

GRADE LEVEL CONTENT EXPECTATIONS

7 SCIENCE

v.1.09

Welcome to Michigan's K-7 Grade Level Content Expectations

SCIENCE PROCESSES

PHYSICAL SCIENCE

LIFE SCIENCE

EARTH SCIENCE

Purpose & Overview

In 2004, the Michigan Department of Education embraced the challenge of creating Grade Level Content Expectations in response to the Federal No Child Left Behind Act of 2001. This act mandated the existence of a set of comprehensive state grade level assessments in mathematics and English language arts that are designed based on rigorous grade level content. In addition, assessments for science in elementary, middle, and high school were required. To provide greater clarity for what students are expected to know and be able to do by the end of each grade, expectations for each grade level have been developed for science.

In this global economy, it is essential that Michigan students possess personal, social, occupational, civic, and quantitative literacy. Mastery of the knowledge and essential skills defined in Michigan's Grade Level Content Expectations will increase students' ability to be successful academically, and contribute to the future businesses that employ them and the communities in which they choose to live.

Reflecting best practices and current research, the Grade Level Content Expectations provide a set of clear and rigorous expectations for all students, and provide teachers with clearly defined statements of what students should know and be able to do as they progress through school.

Development

In developing these expectations, the K-7 Scholar Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006) which has been the gold standard for the high school content expectations. Additionally, the *National Science Education Standards* (National Research Council, 1996), the Michigan Curriculum Framework in Science (2000 version), and the *Atlas for Science Literacy*, Volumes One (AAAS, 2001) and Two (AAAS, 2007), were all continually consulted for developmental guidance. As a further resource for research on learning progressions and curricular designs, *Taking Science to School: Learning and Teaching Science in Grades K-8* (National Research Council, 2007) was extensively utilized. The following statement from this resource was a guiding principle:

"The next generation of science standards and curricula at the national and state levels should be centered on a few core ideas and should expand on them each year, at increasing levels of complexity, across grades K-8. Today's standards are still too broad, resulting in superficial coverage of science that fails to link concepts or develop them over successive grades."

Michigan's K-7 Scholar Work Group executed the intent of this statement in the development of "the core ideas of science...the big picture" in this document.

Curriculum

Using this document as a focal point in the school improvement process, schools and districts can generate conversations among stakeholders concerning current policies and practices to consider ways to improve and enhance student achievement. Together, stakeholders can use these expectations to guide curricular and instructional decisions, identify professional development needs, and assess student achievement.

Assessment

The Science Grade Level Content Expectations document is intended to be a curricular guide with the expectations written to convey expected performances by students. Science will continue to be assessed in grades five and eight for the Michigan Educational Assessment Program (MEAP) and MI-Access.

Preparing Students for Academic Success

In the hands of teachers, the Grade Level Content Expectations are converted into exciting and engaging learning for Michigan's students. As educators use these expectations, it is critical to keep in mind that content knowledge alone is not sufficient for academic success. Students must also generate questions, conduct investigations, and develop solutions to problems through reasoning and observation. They need to analyze and present their findings which lead to future questions, research, and investigations. Students apply knowledge in new situations, to solve problems by generating new ideas, and to make connections between what they learn in class to the world around them.

Through the collaborative efforts of Michigan educators and creation of professional learning communities, we can enable our young people to attain the highest standards, and thereby open doors for them to have fulfilling and successful lives.

Understanding the Organizational Structure

The science expectations in this document are organized into disciplines, standards, content statements, and specific content expectations. The content statements in each science standard are broader, more conceptual groupings. The skills and content addressed in these expectations will, in practice, be woven together into a coherent, science curriculum.

To allow for ease in referencing expectations, each expectation has been coded with a discipline, standard, grade-level, and content statement/expectation number.

For example, **P.FM.02.34** indicates:

P - Physical Science Discipline

FM-Force and Motion Standard

02-Second Grade

34-Fourth Expectation in the Third Content Statement

Content statements are written and coded for Elementary and Middle School Grade Spans. Not all content expectations for the content statement will be found in each grade.

Why Create a 1.09 Version of the Expectations?

The Office of School Improvement is committed to creating the best possible product for educators. This commitment served as the impetus for revision of the 12.07 edition. This new version, v.1.09, refines and clarifies the original expectations, while preserving their essence and original intent and reflects the feedback from educators across the state during the past year.

