Test Specifications: Grade 8 - 2.0

Introduction

The Grade 8 Science Test Specifications provide an overview of the structure and content of the test. This overview includes a description of the test design as well as information on the types of items that will appear on the test. Also included is a test blueprint composed of a table identifying the range and distribution of items and points grouped by categories. The test specifications also provide specific guidelines for the development of all items used for the Grade 8 Science Test. This document is intended to be a resource not only for item writers and test designers, but for Ohio educators and other stakeholders who are interested in a deeper understanding of the test. The *Content Limits* and *Do Not Assess* sections identify boundaries for the content that will appear on the Grade 8 Science Test. The *Do Not Assess* section lists content that is either beyond the scope of the standard or which is pertinent to the standard but will not be explicitly tested in isolation. Do not assess does not necessarily mean do not instruct.

General Description of the Grade 8 Science Test

In 2018 Ohio adopted revised academic content standards for Grade 8 Science. A model curriculum based on these standards was adopted in 2019.

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

Test Design

The structure of the Grade 8 Science Test will consist of two parts that will be given near the end of the academic year. Both parts of the test are fixed forms that are administered in an online format. The sequence and timing of the administration of Part 1 and Part 2 is determined by the district. After the student has completed both parts of the test, his or her scores will be combined to yield a comprehensive view of the student's progress.

Test Blueprint

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

Grade 8 Science Test Blueprint

Reporting Category	Topic	Points	Total Points on Form	Approximate Percent of Test
Earth Science	8.ES.1: The composition and properties of Earth's interior are identified by the behavior of seismic waves 8.ES.2: Earth's lithosphere consists of major and minor tectonic plates that move relative to each other. 8.ES.3: A combination of constructive and destructive geologic processes formed Earth's surface 8.ES.4: Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.	21-23	54-56	38%-43%
Physical Science	8.PS.1: Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields. 8.PS.2: Forces can act to change the motion of objects.	16-18		29%-33%
Life Science	8.LS.1: Diversity of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The fossil record provides evidence that changes have occurred in number and types of species. 8.LS.2: Every organism alive today comes from a long line of ancestors who reproduced successfully every generation. 8.LS.3: The characteristics of an organism are a result of inherited traits received from parent(s)	16-18		29%-33%

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

Cognitive Demands: Expectations for Learning

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

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

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

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

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

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

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

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

Interaction Types

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

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

	scanned and scored electronically. The student fills in a circle to indicate the correct response. **Drag-and-Drop Hot Text -** Given a set of options (e.g., numbers, words, phrases, or sentences) the student hovers over the options which then highlight, indicating that the option is selectable ("hot"). The student can then click on the object, hold down the mouse button, and drag it to a graphic, table, or paragraph. For paper-based assessments, the options are associated with a letter, and students write a letter for their response in each response area
Inline Choice Item (IC)	Given a sentence, paragraph, or table, the student clicks a blank box embedded within a sentence or table which reveals a drop-down menu containing options for completing a sentence or table. The student then selects an option from the drop-down menu to respond. For paper-based assessments, the interaction is modified so that it can be scanned and scored electronically. The student fills in a circle to indicate the correct response.
Matching Item (MI)	Given column and row headers in a table format, the student checks a box to indicate if information from a column header matches information from a row header. For paper-based assessments, the interaction is modified so that it can be scanned and scored electronically. The student fills in a circle to indicate the correct response.
Multiple Choice Item (MC)	The student selects one correct answer from four options. For paper-based assessments, the student fills in a circle to indicate the correct response.
Multi Select Item (MS)	The student is directed to either select an indicated number of correct answers or to select all of the correct answers. Students in grades 3-5 always select an indicated number of correct answers; students in grades 6-8 select an indicated number of correct answers on 50% of the items and select all on 50% of the items; and students taking high school end-of-course tests are always directed to select all correct answers. These items are different from multiple choice items and require the student to select 2 or more correct answers. For paper-based assessments, the student fills in circles to indicate the correct responses.
Simulation Item (Sim)	Given a set of instructions, the student may interact with any of the following controls to generate data: radio buttons, drop-down menus, slide bars, or selecting a number by clicking arrows. Once the student has set the parameters, they click the start button to begin the simulation and generate a data set. Once the student has enough data, they may answer questions about the data using a different interaction type. For paper-based assessments, this interaction will be replaced with another interaction type that assesses the same standard at the same level of difficulty and can be scanned and scored electronically.

