Ohio’s Learning Standards

Science

ADOPTED FEBRUARY 2018

Ohio | Department of Education

Table of Contents

Introduction to Ohio's Learning Standards for Science

OVERVIEW

This overview restates the visions and goals of Ohio's Learning Standards and Model Curriculum for Science, lists the guiding principles that framed their development and contains definitions of terms used in the document. Users also will see definitions for the Cognitive Demands that guided the development of the Expectations for Learning.

STANDARDS

Ohio's Learning Standards and Model Curriculum for Science outlines what all students should know and be able to do to become scientifically literate citizens. This includes the knowledge and skills they need for the 21st century workforce and higher education. The standards provide Ohio educators with the content and expectations for learning they can use to develop science curriculum at each grade level. By the end of high school, students should be proficient in science in order to:

- Know, use and interpret scientific explanations of the natural world;
- Generate and evaluate scientific evidence and explanations, distinguishing science from pseudoscience;
- Understand the nature and development of scientific knowledge; and
- Participate productively in scientific practices and discourse.[1]

"Knowledge of science can enable us to think critically and frame productive questions. Without scientific knowledge, we are wholly dependent on others as "experts." With scientific knowledge, we are empowered to become participants rather than merely observers. Science, in this sense, is more than a means for getting ahead in the world of work. It is a resource for becoming a critical and engaged citizen in a democracy." -Ready, Set, *SCIENCE! (2008)*[2]

The K-8 and high school document offers guidance for educators who teach science to Ohio students. Each Content Statement and Content Elaboration presents what students should know about a given discipline of science. The accompanying Expectations for Learning incorporate science skills and processes, and technological and engineering design. The Visions into Practice section offers optional examples of tasks students can perform to learn about science and demonstrate their understanding of the grade-level materials. The Instructional Supports section includes subsections on Instructional Strategies and Resources, Common Misconceptions, Diverse Learners, and Classroom Portals.

It is the blending of the Content Statements and Content Elaborations with the Expectations for Learning that will form the basis for future assessments.

Note: The model curriculum is being revised. The Ohio Department of Education will add the model curriculum to this document once it is adopted. The model curriculum includes the Content Elaborations, Expectations for Learning, and Visions into Practice.

GOALS

Ohio's student-centered goals (Duschl et. al., 2007; Bell et. al. 2009) for science education include helping students:

1. Experience excitement, interest and motivation to learn about phenomena in the natural and physical world.
2. Come to generate, understand, remember and use concepts, explanations, arguments, models and facts related to science.
3. Manipulate, test, explore, predict, question, observe and make sense of the natural and physical world.
4. Reflect on science as a way of knowing; on processes, concepts and institutions of science; and on their own process of learning about phenomena.
5. Participate in scientific activities and learning practices with others, using scientific language and tools.
6. Think about themselves as science learners and develop an identity as someone who knows about, uses and sometimes contributes to science

These goals are consistent with the expectations of Ohio law.

GUIDING PRINCIPLES

Ohio's Learning Standards Science reflect knowledge drawn from international and national studies, education stakeholders and academic content experts. The guiding principles include:

- **Definition of Science:** Science is a systematic method of continuing investigation based on observation, scientific hypothesis testing, measurement, experimentation and theory building. It leads to explanations of natural phenomena, processes or objects that are open to further testing and revision based on evidence.[3] Scientific knowledge is logical, predictive and testable and expands and advances as new evidence is discovered.
- **Scientific Inquiry:** There is no science without inquiry. Scientific inquiry is a way of knowing and process of doing science. Scientific inquiry includes the diverse ways scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities that help students develop knowledge of scientific ideas and understanding of how scientists study the natural world.[4] Teachers model scientific inquiry throughout their instruction.
- **21st Century Skills:** According to Ohio law, 21st century skills include creativity and innovation; critical thinking, problem-solving and communication; information, media and technological literacy; personal management, productivity, accountability, leadership and responsibility; and interdisciplinary, project-based, real-world learning opportunities.[5]

  21st century skills are integral to the revised science standards and model curriculum. The model curriculum incorporates and integrates these skills through scientific inquiry, science skills and process, and technological and engineering design.
- **Technological Design:** Technological design is a problem- or project-based way of applying creativity, science, engineering and mathematics to meet a human want or need. Modern science is an integrated endeavor. Technological design integrates learning by using science, technology, engineering and mathematics and fosters 21st century skills.
- **Technology and Engineering:** Technology modifies the natural world through innovative processes, systems, structures and devices to extend human abilities. Engineering is design under constraint that develops and applies technology to satisfy human wants and needs. Technology and engineering, coupled with the knowledge and methods derived from science and mathematics, profoundly influence the quality of life.

