**Note 2: The content description states that there will be acceleration when "the net force is greater than zero." When positive and negative values are used to represent the direction of forces, this statement will need to be expanded. Any nonzero net force, including a negative net force, also may result in a change in speed or direction (acceleration).**

### Future Application of Concepts

**High School:** Newton's second law will be developed quantitatively and situations will be 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 |
|---|---|---|---|
| Design and build a simple model to demonstrate the benefits of seatbelts using Newton's first law of motion. Use the models to compare the effectiveness of shoulder and lap belts vs. lap belts alone.  | Plan and implement a scientific experiment to determine how two opposing forces affect the change in motion of a system when two opposing weights are connected by a string hanging over a pulley.  | Explain how the force of gravity can be acting on a book at rest on a table and yet the book does not change its motion.  | Recognize that an unbalanced force acting on an object changes that object's speed and/or direction. |
| | Implement a scientific investigation to determine what type of force is needed to get a moving puck on an air hockey table to slow down, speed up and move in a circle.<br><br>**Note: Using a broom on a bowling ball to trace the lines and circles on the gymnasium floor could be substituted if an air hockey table is not available.**  | Explain why a heavy cabinet does not change its motion, even though a strong pushing force is applied.  | Recognize that free fall results from the gravitational attraction between Earth and an object. |
| | | Predict the combined effect of several forces on an object at rest or an object moving in a straight line (e.g., speed up, slow down, turn left, turn right).  | Recall that an unbalanced force acting on an object changes that object's speed and/or direction. |

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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.

- Use balloon cars, hover pucks and air hockey tables with students to explore motion that is not affected by a great deal of friction.
- **Friction**, an interactive simulation from BBC Schools, allows students to apply different forces to start a cart moving and explore how far the cart travels on different surfaces.
- **Forces in Action**, an interactive simulation from BBC Schools, allows students to observe how different-sized parachutes with different amounts of drag affect the motion of a truck.
- **Gravity Force Lab**, an interactive simulation from PhET, allows students to visualize the gravitational force that two objects exert on each other. Students may change the mass of and distance between the objects and observe the changes in the gravitational force.
- **Forces in 1-Dimension** is an interactive simulation from PhET that allows students to use different forces to push an object, see the resulting friction force, net force, and any change in motion that occurs.

## COMMON MISCONCEPTIONS

- **The only natural motion is for an object to be at rest.**
- If an object is at rest, no forces are acting on the object.
- Only animate objects can exert a force. Thus, if an object is at rest on a table, no forces are acting on it.
- Force is a property of an object. An object has force and when it runs out of force, it stops moving.
- A force is needed to keep an object moving with a constant speed. Students do not realize that gravity and friction are forces.

## 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 8

## PHYSICAL SCIENCE (PS)

**Topic: Forces and Motion**

This topic focuses on forces and motion within, on and around the Earth and within the universe.

### CONTENT STATEMENT

**There are different types of potential energy.**

Gravitational potential energy changes in a system as the masses or relative positions of objects are changed. Objects can have elastic potential energy due to their compression or chemical potential energy due to the nature and arrangement of the atoms that make up the object.

### CONTENT ELABORATION

**Prior Concepts Related to Energy**

**PreK-2:** The sun is the principal source of energy (ESS). Plants get energy from sunlight (LS).

**Grades 3-5:** Energy is the ability to cause motion or create change. Heat, electrical energy, light, sound and magnetic energy are forms of energy. Earth's renewable and nonrenewable resources can be used for energy (ESS). All processes that take place within organisms require energy (LS).

**Grades 6-7:** All matter is composed of atoms. Each substance has its own unique, unchanging composition of type and number of atoms. There are two general categories of energy: kinetic and potential. Energy can be transformed or transferred, but is never lost. The thermal energy of water changes during the water cycle (ESS). Thermal energy transfers in the ocean and the atmosphere contribute to the formation of currents that influence global climate patterns (ESS). Plants transform light energy into the potential energy contained in organic molecules, which can then be transformed into thermal and other forms of energy when the molecules are broken down (LS).