Table Item (TI)	The student types numeric values into a given table. The student may complete the entire table or portions of the table depending on what is being asked. For paper-based assessments, the student writes their responses in the blank boxes of the table.

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

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

Stimulus Types

A simulation stimulus consists of the following:

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

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

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

Item Specifications: Grade 8 Science

Nature of Science One goal of science education is to help students become scientifically literate citizens that are able to use science as a way of knowing about the natural and material world. All students should have sufficient understanding of scientific knowledge and scientific processes to enable them to distinguish what is science from what is not science and to make informed decisions about career choices, health maintenance, quality of life, community and other decisions that impact both themselves and others.	
Categories	**6-8**
Scientific Inquiry, Practice and Applications All students must use these scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas.	● Apply knowledge of science content to real-world challenges. ● Identify questions that can be answered through scientific investigations. ● Design and conduct scientific investigations using appropriate safety techniques. ● Use appropriate mathematics, tools and techniques to gather data and information. ● 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. ● Communicate scientific procedures and explanations. ● Design technological/engineering solutions.
Science is a Way of Knowing Science assumes the universe is a vast single system in which basic laws are consistent. Natural laws operate today as they did in the past and they will continue to do so in the future. Science is both a body of knowledge that represents a current understanding of natural systems and the processes used to refine, elaborate, revise and extend this knowledge.	● Science is a way of knowing about the world around us based on evidence from experimentation and observations. ● Science is a continual process and the body of scientific knowledge continues to grow and change. ● Science assumes that objects and events occur in consistent patterns that are understandable through measurement and observation. ● Science should carefully consider and evaluate all data including outliers. ● Science is based on observable phenomena and empirical evidence. ● Science disciplines share common rules for obtaining and evaluating empirical evidence.
Science is a Human Endeavor Science has been, and continues to be, advanced by individuals of various races, genders, ethnicities, languages, disabilities, family backgrounds and incomes.	● Individuals from different social, cultural, and ethnic backgrounds work as scientists and engineers. ● Scientists and engineers are guided by habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism and openness to ideas. ● Scientists and engineers rely on human qualities such as persistence, precision, reasoning, logic, imagination, and creativity.
Scientific Knowledge is Open to Revision in Light of New Evidence Science is not static. Science is constantly changing as we acquire more knowledge.	● Science explanations are subject to revision and improvement in light of scientific evidence or new understanding of scientific evidence.

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

8.ESS.1: 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 are used to differentiate the layers of Earth's interior. Earth has a core, a mantle and a crust.

Impacts during planetary formation generated primordial heat, converting gravitational potential energy into kinetic and thermal energy. Gravitational heat was also released when the Earth's layers separated as heavier elements sank to form the core. Earth also generates heat via radioactive decay from elements in the mantle. Thermal energy from Earth's mantle drives convection currents in the asthenosphere.

Note 1: *Radioactive decay is not the focus; this will be discussed in Physical Science and Chemistry.*

Note 2: *At this grade level, analyzing seismograms (e.g., amplitude and lag time) and reading a travel time curve are not the focus. At this grade, the properties of seismic waves should be addressed.*

Content Elaborations

Grade 8 Concepts

It is important to provide 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 can be used to study Earth's interior. Earth is differentiated into distinct chemical and physical layers. They correspond in the following way [the chemical layer is stated first, followed by the physical layers in parentheses]: the crust (upper lithosphere), the mantle (lower lithosphere, asthenosphere, mesosphere) and the core (outer and inner).