- **Depth of Content:** It is vital that the *Content Statements* and *Content Elaborations* within the standards document communicate the most essential concepts and the complexity of the discipline in a manner that is manageable and accessible for teachers. The focus is on what students must know to master the specific grade-level content. The *Expectations for Learning,* cognitive demands, provide the means by which students can demonstrate this grade-level mastery.
- **Internationally Benchmarked:** Ohio's Learning Standards and Model Curriculum for Science incorporate findings from research on the science standards of:
    - Countries whose students demonstrate high-performance on both the Trends in International Mathematics and Science Studies (TIMSS) and Program in Student Assessment (PISA) tests; and
    - States with students who perform well on the National Assessment of Education Progress (NAEP).

  As a result, the revised standards and model curriculum are rigorous, relevant, coherent and organized, emphasizing horizontal and vertical articulation of content within and across disciplines.
- **Assessment:** Ohio's State Tests will align with the Content Statements, Content Elaborations and Expectations for Learning.
- **Standards and Curriculum:** The standards and model curriculum provide a framework for developing local curricula. They do not constitute the local curriculum. Development of curriculum will continue to be a local responsibility.

1. Taking Science to School Learning and Teaching Science in Grades K-8. National Research Council of the National Academies
2. Michaels S., Shouse, A.W., & Schweingruber H. A. (2008). *Ready, Set, SCIENCE!* Washington DC: The National Academies Press.
3. National Research Council (1996), National Science Education Standards (Washington, DC: National Academy Press) and including excerpts with minor revision, of The Ohio Academy of Science (2000) definition of science: http://www.ohiosci.org/s/whatisscience.pdf
4. Research Council (1996), National Science Education Standards (Washington, DC: National Academy Press), p 192.
5. http://www.21stcenturyskills.org/index.php?option=com_

STANDARDS FORMAT AND DEVELOPMENT

The standards are web-based resources that provide the content to be taught in science classrooms. The standards define what all students should know and be able to do, not how teachers should teach. While the standards focus on what is most essential, they do not describe all that teachers can or should teach. Teachers and curriculum developers maintain a great deal of discretion in this area. The model curriculum will offer information and support for planning, developing, implementing and evaluating instruction directly aligned to standards.

Work to revise Ohio's Learning Standards Science took place from November 2016 through September 2017, with input from stakeholders around the state. The Ohio Department of Education started the process by seeking public comment on the existing standards in fall 2016. An advisory committee of representatives from various Ohio agencies and organizations related to science and science education reviewed this public feedback. The advisory committee forwarded suggestions for revisions to working groups consisting of K-12 and higher education professionals. There were three main working groups based on the individual science disciplines: life sciences, Earth and space sciences, and physical sciences.

When comment on the initial public survey pointed to the need for a new human anatomy and physiology course, the Department formed a related subcommittee of the life science working group. These four groups constructed the proposed 2017 standards with Ohio students in mind. The Department presented the proposed standards revisions for public feedback through a summer 2017 survey. The Department made more revisions based on that feedback. The State Board of Education reviewed the revised science standards during its October 2017 meeting and adopted them in February 2018.

The goal of revising the standards was to improve K-12 science education by providing clarity, focus and a logical, vertical progression in each discipline. All Ohio students deserve rigorous, scientifically accurate instruction that makes them college or career ready and scientifically literate. These standards serve as a road map for Ohio science teachers to use as they customize instruction to fit individual student needs.

TRANSITION PERIOD

Ohio allows districts until the 2019-2020 school year to fully implement the revised Ohio's Learning Standards Science to give them time to align instruction and resources to the standards. State tests aligned to the standards will be available in spring 2020.

Topics by Grade Level

SCIENCE INQUIRY AND APPLICATIONS

During the years of **K to grade 4**, all students must develop the ability to: Observe and ask questions about the natural environment; Plan and conduct simple investigations; Employ simple equipment and tools to gather data and extend the senses; Use appropriate mathematics with data to construct reasonable explanations; Communicate about observations, investigations and explanations; and Review and ask questions about the observations and explanations of others.

THEMES	GRADE	THE PHYSICAL SETTING		THE LIVING ENVIRONMENT
		EARTH AND SPACE SCIENCE	PHYSICAL SCIENCE	LIFE SCIENCE
Observations of the Environment This theme focuses on helping students develop the skills for systematic discovery to understand the science of the natural world around them in greater depth by using scientific inquiry.	K	Living and nonliving things have specific physical properties that can be used to sort and classify. The physical properties of air and water are presented as they apply to weather.		
		Daily and Seasonal Changes	**Properties of Everyday Objects and Materials**	**Physical and Behavioral Traits of Living Things**
	1	Energy is observed through movement, heating, cooling and the needs of living organisms.		
		Sun, Energy and Weather	**Motion and Materials**	**Basic Needs of Living Things**
	2	Living and nonliving things may move. A moving object has energy. Air moving is wind and wind can make a windmill turn. Changes in energy and movement can cause change to organisms and the environments in which they live.		
		The Atmosphere	**Changes in Motion**	**Interactions within Habitats**
Interconnections within Systems This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.	3	Matter is what makes up all substances on Earth. Matter has specific properties and exists in different states. Earth's resources are made of matter. Matter can be used by living things and can be used for the energy they contain. There are many different forms of energy. Each living component of an ecosystem is composed of matter and uses energy.		
		Earth's Resources	**Matter and Forms of Energy**	**Behavior, Growth and Changes**
	4	Heat and electrical energy are forms of energy that can be transferred from one location to another. Matter has properties that allow the transfer of heat and electrical energy. Heating and cooling affect the weathering of Earth's surface and Earth's past environments. The processes that shape Earth's surface and the fossil evidence found can help decode Earth's history.		
		Earth's Surface	**Electricity, Heat and Matter**	**Earth's Living History**