Middle School (5-7) Science Organizational Structure

| Discipline 1 Science Processes | Discipline 2 Physical Science | Discipline 3 Life Science | Discipline 4 Earth Science |
|---|---|--|--|
| Standards and Statements <i>(and number of Content Expectations in each Statement)</i> | | | |
| Inquiry Process (IP) Inquiry Analysis and Communication (IA) Reflection and Social Implications (RS) | Force and Motion (FM) Force Interactions (2) Force (4) Speed (3) Energy (EN) Kinetic and Potential Energy (2) Waves and Energy (3) Energy Transfer (3) Solar Energy Effects (2) Properties of Matter (PM) Chemical Properties (1) Elements and Compounds (4) Changes in Matter (CM) Changes in State (2) Chemical Changes (3) | Organization of Living Things (OL) Cell Functions (4) Growth and Development (2) Animal Systems (2) Producers, Consumers, and Decomposers (2) Photosynthesis (3) Heredity (HE) Inherited and Acquired Traits (2) Reproduction (2) Evolution (EV) Species Adaptation and Survival (4) Relationships Among Organisms (1) Ecosystems (EC) Interactions of Organisms (1) Relationships of Organisms (3) Biotic and Abiotic Factors (2) Environmental Impact of Organisms (2) | Earth Systems (ES) Solar Energy (3) Human Consequences (2) Seasons (2) Weather and Climate (4) Water Cycle (2) Solid Earth (SE) Soil (4) Rock Formation (1) Plate Tectonics (3) Magnetic Field of Earth (2) Fluid Earth (FE) Atmosphere (2) Earth in Space and Time (ST) Solar System (1) Solar System Motion (5) Fossils (1) Geologic Time (2) |

Science Processes: Inquiry Process, Inquiry Analysis and Communication, Reflection, and Social Implications

The seventh grade content expectations present the final opportunity for the middle school learners to refine and develop their inquiry skills prior to the introduction of the high school curriculum. Students should be able to recognize that different kinds of questions suggest different approaches for scientific investigation. Students should be able to generate a variety of questions through observation, sets of data, manipulation of variables, investigations, and research. They further develop and sharpen their skills in measurement and the use of tools and scientific equipment. They collect and organize their own sets of data into charts and graphs, make sense of their findings, evaluate and analyze their own data as well as the data of others, and evaluate the strengths and weaknesses of their findings and the claims of others. Students recognize the importance of collaborative science discourse. Learners understand that science investigations and advances may result in new ideas and areas of study generating new methods and possibly resulting in new investigations.

Reflection and social implications are the application of the students' new knowledge and affects their decision making and their perception of the effect humans, scientific discovery, and technology have on society and the natural world.

Physical Science: Energy, Properties of Matter, Changes in Matter

Seventh grade students continue their exploration into the concept of energy through the exploration of light energy and solar energy effects. Students gain a greater understanding of the role of the sun's warming and lighting of the Earth, and how light energy is transferred to chemical energy through photosynthesis. The transfer of energy is studied through examples of waves (sound, seismic, and water) and how waves transfer energy when they interact with matter.

Their earlier studies of properties of matter emphasized observable physical properties. Seventh grade students explore a more in-depth study of physical properties (boiling point, density, and color) and chemical properties of matter (flammability, pH, acid-base indicators, and reactivity). Students are introduced to organization of the Periodic Table of the Elements and recognize the atom as the smallest component that makes up an element.

Seventh grade students draw upon their knowledge of properties of matter and use evidence to describe physical and chemical change. They recognize that when a chemical change occurs, a new substance is produced and that the new substance has different physical and chemical properties than the original substance. Students describe evidence of chemical change as a change in color, gas formation, solid formation, and temperature change.

Life Science: Organization of Living Things and Heredity

Seventh grade students expand their investigations of living things to include the study of cells. They demonstrate that all organisms are composed of cells and that multicellular organisms and single cellular organisms exist in ecosystems. The seventh grade study of cells includes how cells make up different body tissues, organs, and organ systems and are specialized in their functions. Cell division is explored to help the students describe growth and development. Seventh grade students have the fine motor skills and conceptual development to use a light microscope and accurately interpret what they see. This enhances their introduction to cells and microorganisms, establishing a foundation for molecular biology at the high school level.

In the seventh grade content expectations, students expand their knowledge to include how characteristics of living things are passed on through generations, both asexually and sexually. Seventh grade students are able to understand that genetic material carries information. They compare and contrast the advantages of sexual vs. asexual reproduction, and recognize that reproduction is a characteristic of all living things and necessary for the continuation of every species.

Earth Science: Earth Systems and Fluid Earth

The primary focus of the Earth science content expectations is understanding the relationship between the sun's warming of the Earth, the water cycle, and weather and climate. In the sixth grade Earth science curriculum, students studied the rock cycle and physical and chemical weathering. The seventh grade units of study explore another Earth cycle in the context of the water cycle and the composition of the atmosphere. Students investigate the sun's warming of the atmosphere, land, and water, and how it affects the movement of water through the atmosphere, weather, and climate. Their knowledge of weather goes beyond the more basic observations of weather from the elementary curriculum to include the frontal boundaries, major air masses, and the jet stream. The reflection of their knowledge is applied to how human activities have changed the land, oceans, and atmosphere, and the implications of pollution, climate change, and threatening or endangering species.