The refraction and reflection of seismic waves, as they travel through the lithosphere to the inner core, is used to identify the different physical layers of Earth's interior. The thicknesses of each layer of Earth can vary and be transitional, depending on composition, density, temperature and pressure, rather than uniform and distinct as often depicted in textbooks.

Earth and other planets in the solar system formed as heavier elements (primarily iron and nickel) coalesced in their centers and formed planetary cores. The less dense, lighter elements (potassium and sodium for example) remained closer to the planetary surface. This is planetary differentiation, a process through which distinct layers with characteristic chemical and/or physical properties are formed. A major period of planetary differentiation occurred in our solar system approximately 4.6 billion years ago (College Board Standards for College Success, 2009). There are three main sources of heat in Earth's interior: primordial heat left over from planetary accretion, the decay of radioactive elements and friction as materials move within the Earth.

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

Content Limits:

- Matter and energy (thermal, radioactive, seismic) are transferred through the interior of Earth;
- Behavior and properties of seismic waves;
- Mechanisms and techniques to indirectly study the composition of Earth's interior;
- Interpretation of seismic wave speed data relative to depth within Earth or state of matter;
- Radioactive decay (only as it relates to energy in Earth's interior);
- History of formation, including planetary differentiation based on density of materials;
- Role of asthenosphere convection currents in energy and matter transfer;
- Composition and thickness of Earth layers vary and are transitional as opposed to uniform and distinct;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Properties of solids, liquids and gases;
- Definitions and characteristics of P-waves and S-waves;
- Physical properties and behaviors of waves not directly related to the study of Earth's interior;
- Mechanisms of the formation of the solar system;
- The speed of seismic waves within specific substances (e.g. the speed in basalt);
- The actual thickness of Earth's layers;
- Features of instruments that measure seismic activity;
- The details and processes of radioactive decay.

Stimulus Attributes:

- Diagrams of Earth's interior;
- Graphs or data representing seismic waves (e.g., seismic profile and seismograms);
- Advancing technologies that impact the study of Earth's interior;
- Cross sections of Earth and other planets;
- Graphs or tables of temperature vs. depth from Earth's surface;
- Diagrams/images showing energy transfer by radiation, convection and conduction as it applies to Earth's interior;
- Simulations that allow for the collection of seismic data;
- Primary sources relating to study of the structure and composition of the Earth through the use of seismic waves.

Response Attributes:

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

- Completing or interpreting diagrams showing energy transfer (convection, conduction, radiation) within the Earth's interior;
- Interpreting seismic wave data to determine changes in density or state of matter in Earth's interior;

- Predicting the direction and/or rate of the transfer of energy or matter within Earth based on data;
- Given data or diagrams, drawing conclusions about the formation of Earth (e.g., radioactive decay, differentiation);
- Evaluating or interpreting information gathered from technological advances relating to Earth's interior.

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

- Layers of Earth are uniform;
- Seismic waves only relate to earthquakes;
- Planetary differentiation was recent;
- The interior of Earth has a uniform temperature;
- Seismic waves travel at uniform speeds.

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.

8.ESS.2: Earth's lithosphere 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 seafloor 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 asthenosphere cause the movement of the lithospheric plates. The energy that forms convection currents comes from deep within 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 Elaborations:

Historical data related to the modern-day theory of plate tectonics, which led to theories of continental drift (Wegener), convection theory (Holmes) and seafloor spreading (Hess, Deitz) is introduced. The data supporting these theories include paleontological data, paleoclimate data, paleomagnetic data and the continental "puzzle-like-fit" noticed as early as Magellan and by other mapmakers and explorers. Contemporary data is 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 are used to identify plate boundaries, movement at the boundary and the resulting feature or event. The relationship between heat from Earth's interior, convection in the magma and plate movement is 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 are included in the identification of plates and plate boundaries. Plate boundary identification (convergent, divergent, transform) is based on the resulting features or events. The focus is 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.