SCIENCE INQUIRY AND APPLICATIONS

During the years of **grades 5 through 8**, all students must have developed the ability to: Identify questions that can be answered through scientific investigations; Design and conduct a scientific investigation; Use appropriate mathematics, tools and techniques to gather data and information; Analyze and interpret data; Develop descriptions, models, explanations and predictions; Think critically and logically to connect evidence and explanations; Recognize and analyze alternative explanations and predictions; and Communicate scientific procedures and explanations.

THEMES	GRADE	THE PHYSICAL SETTING		THE LIVING ENVIRONMENT
		EARTH AND SPACE SCIENCE	PHYSICAL SCIENCE	LIFE SCIENCE
Interconnections within Systems This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.	5	Cycles on Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. Speed is a measurement of movement. Change in speed is related to force and mass. The transfer of energy drives changes in systems, including ecosystems and physical systems.		
		Cycles and Patterns in the Solar System	**Light, Sound and Motion**	**Interactions within Ecosystems**
Order and Organization This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be inferred from simple principles. These principles are related to the properties or interactions within and between systems.	6	All matter is made of small particles called atoms. The properties of matter are based on the order and organization of atoms and molecules. Cells, minerals, rocks and soil are all examples of matter.		
		Rocks, Minerals and Soil	**Matter and Motion**	**Cellular to Multicellular**
	7	Systems can exchange energy and/or matter when interactions occur within systems and between systems. Systems cycle matter and energy in observable and predictable patterns.		
		Cycles and Patterns of Earth and the Moon	**Conservation of Mass and Energy**	**Cycles of Matter and Flow of Energy**
	8	Systems can be described and understood by analysis of the interaction of their components. Energy, forces and motion combine to change the physical features of Earth. The changes of the physical Earth and the species that have lived on Earth are found in the rock record. For species to continue, reproduction must be successful.		
		Physical Earth	**Forces and Motion**	**Species and Reproduction**

Ohio's Learning Standards for Science, Grades K-8

Kindergarten

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: OBSERVATIONS OF THE ENVIRONMENT

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Living and nonliving things have specific physical properties that can be used to sort and classify. The physical properties of air and water are presented as they apply to weather.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Daily and Seasonal Changes This topic focuses on observing, exploring, describing and comparing weather changes, patterns in the sky and changing seasons.	**Topic: Physical and Behavioral Traits of Living Things** This topic focuses on observing, exploring, describing and comparing living things in Ohio.	**Topic: Properties of Everyday Objects and Materials** This topic focuses on the production of sound and on observing, exploring, describing and comparing the properties of objects and materials with which the student is familiar.
CONDENSED CONTENT STATEMENTS		
• Weather changes are long-term and short-term. • The moon, sun and stars can be observed at different times of the day or night.	• Living things have specific characteristics and traits. • Living things have physical traits and behaviors, which influence their survival.	• Objects and materials can be sorted and described by their properties. • Some objects and materials can be made to vibrate and produce sound.

Grade 1

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: OBSERVATIONS OF THE ENVIRONMENT

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Energy is observed through movement, heating, cooling and the needs of living organisms.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Sun, Energy and Weather This topic focuses on the sun as a source of energy and energy changes that occur to land, air and water.	**Topic: Basic Needs of Living Things** This topic focuses on the physical needs of living things in Ohio. Energy from the sun or food, nutrients, water, shelter and air are some of the physical needs of living things.	**Topic: Motion and Materials** This topic focuses on the changes in properties that occur in objects and materials. Changes of position of an object are a result of pushing or pulling.
CONDENSED CONTENT STATEMENTS		
• The sun is the principal source of energy. • Water on Earth is present in many forms.	• Living things have basic needs, which are met by obtaining materials from the physical environment. • Living things survive only in environments that meet their needs.	• Properties of objects and materials can change. • Objects can be moved in a variety of ways, such as straight, zigzag, circular and back and forth.