Seventh Grade Science Standards, Statements, and Expectations

Note: The number in parentheses represents the number of expectations.

Discipline 1: Science Processes (S)

Standard: Inquiry Process (IP)

1 Statement (6)

Standard: Inquiry Analysis and Communication (IA)

1 Statement (5)

Standard: Reflection and Social Implications (RS)

1 Statement (9)

Discipline 2: Physical Science (P)

Standard: Energy (EN)

Waves and Energy (3)

Energy Transfer (1)

Solar Energy Effects (2)

Standard: Properties of Matter (PM)

Chemical Properties (1)

Elements and Compounds (4)

Standard: Changes in Matter (CM)

Chemical Changes (3)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)

Cell Functions (4)

Growth and Development (2)

Photosynthesis (3)

Standard: Heredity (HE)

Reproduction (2)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)

Solar Energy (3)

Human Consequences (2)

Weather and Climate (4)

Water Cycle (2)

Standard: Fluid Earth (FE)

Atmosphere (2)

K-7 Standard S.IP: *Develop an understanding that scientific inquiry and reasoning involves observing, questioning, investigating, recording, and developing solutions to problems.*

S.IP.M.1 Inquiry involves generating questions, conducting investigations, and developing solutions to problems through reasoning and observation.

S.IP.07.11 Generate scientific questions based on observations, investigations, and research.

S.IP.07.12 Design and conduct scientific investigations.

S.IP.07.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations.

S.IP.07.14 Use metric measurement devices in an investigation.

S.IP.07.15 Construct charts and graphs from data and observations.

S.IP.07.16 Identify patterns in data.

Inquiry Analysis and Communication

K-7 Standard S.IA: *Develop an understanding that scientific inquiry and investigations require analysis and communication of findings, using appropriate technology.*

S.IA.M.1 Inquiry includes an analysis and presentation of findings that lead to future questions, research, and investigations.

S.IA.07.11 Analyze information from data tables and graphs to answer scientific questions.

S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.

S.IA.17.13 Communicate and defend findings of observations and investigations.

S.IA.07.14 Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions.

S.IA.07.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

Reflection and Social Implications

K-7 Standard S.RS: *Develop an understanding that claims and evidence for their scientific merit should be analyzed. Understand how scientists decide what constitutes scientific knowledge. Develop an understanding of the importance of reflection on scientific knowledge and its application to new situations to better understand the role of science in society and technology.*

S.RS.M.1 Reflecting on knowledge is the application of scientific knowledge to new and different situations. Reflecting on knowledge requires careful analysis of evidence that guides decision-making and the application of science throughout history and within society.

- S.RS.07.11** Evaluate the strengths and weaknesses of claims, arguments, and data.
- S.RS.07.12** Describe limitations in personal and scientific knowledge.
- S.RS.07.13** Identify the need for evidence in making scientific decisions.
- S.RS.07.14** Evaluate scientific explanations based on current evidence and scientific principles.
- S.RS.07.15** Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
- S.RS.07.16** Design solutions to problems using technology.
- S.RS.07.17** Describe the effect humans and other organisms have on the balance of the natural world.
- S.RS.07.18** Describe what science and technology can and cannot reasonably contribute to society.
- S.RS.07.19** Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

PHYSICAL SCIENCE

Energy

K-7 Standard P.EN: *Develop an understanding that there are many forms of energy (such as heat, light, sound, and electrical) and that energy is transferable by convection, conduction, or radiation. Understand energy can be in motion, called kinetic; or it can be stored, called potential. Develop an understanding that as temperature increases, more energy is added to a system. Understand nuclear reactions in the sun produce light and heat for the Earth.*

P.EN.M.3 Waves and Energy-Waves have energy and transfer energy when they interact with matter. Examples of waves include sound waves, seismic waves, waves on water, and light waves.

- P.EN.07.31** Identify examples of waves, including sound waves, seismic waves, and waves on water.
- P.EN.07.32** Describe how waves are produced by vibrations in matter.
- P.EN.07.33** Demonstrate how waves transfer energy when they interact with matter (for example: tuning fork in water, waves hitting a beach, earthquake knocking over buildings).

P.EN.M.4 Energy Transfer- Energy is transferred from a source to a receiver by radiation, conduction, and convection. When energy is transferred from one system to another, the quantity of energy before the transfer is equal to the quantity of energy after the transfer. *

- P.EN.07.43** Explain how light energy is transferred to chemical energy through the process of photosynthesis.

* Revised expectations marked by an asterisk.

P.EN.M.6 Solar Energy Effects- Nuclear reactions take place in the sun producing heat and light. Only a tiny fraction of the light energy from the sun reaches Earth, providing energy to heat the Earth.