Content Limits:

- Evidence for the theory of plate tectonics (including historical data);
- Contemporary research and discoveries that measure plate movement;
- Movement of tectonic plates caused by convection currents in the asthenosphere;
- Movement of tectonic plates at boundaries as it relates to plate density;
- Types and characteristics of tectonic plate boundaries and the resulting features or events;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Characteristics of rocks;
- Numeric values of the rate of plate movement;
- Identifying tectonic plate, site, or boundary names (e.g., Pacific plate, North American plate, San Andreas Fault, Mariana Trench);
- Identifying scientists by name or contribution.

Stimulus Attributes:

- Maps or data to support evidence of continental drift, seafloor spreading, and plate tectonics;
- Diagrams, images, maps, cross-sections showing tectonic plate boundaries and/or the history of plate movement;
- Diagrams, images, maps, cross-sections showing tectonic events or features;
- Tables, graphs and images showing data of tectonic activity (e.g., incidents of earthquakes over time, rate of volcanic eruptions, GPS/GIS);
- Primary sources relating to plate tectonics.

Response Attributes:

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

- Interpreting data or visual representations relating to tectonic plate boundaries or the history of plate movement;
- Differentiating between characteristics of plate tectonics and continental drift;
- Explaining or predicting geological features caused by plate boundaries;
- Categorizing tectonic plate boundaries based on features or events;
- Given data about tectonic plates, predicting type of boundary or movement;
- Using evidence to support continental drift, seafloor spreading and plate tectonics.

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

- All tectonic plates move at the same rate;
- Earthquakes and volcanoes only occur at plate boundaries or at specific geographical locations;
- Plates and continents are equivalent;
- Continents float;
- Continental drift and plate tectonics are equivalent.

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.

8.ESS.3: 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.

Content Elaboration:

The interactions between the hydrosphere and lithosphere are studied as they relate to erosional events (e.g., flooding, mass movement). The characteristics of rocks and soil, 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. Technology (e.g., 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, erratics, kettles, eskers), tectonic activity (includes the features listed in the previous content statement), coastlines, flooding and deserts should be studied.

Content Limits:

Note: Geologic features related to tectonic activity are assessed in the previous content statement.

- Characteristics of rocks and soil, climate, location, and topography as they relate to constructive and destructive processes between the atmosphere, hydrosphere and lithosphere;
- Major geologic processes that form specific features on the surface of Earth (tectonic activity, erosion, deposition);
- Factors (e.g., topography, climate, soil and rock characteristics) that affect the surface patterns associated with streams, floodplains, glaciers, coastlines, flooding and deserts;
- The relationship between glaciers and climate change;
- The role of glaciers in Ohio's geologic history;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Specific types of weathering or forms of deposition, stream evolution, seismology, volcanics and/or bathymetry;
- Numerical values for rates of erosion, water flow, deposition, etc.;

- Specific names of landforms or faults (e.g., San Andreas Fault).

Stimulus Attributes:

- Images, diagrams, cross-sections, maps (including topographical maps) of geologic features produced by tectonic activity, erosion and/or deposition;
- Tables reporting characteristics of various rock and soil types as they relate to the formation of land forms;
- Tables, graphs, data showing stream discharge rate, velocity, volume and/or seasonal depth;
- Tables, graphs, data showing glacial velocity, movement, and thickness;
- Tables, graphs, data showing precipitation type and amount, slope, graduation, rock/soil type, geomorphic data, and ground water velocity;
- Images, diagrams, maps showing changes in waterways over time.
- Primary accounts of landforms (historical).

Response Attributes:

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

- Interpreting images or diagrams of geologic features to determine the process of formation;
- Predicting the effect of rock and soil types (e.g., sandy, clay), location, topography, and climate on erosion and deposition;
- Using a map to indicate where specific landforms would be located due to constructive or destructive processes over time;
- Completing a diagram based on data that shows how constructive or destructive processes will affect the lithosphere over time;
- Identifying the processes that cause various types of surface features to form (e.g., rivers/streams, glaciers, deserts, coastlines);
- Describing the processes that cause various types of surface features to form (e.g., rivers/streams, glaciers, deserts, coastlines).