Grade 2

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: OBSERVATIONS OF THE ENVIRONMENT

This theme focuses on helping students develop the skills for systematic discovery to understand the science of the physical world around them in greater depth by using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Living and nonliving things may move. A moving object has energy. Air moving is wind and wind can make a windmill turn. Changes in energy and movement can cause change to organisms and the environments in which they live.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: The Atmosphere This topic focuses on air and water as they relate to weather and weather changes that can be observed and measured.	**Topic: Interactions within Habitats** This topic focuses on how ecosystems work by observations of simple interactions between the biotic/living and abiotic/nonliving parts of an ecosystem. Just as living things impact the environment in which they live, the environment impacts living things.	**Topic: Changes in Motion** This topic focuses on observing the relationship between forces and motion.
CONDENSED CONTENT STATEMENTS		
• The atmosphere is primarily made up of air. • Water is present in the atmosphere. • Long- and short-term weather changes occur due to changes in energy.	• Living things cause changes on Earth. • All organisms alive today result from their ancestors, some of which may be extinct. Not all kinds of organisms that lived in the past are represented by living organisms today.	• Forces change the motion of an object.

Grade 3

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Matter is what makes up all substances on Earth. Matter has specific properties and exists in different states. Earth's resources are made of matter. Matter can be used by living things and can be used for the energy it contains. There are many different forms of energy. Each living component of an ecosystem is composed of matter and uses energy.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Earth's Resources This topic focuses on Earth's resources. While resources can be living and nonliving, within this strand, the emphasis is on Earth's nonliving resources, such as water, air, rock, soil and the energy resources they represent.	**Topic: Behavior, Growth and Changes** This topic explores life cycles of organisms and the relationship between the natural environment and an organism's (physical and behavioral) traits, which affect its ability to survive and reproduce.	**Topic: Matter and Forms of Energy** This topic focuses on the relationship between matter and energy. Matter has specific properties and is found in all substances on Earth. Heat is a familiar form of energy that can change the states of matter.
CONDENSED CONTENT STATEMENTS		
• Earth's nonliving resources have specific properties. • Earth's resources can be used for energy. • Some of Earth's resources are limited.	• Offspring resemble their parents and each other. • Individuals of the same kind of organism differ in their inherited traits. These differences give some individuals an advantage in surviving and/or reproducing. • Plants and animals have life cycles that are part of their adaptations for survival in their natural environments.	• All objects and substances in the natural world are composed of matter. • Matter exists in different states, each of which has different properties. • Heat, electrical energy, light, sound and magnetic energy are forms of energy.

Grade 4

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Heat and electrical energy are forms of energy that can be transferred from one location to another. Matter has properties that allow the transfer of heat and electrical energy. Heating and cooling affect the weathering of Earth's surface and Earth's past environments. The processes that shape Earth's surface and the fossil evidence found can help decode Earth's history.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Earth's Surface This topic focuses on the variety of processes that shape and reshape Earth's surface.	**Topic: Earth's Living History** This topic focuses on using fossil evidence and living organisms to observe that suitable habitats depend upon a combination of biotic and abiotic factors.	**Topic: Electricity, Heat and Matter** This topic focuses on the conservation of matter and the processes of energy transfer and transformation, especially as they relate to heat and electrical energy
CONDENSED CONTENT STATEMENTS		
• Earth's surface has specific characteristics and landforms that can be identified. • The surface of Earth changes due to weathering. • The surface of Earth changes due to erosion and deposition.	• Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful. • Fossils can be compared to one another and to present-day organisms according to their similarities and differences.	• When objects break into smaller pieces, dissolve, or change state, the total amount of matter is conserved. • Energy can be transferred from one location to another or can be transformed from one form to another.

Grade 5

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: INTERCONNECTIONS WITHIN SYSTEMS

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Cycles on Earth, such as those occurring in ecosystems, in the solar system, and in the movement of light and sound result in describable patterns. Speed is a measurement of movement. Change in speed is related to force and mass. The transfer of energy drives changes in systems, including ecosystems and physical systems.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Cycles and Patterns in the Solar System This topic focuses on the characteristics, cycles and patterns in the solar system and within the universe.	**Topic: Interactions within Ecosystems** This topic focuses on foundational knowledge of the structures and functions of ecosystems.	**Topic: Light, Sound and Motion** This topic focuses on the forces that affect motion. This includes the relationship between the change in speed of an object, the amount of force applied and the mass of the object. Light and sound are explored as forms of energy that move in predictable ways, depending on the matter through which they move.
CONDENSED CONTENT STATEMENTS		
• The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the solar system has unique characteristics. • The sun is one of many stars that exist in the universe. • Most of the cycles and patterns of motion between the Earth and sun are predictable.	• Organisms perform a variety of roles in an ecosystem. • All of the processes that take place within organisms require energy.	• The amount of change in movement of an object is based on the mass of the object and the amount of force exerted. • Light and sound are forms of energy that behave in predictable ways.