**Grade 8 Concepts:**

Gravitational potential energy is associated with the mass of an object and its height above a reference point (e.g., above ground level, above floor level). A change in the height of an object is evidence that the gravitational potential energy has changed.

Elastic potential energy is associated with how much an elastic object has been stretched or compressed and how difficult such a compression or stretch is. A change in the amount of compression or stretch of an elastic object is evidence that the elastic potential energy has changed.

Chemical potential energy is associated with the position and arrangement of the atoms within substances. Rearranging atoms into new positions to form new substances (chemical reaction) is evidence that the chemical potential energy has most likely changed. The energy transferred when a chemical system undergoes a reaction is often thermal energy.

Electrical potential energy is associated with the position of electrically charged objects relative to each other and the amount of charge they have. A change in the position of charged particles relative to each other is evidence of a change in electrical potential energy.

Magnetic potential energy is associated with the position of magnetic objects relative to each other.

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The different types of potential energy must be explored through experimentation and investigation that include the relationship of energy transfer and springs, magnets or static electricity.

**Note: Potential energy is often taught as "stored" energy. If the word "stored" means that it is kept by the object and not given away to another object, then kinetic energy also can be classified as "stored" energy. A rocket moving at constant speed through space has kinetic energy and is not transferring any of this energy to another object.**

### Future Application of Concepts

**High School:** Gravitational potential energy will be calculated for objects at varying heights and kinetic energy will be calculated for moving objects. Conservation of energy will be explored mathematically. Elastic potential energy will be calculated for different systems. Electric potential and electric potential energy will be introduced.

## EXPECTATIONS FOR LEARNING: COGNITIVE DEMANDS

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| **Explore potential energy in the design of a pinball machine.** | | | |
| Design a way to give a steel marble the most possible potential energy in a pinball machine before it is launched.  | With the class, plan a scientific investigation to test and compare the amount of energy of the designs of the different groups in the class.<br>Implement the test on the class designs.<br>Formulate a hypothesis about which design features provide the marble with the most potential energy.  | Compare the design features to determine what features affect the amount of potential energy given to the ball.  | |

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| | **Investigate the relationship between height and gravitational potential energy.** | | |
| | Plan and implement a scientific experiment to determine the relationship between the height of a metal sphere and the amount of change it can make to sand that is held in a container. Determine how to quantify the changes to the sand.<br><br>Formulate a conclusion about how the height of an object is related to its potential energy. | Represent the data graphically.<br><br>Support the conclusion with data from the experiment. | Recognize that gravitational potential energy increases with height. |
| | **Investigate the relationship between mass and gravitational potential energy.** | | |
| | Plan and implement a scientific experiment to determine the relationship between the mass of a metal sphere and the amount of change it can make to sand that is held in a container. Determine how to quantify the changes to the sand.<br><br>Formulate a conclusion about how the mass of an object is related to its potential energy. | Represent the data graphically.<br><br>Support the conclusion with data from the experiment. | Recognize that gravitational potential energy increases with mass. |
| | | Use an energy bar graph to show different types of energy (gravitational potential, elastic potential, kinetic energy) for a stretched rubber band that is launched straight up into the air. Show bar graphs for five different positions: before launching, ¼ the way up, ½ the way up, ¾ the way up, and at the top of its path. | Identify five different types of potential energy. |

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- **Masses and Springs** is an interactive simulation from PhET that has a realistic simulation of a mass and spring lab. Students select a mass to hang from a spring and adjust the spring stiffness and damping. The results can be observed in slow motion and the simulation includes transporting the apparatus to different planets. A chart can show the kinetic, potential and thermal energy for each spring.

## COMMON MISCONCEPTIONS

- **An object at rest has no energy.**
- The only type of potential energy is gravitational.
- Gravitational potential energy depends only on the height of an object.
- The terms "energy" and "force" are interchangeable.
- **Energy is a thing, an object or something that is tangible.**

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