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

- Erosion and deposition are similar;
- Weathering and erosion are equivalent;
- Erosion and deposition are always fast or always slow.

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.

8.ESS.4: 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.

Content Elaboration:

Representations of the age of Earth should 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 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, cross-cutting 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 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. Environmental and climate conditions can also be documented through the cryosphere as seen through ice cores. 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 (virtual/digital) can help identify local formations and interpret the environment that existed at the time they were formed. Analyzing and interpreting the data to draw conclusions about geologic history is an important part of this content statement.

Content Limits:

- Connection between presence of specific rock types, rock features, or fossils and environmental conditions at the time of formation (e.g., rocks with ripple marks and moving water or basalt and volcanic activity);
- The concept of uniformitarianism, which can be used to interpret past environmental conditions by comparing to current conditions;
- Relative age, which is determined by the Law of Superposition, index fossils, and crosscutting relationships;
- Absolute age, which is determined by radiometric dating;

- Relative age and absolute age, which provide evidence for the geologic history of an area;
- Climate change as documented by the geologic record, ice cores or other primary source documents;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Fossils as a point of comparison between the types of organisms that lived long ago and those living today;
- Names of fossils;
- Specific evolution and extinction events throughout Earth's history;
- The names and dates of geologic time periods (e.g., epochs, eras, the Jurassic period);
- Half-life determination and the mechanics of absolute dating.

Stimulus Attributes:

- Images, diagrams, cross-sections of bedrock with and without intrusions folding and overturning showing actual or hypothetical rock records;
- Surface/bedrock maps of Ohio or other primary source documents related to Ohio's landscapes;
- Images and diagrams of geologic columns and/or glacial cores;
- Geologic timelines with other images/diagrams/cross-sections of bedrock;
- Primary sources related to climate.

Response Attributes:

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

- Interpreting relative age and/or environmental conditions from cross sections, images, or diagrams showing geologic columns and/or glacial cores;
- Comparing and contrast relative age and/or environmental conditions of two or more geologic columns and/or glacial cores;
- Given data, determining relative age and explaining how it can be determined by the Law of Superposition, index fossils, and cross-cutting relationships;
- Comparing absolute and relative age.

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

- Climate change and global warming are equivalent;
- Climate and weather are equivalent;
- Humans and dinosaurs coexisted;
- Human timescales and geologic timescales are equivalent;
- The present environment is the same as the past environment.

Physical Science (PS)

Topic: Forces and Motion

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

8.PS.1: Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields.

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

Content Elaboration:

This content statement involves a basic introduction to the field model. A field model can be used to explain how two objects can exert forces on each other without touching. 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. 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. In grade 8, content will focus on connecting and organizing prior knowledge using the field model. Three types of fields should be investigated: gravitational, electric and magnetic.

Every object with mass 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 the force that a mass experiences in a gravitational field. Weight 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.

Electrostatic fields exist around objects with a net charge. If a second object with a net charge is placed in the field, the two objects experience electric forces that can attract or repel them, depending on the sign of the charges involved.

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 orientation of the objects involved. Magnetic field lines can be seen when iron filings are sprinkled around a magnet.

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.

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.*

Content Limits:

- Basic understanding of gravitational, electric and magnetic fields;
- Behavior of objects with mass, charge and/or magnetic properties in gravitational, electric or magnetic fields;
- The effect of distance on field strength (electric, magnetic and gravitational);
- Differences between mass and weight (gravitational force);
- Relationship between electric currents and magnetic fields;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Field diagrams (other than iron filings sprinkled over magnets);
- The amount of change in movement of an object is based on the mass of the object and the amount of force exerted;
- Calculations involving field theory, Newton's universal law of gravitation, Coulomb's Law or any mathematical laws of magnetism;
- Details about the field model beyond a field is a concept that is used to understand forces that act at a distance;
- Details about electromagnetic fields
- Electric circuits.