Grade 6

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: ORDER AND ORGANIZATION

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

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: All matter is made of small particles called atoms. The properties of matter are based on the order and organization of atoms and molecules. Cells, minerals, rocks and soil are all examples of matter.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Rocks, Minerals and Soil This topic focuses on the study of rocks, minerals and soil, which make up the lithosphere. Classifying and identifying different types of rocks, minerals and soil can decode the past environment in which they formed.	**Topic: Cellular to Multicellular** This topic focuses on the study of the basics of Modern Cell Theory. All organisms are composed of cells, which are the fundamental unit of life. Cells carry on the many processes that sustain life. All cells come from pre-existing cells.	**Topic: Matter and Motion** This topic focuses on the study of foundational concepts of the particulate nature of matter, linear motion, and kinetic and potential energy.
CONDENSED CONTENT STATEMENTS		
• Minerals have specific, quantifiable properties. • Igneous, metamorphic and sedimentary rocks have unique characteristics that can be used for identification and/or classification. • Igneous, metamorphic and sedimentary rocks form in different ways. • Soil is unconsolidated material that contains nutrient matter and weathered rock. • Rocks, mineral and soils have common and practical uses.	• Cells are the fundamental unit of life. • All cells come from pre-existing cells. • Cells carry on specific functions that sustain life. • Living systems at all levels of organization demonstrate the complementary nature of structure and function.	• Matter is made up of small particles called atoms. • Changes of state are explained by a model of matter composed of particles that are in motion. • There are two categories of energy: kinetic and potential. • An object's motion can be described by its speed and the direction in which it is moving.

Grade 7

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: ORDER AND ORGANIZATION

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

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

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

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
Topic: Cycles and Patterns of Earth and the Moon This topic focuses on Earth's hydrologic cycle, patterns that exist in atmospheric and oceanic currents, the relationship between thermal energy and the currents, and the relative position and movement of the Earth, sun and moon.	**Topic: Cycles of Matter and Flow of Energy** This topic focuses on the impact of matter and energy transfer within the biotic component of ecosystems.	**Topic: Conservation of Mass and Energy** This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy.
CONDENSED CONTENT STATEMENTS		
• The hydrologic cycle illustrates the changing states of water as it moves through the lithosphere, biosphere, hydrosphere and atmosphere. • Thermal-energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns. • The atmosphere has different properties at different elevations and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere. • The relative patterns of motion and positions of Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon. • The relative positions of Earth and the sun cause patterns we call seasons.	• Energy flows and matter is transferred continuously from one organism to another and between organisms and their physical environments. • In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors.	• Elements can be organized by properties. • Matter can be separated or changed, but in a closed system, the number and types of atoms remains constant. • Energy can be transformed or transferred but is never lost. • Energy can be transferred through a variety of ways.

Grade 8

INTRODUCTION TO CONTENT STATEMENTS

GRADE BAND THEME: ORDER AND ORGANIZATION

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

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

STRANDS

Strand Connections: Systems can be described and understood by analysis of the interaction of their components. Energy, forces and motion combine to change the physical features of the Earth. The changes of the physical Earth and the species that have lived on Earth are found in the rock record. For species to continue, reproduction must be successful.

EARTH AND SPACE SCIENCE (ESS)	LIFE SCIENCE (LS)	PHYSICAL SCIENCE (PS)
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.	**Topic: Species and Reproduction** This topic focuses on continuation of the species.	**Topic: Forces and Motion** This topic focuses on forces and motion within, on and around the Earth and within the universe.
CONDENSED CONTENT STATEMENTS		
• The composition and properties of Earth's interior are identified by the behavior of seismic waves. • Earth's lithosphere consists of major and minor tectonic plates that move relative to each other. • A combination of constructive and destructive geologic processes formed Earth's surface. • Evidence of the dynamic changes of Earth's surface through time is found in the geologic record.	• 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. • Every organism alive today comes from a long line of ancestors who reproduced successfully every generation. • The characteristics of an organism are a result of inherited traits received from parent(s).	• Objects can experience a force due to an external field such as magnetic, electrostatic, or gravitational fields. • Forces can act to change the motion of objects.

Ohio's Learning Standards for Science, High School

Physical Science

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Physical science is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Physical science introduces students to key concepts and theories that provide a foundation for further study in other sciences and advanced science disciplines. Physical science comprises the systematic study of the physical world as it relates to fundamental concepts about matter, energy and motion. A unified understanding of phenomena in physical, living, Earth and space systems is the culmination of all previously learned concepts related to chemistry, physics, and Earth and space science, along with historical perspective and mathematical reasoning.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

PS.M: STUDY OF MATTER

PS.M.1: Classification of matter

- Heterogeneous vs. homogeneous
- Properties of matter
- States of matter and its changes

PS.M.2: Atoms

- Models of the atom (components)
- Ions (cations and anions)
- Isotopes

PS.M.3: Periodic trends of the elements

- Periodic law
- Representative groups

PS.M.4: Bonding and compounds

- Bonding (ionic and covalent)
- Nomenclature

PS.M.5: Reactions of matter

- Chemical reactions
- Nuclear reactions

PS.EW: ENERGY AND WAVES

PS.EW.1: Conservation of energy

- Quantifying kinetic energy
- Quantifying gravitational potential energy

PS.EW.2: Transfer and transformation of energy (including work)

PW.EW.3: Waves

- Refraction, reflection, diffraction, absorption, superposition
- Radiant energy and the electromagnetic spectrum
- Doppler shift

PS.EW.4: Thermal energy

PS.EW.5: Electricity

- Movement of electrons
- Current
- Electric potential (voltage)
- Resistors and transfer of energy

PS.FM: FORCES AND MOTION

PS.FM.1: Motion

- Introduction to one-dimensional vectors
- Displacement, velocity (constant, average and instantaneous) and acceleration
- Interpreting position vs. time and velocity vs. time graphs

PS.FM.2: Forces

- Force diagrams
- Types of forces (gravity, friction, normal, tension)
- Field model for forces at a distance

PS.FM.3: Dynamics (how forces affect motion)

- Objects at rest
- Objects moving with constant velocity
- Accelerating objects

PS.U: THE UNIVERSE

PS.U.1: History of the universe

PS.U.2: Galaxies

PS.U.3: Stars

- Formation: stages of evolution
- Fusion in stars

Biology

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Biology is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Biology investigates the composition, diversity, complexity and interconnectedness of life on Earth. Fundamental concepts of heredity and evolution provide a framework through inquiry-based instruction to explore the living world, the physical environment and the interactions within and between them.

Students engage in investigations to understand and explain the behavior of living things in a variety of scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

B.H: HEREDITY

B.H.1: Cellular genetics

B.H.2: Structure and function of DNA in cells

B.H.3: Genetic mechanisms and inheritance

B.H.4: Mutations

B.H.5: Modern genetics

B.E: EVOLUTION

B.E.1: Mechanisms

- Natural selection
- Mutation
- Genetic drift
- Gene flow (immigration, emigration)
- Sexual selection

B.E.2: Speciation

- Biological classification expanded to molecular evidence
- Variation of organisms within species due to population genetics and gene frequency

B.DI: DIVERSITY AND INTERDEPENDENCE OF LIFE

B.DI.1: Biodiversity

- Genetic diversity
- Species diversity

B.DI.2: Ecosystems

- Equilibrium and disequilibrium
- Carrying capacity

B.DI.3: Loss of Diversity

- Climate change
- Anthropocene effects
- Extinction
- Invasive species

B.C: CELLS

B.C.1: Cell structure and function

- Structure, function and interrelatedness of cell organelles
- Eukaryotic cells and prokaryotic cells

B.C.2: Cellular processes

- Characteristics of life regulated by cellular processes
- Photosynthesis, chemosynthesis, cellular respiration, biosynthesis of macromolecules

Chemistry

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Chemistry is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Chemistry comprises a systematic study of the predictive physical interactions of matter and subsequent events that occur in the natural world. The study of matter through the exploration of classification, its structure and its interactions is how this course is organized.

Investigations are used to understand and explain the behavior of matter in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications. An understanding of leading theories and how they have informed current knowledge prepares students with higher order cognitive capabilities of evaluation, prediction and application.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

C.PM: STRUCTURE AND PROPERTIES OF MATTER

C.PM.1: Atomic structure

- Evolution of atomic models/theory
- Electrons
- Electron configurations

C.PM.2: Periodic Table

- Properties
- Trends

C.PM.3: Chemical bonding

- Ionic
- Polar/covalent

C.PM.4: Representing compounds

- Formula writing
- Nomenclature
- Models and shapes (Lewis structures, ball and stick, molecular geometries)

C.PM.5: Quantifying matter

C.PM.6: Intermolecular forces of attraction

- Types and strengths
- Implications for properties of substances
    - Melting and boiling point
    - Solubility
    - Vapor pressure

C.IM: INTERACTIONS OF MATTER

C.IM.1: Chemical reactions

- Types of reactions
- Kinetics
- Energy
- Equilibrium
- Acids/bases

C.IM.2: Gas laws

- Pressure, volume and temperature
- Ideal gas law

C.IM.3: Stoichiometry

- Molecular calculations
- Solutions
- Limiting reagents

Environmental Science

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Environmental science is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Environmental science incorporates biology, chemistry, physics and physical geology and introduces students to key concepts, principles and theories within environmental science.

Investigations are used to understand and explain the behavior of nature in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications. It should be noted that there are classroom examples in the model curriculum that can be developed to meet multiple sections of the syllabus, so one well-planned long-term project can be used to teach multiple topics.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

EARTH SYSTEMS: INTERCONNECTED SPHERES OF EARTH

ENV.ES.1: Biosphere

- Evolution and adaptation in populations
- Biodiversity
- Ecosystems (equilibrium, species interactions, stability)
- Population dynamics

ENV.ES.2: Atmosphere

- Atmospheric properties and currents

ENV.ES.3: Lithosphere

- Geologic events and processes

ENV.ES.4: Hydrosphere

- Oceanic currents and patterns (as they relate to climate)
- Surface and ground water flow patterns and movement
- Cryosphere

ENV.ES.5: Movement of matter and energy through the hydrosphere, lithosphere, atmosphere and biosphere

- Energy transformation on global, regional and local scales
- Biogeochemical cycles
- Ecosystems
- Weather
- Climate