Stimulus Attributes:

- Diagrams or images showing 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);
- Diagrams or images of a magnet and iron filings;
- Diagrams or images of an object in an electric field (e.g., charged sphere);
- Diagrams or images of an object in a magnetic field (e.g., compass);
- Diagrams or images of an object in a gravitational field (e.g., falling mass, satellite in orbit);
- Basic diagrams or images of electromagnets;
- Simulations which generate data for non-contact forces.

Response Attributes:

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

- Comparing the properties of gravitational, electric and magnetic fields;
- Comparing the properties of fields and forces;
- Interpreting the magnetic field from drawings/images of a magnet and iron filings;
- Determining what types of objects (e.g., massive, electric, magnetic) will experience a force in a given field;

- Relating the force on an object to its distance from the source of a field (e.g., masses, charged objects);
- Using diagrams of electromagnets, relating how the relationship between current and magnetic field is utilized to make them work;
- Designing an experiment to assess how objects would behave in a(n) electric, magnetic or gravitational field;
- Explaining at a basic level how electromagnets work (based on transformation of energy and the relationship between current and magnetic field).

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

- Mass and weight are equivalent;
- Force is a property of an object that can be “used up”;
- Only moving objects can exert a force;
- There is no gravity in space;
- Large objects create a greater force than small objects;
- Magnetic poles are confused with electric charges.

Physical Science (PS)

Topic: Forces and Motion

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

8.PS.2: Forces can act to change the motion of objects.

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 the forces acting on the object.

If there is a nonzero net force acting on an object, its speed and/or direction will change.

Kinetic friction and drag are forces that act in a direction opposite the relative motion of objects.

Content Elaboration:

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).

When multiple forces act on an object, their combined effort is what influences the object's motion (speed and direction). 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, 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. When the net force is nonzero, the forces are unbalanced and the object's motion will change.

The forces acting on an object can be modeled by a force diagram. Forces are represented by arrows drawn on an isolated picture of the object. The direction of each arrow shows the direction of the force. The length of each arrow represents the magnitude of the force. The effect of the net force on the motion of an object can be predicted from a force diagram. The direction and relative size of the net force can be identified from force diagrams involving multiple forces. Diagrams with forces in both the horizontal and vertical directions can be considered. At this grade level, there should be unbalanced forces in only one of these dimensions. Forces can also act to change the direction of objects. If a force on an object acts toward a single center, the object's path may curve into an orbit around the center.

Friction is a force that opposes sliding between two surfaces. For surfaces that are sliding relative to each other, the force on an object always points in the direction opposite the relative motion of the object. This force is known as kinetic friction. Drag is a force that opposes the motion of an object when a solid 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. A lack of understanding of friction can

lead 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 this misconception. In grade 8, friction will only be calculated from force diagrams. Static friction, as well as the equations for static and kinetic friction, are found in Physics.

Content Limits:

- The effect of multiple forces (in the same or opposite directions) on the motion of an object, including kinetic friction and drag;
- Force/Free-body diagrams;
- The relativity of motion depending on the observer;
- Direction of net forces related to circular motion;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Newton's Laws referenced by name or number;
- The term "inertia";
- A single force acting on an object;
- Forces in two dimensions unless the net force in one of the dimensions is zero;
- The term "acceleration."

Stimulus Attributes:

- Simple force/free body diagrams;
- Tables or data describing forces on an object or motion;
- Scenarios involving relative motion;
- Simulations of forces acting on objects.

Response Attributes:

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

- Completing or analyzing simple force/free body diagrams;
- Given a scenario about relative motion, describing the motion of an object from a specific reference point;
- Given a scenario involving balanced or unbalanced forces, explaining or predicting changes in motion.

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

- Objects in motion require a force;
- Objects at rest have no forces acting on them.

Life Science (LS)

Topic: Species and Reproduction
This topic focuses on continuation of the species.

8.LS.1: Diversity of species, a result of variation of traits, occurs through the process of evolution and extinction over many generations. The 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 1: *Population genetics and the ability to use statistical mathematics to predict changes in a gene pool are reserved for high school Biology.*

Content Elaboration:
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 can be used to further develop the concepts of extinction, biodiversity and the diversity of species. The term "transitional form" is used to describe intermediate organisms between ancestral forms and their descendants. Some examples of transitional forms were fossilized and found in the fossil record. Other transitional forms are missing from the fossil record.

Evidence from the geologic and fossil record 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. Diversity can result from sexual reproduction. The sorting and combination of genes result in different genetic combinations, which allow offspring to be similar to, yet different from, their parents and each other (this statement connects 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 and reproduce when conditions change.

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

Content Limits:

- Diversity in a species may provide benefits through changing environmental conditions;
- Geologic and fossil records as evidence for past environmental conditions;
- The fossil record as evidence for biodiversity, diversity within a species, and the fact that the majority of species that have lived on Earth are now extinct;
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Fossils as a point of comparison between the types of organisms that lived long ago and those existing today;
- Population genetics and the ability to use statistical mathematics to predict changes in a gene pool;
- Identifying biotic and abiotic conditions in an ecosystem;
- The specific mechanisms of evolution.

Stimulus Attributes:

- Tables and graphs showing changes in population traits/characteristics over time as the environment changes;
- Scenarios showing diversity between populations in isolation (e.g., Isle Royale Moose, Galapagos Islands) and other populations (Yellowstone moose);
- Diagrams or charts displaying the fossil record;
- Graphs showing changes in species diversity;
- Primary sources related to environmental conditions.

Response Attributes:

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

- Describing or predicting how genetic variation (e.g., beak structure, coloration) affects the survival or extinction of a species when environmental conditions change gradually or suddenly;
- Inferring past environmental changes based on evidence from the fossil record;
- Evaluating graphs showing population data related to environmental changes.

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

- Changes in a population only happen quickly within a single generation;
- Individual organisms genetically adapt as a response to changing environmental conditions;
- Extinction only occurs in animal populations;
- Extinctions are only caused by catastrophic events;
- Extinctions are rare.

Life Science (LS)

Topic: Species and Reproduction
This topic focuses on continuation of the species.

8.LS.2: 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:
Organisms reproduce either sexually or asexually. Some organisms are capable of both. In asexual reproduction, all genes come from a single parent, resulting in offspring genetically identical to their parent. Mitosis was introduced in grade 6. At this grade level, the end products of mitotic and meiotic cell divisions are compared as they relate to asexual and sexual reproduction. Mitosis and meiosis are addressed in preparation for the study of Mendelian genetics in 8.LS.3.

In sexual reproduction, a single specialized cell from a female (egg) merges with a specialized cell from a male (sperm). Half of the nuclear genes come from each parent. The fertilized cell, carrying genetic information from each parent, multiplies forming the genetically complete organism. Each cell of an organism contains the same genetic information. As opposed to asexual reproduction, sexual reproduction results in offspring with new combinations of traits which may increase or decrease their chances for survival.

Content Limits:
- Mitosis and meiosis are processes by which genetic material is copied and divided;
- Mitosis produces 2 daughter cells that are genetically identical to the parent cell;
- Meiosis produces 4 sex cells containing half the genetic material of the parent cell;
- Sexual reproduction involves the combining of sex cells, which results in an organism with genetic material from the parent(s);
- Asexual reproduction occurs with the transfer of genes from one individual to the next generation and results in an offspring with identical genetic material;
- Advantages and disadvantages of sexual and asexual reproduction for the continuation of the species;
- Nature of Science skills and attributes related to this content.

Do Not Assess:
- Details and importance of gamete formation (spermatogenesis, oogenesis);
- Stages and rate of mitosis and meiosis;
- Modern cell theory that cells originate from pre-existing cells;
- Specific names of types of asexual reproduction such as budding;
- The naming of organisms that reproduce asexually or sexually.