EARTH'S RESOURCES

ENV.ER.1: Energy resources

- Renewable and nonrenewable energy sources and efficiency

- Alternate energy sources and efficiency
- Resource availability
- Mining and resource extraction

ENV.ER.2: Air and air pollution

- Primary and secondary contaminants
- Greenhouse gases
- Clean Air Act

ENV.ER.3: Water and water pollution

- Potable water and water quality
- Hypoxia, eutrophication
- Clean Water Act
- Point source and non-point source contamination

ENV.ER.4: Soil and land

- Desertification
- Mass movement and erosion
- Sediment contamination
- Land use and land management (including food production, agriculture and zoning)
- Solid and hazardous waste

ENV.ER.5: Wildlife and wilderness

- Wildlife and wilderness management
  - Endangered species
- Invasive Species
- Introduced Species

ENV.GP: GLOBAL ENVIRONMENTAL PROBLEMS AND ISSUES

ENV.GP.1: Human Population

ENV.GP.2: Potable water quality, use and availability

ENV.GP.3: Climate change

ENV.GP.4: Sustainability

ENV.GP.5: Species depletion and extinction

ENV.GP.6: Air quality

ENV.GP.7: Food production and availability

ENV.GP.8: Deforestation and loss of biodiversity

ENV.GP.9: Waste management (solid and hazardous)

Physical Geology

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Physical Geology is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Physical geology incorporates chemistry, physics and environmental science and introduces students to key concepts, principles and theories within geology. Investigations are used to understand and explain the behavior of nature in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

PG.M: MINERALS

PG.M.1: Atoms and elements

PG.M.2: Chemical bonding (ionic, covalent, metallic)

PG.M.3: Crystallinity (crystal structure)

PG.M.4: Criteria of a mineral (crystalline solid, occurs in nature, inorganic, defined chemical composition)

PG.M.5: Properties of minerals (hardness, luster, cleavage, streak, crystal shape, fluorescence, flammability, density/specific gravity, malleability)

PG.IMS: IGNEOUS, METAMORPHIC AND SEDIMENTARY ROCKS

PG.IMS.1: Igneous

- Mafic and felsic rocks and minerals
- Intrusive (igneous structures: dikes, sills, batholiths, pegmatites)
- Earth's interior (inner core, outer core, lower mantle, upper mantle, Mohorovicic discontinuity, crust)
- Magnetic reversals and Earth's magnetic field
- Thermal energy within the Earth
- Extrusive (volcanic activity, volcanoes: cinder cones, composite, shield)
- Bowen's Reaction Series (continuous and discontinuous branches)

PG.IMS.2: Metamorphic

- Pressure, stress, temperature and compressional forces
- Foliated (regional), non-foliated (contact)
- Parent rock and degrees of metamorphism
- Metamorphic zones (where metamorphic rocks are found)

PG.IMS.3: Sedimentary

- Division of sedimentary rocks and minerals (chemical, clastic/physical, organic)
- Depositional environments

PG.IMS.4: Ocean

- Tides (daily, neap and spring)
- Currents (deep and shallow, rip and longshore)
- Thermal energy and water density
- Waves
- Ocean features (ridges, trenches, island systems, abyssal zone, shelves, slopes, reefs, island arcs)
- Passive and active continental margins
- Transgressing and regressing sea levels
- Streams (channels, streambeds, floodplains, cross-bedding, alluvial fans, deltas)

PG.EH: EARTH'S HISTORY

PG.EH.1: The geologic rock record

- Relative and absolute age
- Principles to determine relative age
  - Original horizontality
  - Superposition
  - Cross-cutting relationships
- Absolute age
  - Radiometric dating (isotopes, radioactive decay)
  - Correct uses of radiometric dating
- Combining relative and absolute age data
- The geologic time scale
  - Comprehending geologic time
  - Climate changes evident through the rock record
  - Fossil record

PG.PT: PLATE TECTONICS

PG.PT.1: Internal Earth

- Seismic waves
  - S and P waves
  - Velocities, reflection, refraction of waves

PG.PT.2: Structure of Earth (Note: specific layers were part of grade 8)

- Asthenosphere
- Lithosphere
- Mohorovicic boundary (Moho)

- Composition of each of the layers of Earth
- Gravity, magnetism and isostasy
- Thermal energy (geothermal gradient and heat flow)

PG.PT.3: Historical review (Note: this would include a review of continental drift and sea-floor spreading found in grade 8)

- Paleomagnetism and magnetic anomalies
- Paleoclimatology

PG.PT.4: Plate motion (Note: introduced in grade 8)

- Causes and evidence of plate motion
- Measuring plate motion
- Characteristics of oceanic and continental plates
- Relationship of plate movement and geologic events
- Mantle plumes

PG.ER: EARTH'S RESOURCES

PG.ER.1: Energy resources

- Renewable and nonrenewable energy sources and efficiency
- Alternate energy sources and efficiency
- Resource availability
- Mining and resource extraction

PG.ER.2: Air

- Primary and secondary contaminants
- Greenhouse gases

PG.ER.3: Water

- Potable water and water quality
- Hypoxia, eutrophication

PG.ER.4: Soil and sediment

- Desertification
- Mass wasting and erosion
- Sediment and contamination

PG.GG: GLACIAL GEOLOGY

PG.GG.1: Glaciers and glaciation

- Evidence of past glaciers (including features formed through erosion or deposition)
- Glacial deposition and erosion (including features formed through erosion or deposition)
- Data from ice cores
  - Historical changes (glacial ages, amounts, locations, particulate matter, correlation to fossil evidence)
  - Evidence of climate changes throughout Earth's history
- Glacial distribution and causes of glaciation
- Types of glaciers – continental (ice sheets, ice caps), alpine/valley (piedmont, valley, cirque, ice caps)
- Glacial structure, formation and movement

Physics

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Physics is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Physics elaborates on the study of the key concepts of motion, forces and energy as they relate to increasingly complex systems and applications that will provide a foundation for further study in science and scientific literacy.

Students engage in investigations to understand and explain motion, forces and energy in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

P.M: MOTION

P.M.1: Motion Graphs

- Position vs. time
- Velocity vs. time
- Acceleration vs. time

P.M.2: Problem Solving

- Using graphs (average velocity, instantaneous velocity, acceleration, displacement, change in velocity)
- Uniform acceleration including free fall (initial velocity, final velocity, time, displacement, acceleration, average velocity)

P.M.3: Projectile Motion

- Independence of horizontal and vertical motion
- Problem-solving involving horizontally launched projectiles

P.F: MOMENTUM AND MOTION

P.F.1: Newton's laws applied to complex problems

P.F.2: Gravitational force and fields

P.F.3: Elastic forces

P.F.4: Friction force (static and kinetic)

P.F.5: Air resistance and drag

P.F.6: Forces in two dimensions

- Adding vector forces
- Motion down inclines
- Centripetal forces and circular motion

P.F.7: Momentum, impulse and conservation of momentum

P.E: ENERGY

P.E.1: Gravitational potential energy

P.E.2: Energy in springs

P.E.3: Work and power

P.E.4: Conservation of energy

P.E.5: Nuclear energy

P.W: WAVES

P.W.1: Wave properties

- Conservation of energy
- Reflection
- Refraction
- Interference
- Diffraction

P.W.2: Light phenomena

- Ray diagrams (propagation of light)
- Law of reflection (equal angles)
- Snell's law
- Diffraction patterns
- Wave—particle duality of light
- Visible spectrum of color

P.EM: ELECTRICTY AND MAGNETISM

P.EM.1: Charging objects (friction, contact and induction)

P.EM.2: Coulomb's law

P.EM.3: Electric fields and electric potential energy

P.EM.4: DC circuits

- Ohm's law
- Series circuits
- Parallel circuits
- Mixed circuits
- Applying conservation of charge and energy (junction and loop rules)

P.EM.5: Magnetic fields

P.EM.6: Electromagnetic interactions

Human Anatomy and Physiology

INTRODUCTION AND SYLLABUS

COURSE DESCRIPTION

Human Anatomy and Physiology is a high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires three one-unit courses. Each course should include inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.

Human Anatomy and Physiology comprises a systematic study in which students will examine human anatomy and physical functions, as well as homeostatic imbalances. They will analyze descriptive results of abnormal physiology and evaluate clinical consequences. A workable knowledge of medical terminology will be demonstrated.

Investigations are used to understand and explain the human body in a variety of investigative scenarios that can incorporate evolutionary concepts, scientific reasoning, comparative analysis, communication skills and real-world applications.

SCIENCE INQUIRY AND APPLICATION

This section is being updated to include the Nature of Science and will be available once the revised Model Curriculum is adopted.

COURSE CONTENT

The following information may be taught in any order; there is no ODE-recommended sequence.

AP.LO: LEVELS OF ORGANIZATION

AP.LO.1: Hierarchy of Organization

AP.LO.2: Types of Tissues

AP.LO.3: Homeostasis

AP.LO.4: Anatomical Terminology

AP.SM: SUPPORT AND MOTION

AP.SM.1: Integumentary System

AP.SM.2: Skeletal System

AP.SM.3: Muscular System

AP.IC: INTEGRATION AND COORDINATION

AP.IC.1: Nervous System

AP.IC.2: Special Senses

- Sense of Sight
- Senses of Hearing and Balance
- Senses of Taste and Smell

AP.IC.3: Endocrine System

AP.T: TRANSPORT

AP.T.1: Blood

AP.T.2: Cardiovascular System

AP.T.3: Lymphatic and Immune Systems

AP.AE: ABSORPTION AND EXCRETION

AP.AE.1: Digestive System

AP.AE.2: Respiratory System

AP.AE.3: Urinary System

AP.R: REPRODUCTION

AP.R.1: Reproductive System