Stimulus Attributes:

- Simple life cycle graphics showing sexual and asexual reproduction;
- Diagrams showing parent and daughter cells with the same and differing numbers of chromosomes;
- Real world scenarios illustrating advantages and disadvantages of sexual and asexual reproduction;
- Charts listing characteristics of parents and offspring;
- Simulations of survival rates under changing environmental conditions;
- Images, charts or diagrams depicting reproductive methods of organisms;
- Primary sources relating to the advantages of genetic diversity.

Response Attributes:

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

- Completing diagrams showing the end products of mitosis or meiosis;
- Comparing end products of sexual and asexual reproduction with an emphasis on their advantages and disadvantages in relation to the continuation of the species;
- Interpreting data from real-world scenarios or experiments showing outcomes (e.g., survival and reproduction rates) of sexual and asexual reproduction under varying environmental conditions;
- Comparing the end products of mitosis or meiosis and how they relate to sexual and asexual reproduction;
- Evaluating sexual and asexual reproduction and the differences in how they affect the likelihood of survival through environmental changes;
- Interpreting and explaining data from real world scenarios or experiments showing outcomes (e.g., survival and reproduction rates) of sexual and asexual reproduction under varying environmental conditions.

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

- Sexual reproduction produces traits that are always beneficial and never harmful;
- Organisms reproduce only sexually or asexually;
- Sexual reproduction requires two individuals;
- Plants can’t reproduce sexually;
- One reproductive process is better than another.

Life Science (LS)

Topic: Species and Reproduction
This topic focuses on continuation of the species.

8.LS.3: The characteristics of an organism are a result of inherited traits received from the 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:
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. The principles of Mendelian genetics are introduced 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 dominant and recessive traits. 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. Dihybrid crosses and sex-linked traits also are reserved for high school.

A long-term investigation to analyze and compare characteristics passed on from parent to offspring through sexual and asexual reproduction can be conducted. These investigations can lead to questions about the phenotypes that appear in the resulting generations and what they infer about genotypes of the offspring.

Content Limits:

- Genetic traits are determined by information encoded in DNA passed on from parent to offspring;
- Principles of Mendelian genetics, Law of Segregation and Law of Independent Assortment (concepts not terms);
- Punnett squares and pedigrees using dominant, recessive and co-dominant traits.
- Nature of Science skills and attributes related to this content.

Do Not Assess:

- Details of gamete formation;
- The molecular function and structure of DNA;
- Names of Mendel's laws;
- Advanced genetics concepts and techniques (e.g., chi square test, dihybrid cross, incomplete dominance, sex-linked inheritance);
- Mechanisms of bacterial reproduction;
- Examples of human genetic traits (e.g., eye color, hair color, diseases);

Stimulus Attributes:

- Pedigrees and Punnett squares or primary sources related to genetics;
- Diagrams/images showing expression of a phenotype in a sample;
- Tables or graphs showing phenotype data in a population;
- Diagrams/images showing genotypes and/or phenotypes of parents and offspring;
- Simulations showing offspring produced by various parents.

Response Attributes:

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

- Determining possible genotypes and their probabilities of occurring in offspring from a cross;
- Analyzing data showing the frequency of phenotypes in a population;
- Completing pedigrees illustrating relationships between phenotypes and genotypes;
- Completing Punnett squares to illustrate probabilities of offspring related to genotype/phenotype;
- Analyzing pedigrees to determine whether a trait is dominant/recessive/co-dominant;
- Designing an experiment to identify genotypes in plants.

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

- The results of a Punnett square are exact predictions of resulting offspring;
- Offspring receive all their genetic traits from the same sex parent.
- Offspring always show the same traits as one parent;
- Parents' genetic traits blend equally in offspring;
- All behavioral traits are genetic or no behavior traits are genetic;
- Every trait is determined by only two genes;
- The male parent's genes are always dominant;
- Some traits come from one parent, and others come from the other parent.