P.EN.07.61 Identify that nuclear reactions take place in the sun, producing heat and light.

P.EN.07.62 Explain how only a tiny fraction of light energy from the sun is transformed to heat energy on Earth.

Properties of Matter

K-7 Standard P.PM: Develop an understanding that all matter has observable attributes with physical and chemical properties that are described, measured, and compared. Understand that states of matter exist as solid, liquid, or gas; and have physical and chemical properties. Understand all matter is composed of combinations of elements, which are organized by common attributes and characteristics on the Periodic Table. Understand that substances can be classified as mixtures or compounds and according to their physical and chemical properties.

P.PM.M.1 Chemical Properties- Matter has chemical properties. The understanding of chemical properties helps to explain how new substances are formed.

P.PM.07.11 Classify substances by their chemical properties (flammability, pH, and reactivity). *

P.PM.M.2 Elements and Compounds- Elements are composed of a single kind of atom that are grouped into families with similar properties on the periodic table. Compounds are composed of two or more different elements. Each element and compound has a unique set of physical and chemical properties such as boiling point, density, color, conductivity, and reactivity.

P.PM.07.21 Identify the smallest component that makes up an element.

P.PM.07.22 Describe how the elements within the Periodic Table are organized by similar properties into families (highly reactive metals, less reactive metals, highly reactive nonmetals, and some almost completely non-reactive gases).

P.PM.07.23 Illustrate the structure of molecules using models or drawings (water, carbon dioxide, table salt). *

P.PM.07.24 Describe examples of physical and chemical properties of elements and compounds (boiling point, density, color, conductivity, reactivity). *

* Revised expectations marked by an asterisk.

Changes in Matter

K-7 Standard P.CM: *Develop an understanding of changes in the state of matter in terms of heating and cooling, and in terms of arrangement and relative motion of atoms and molecules. Understand the differences between physical and chemical changes. Develop an understanding of the conservation of mass. Develop an understanding of products and reactants in a chemical change.*

P.CM.M.2 Chemical Changes- **Chemical changes occur when two elements and/or compounds react (including decomposing) to produce new substances. These new substances have different physical and chemical properties than the original elements and/or compounds. During the chemical change, the number and kind of atoms in the reactants are the same as the number and kind of atoms in the products. Mass is conserved during chemical changes. The mass of the reactants is the same as the mass of the products. ***

P.CM.07.21 Identify evidence of chemical change through color, gas formation, solid formation, and temperature change.

P.CM.07.22 Compare and contrast the chemical properties of a new substance with the original after a chemical change.

P.CM.07.23 Describe the physical properties and chemical properties of the products and reactants in a chemical change.

LIFE SCIENCE

Organization of Living Things

K-7 Standard L.OL: *Develop an understanding that plants and animals (including humans) have basic requirements for maintaining life which include the need for air, water, and a source of energy. Understand that all life forms can be classified as producers, consumers, or decomposers as they are all part of a global food chain where food/energy is supplied by plants which need light to produce food/energy. Develop an understanding that plants and animals can be classified by observable traits and physical characteristics. Understand that all living organisms are composed of cells and they exhibit cell growth and division. Understand that all plants and animals have a definite life cycle, body parts, and systems to perform specific life functions.*

* Revised expectations marked by an asterisk.

L.OL.M.2 Cell Functions- All organisms are composed of cells, from one cell to many cells. In multicellular organisms, specialized cells perform specialized functions. Organs and organ systems are composed of cells, and function to serve the needs of cells for food, air, and waste removal. The way in which cells function is similar in all living organisms.

L.OL.07.21 Recognize that all organisms are composed of cells (single cell organisms, multicellular organisms).

L.OL.07.22 Explain how cells make up different body tissues, organs, and organ systems.

L.OL.07.23 Describe how cells in all multicellular organisms are specialized to take in nutrients, which they use to provide energy for the work that cells do and to make the materials that a cell or organism needs.

L.OL.07.24 Recognize that cells function in a similar way in all organisms.

L.OL.M.3- Growth and Development- Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissue of multicellular organisms. *

L.OL.07.31 Describe growth and development in terms of increase of cell number and/or cell size.

L.OL.07.32 Examine how through cell division, cells can become specialized for specific functions.

L.OL.M.6 Photosynthesis- Plants are producers; they use the energy from light to make sugar molecules from the atoms of carbon dioxide and water. Plants use these sugars along with minerals from the soil to form fats, proteins, and carbohydrates. These products can be used immediately, incorporated into the cells of a plant as the plant grows, or stored for later use.

L.OL.07.61 Recognize the need for light to provide energy for the production of carbohydrates, proteins and fats.

L.OL.07.62 Explain that carbon dioxide and water are used to produce carbohydrates, proteins, and fats.

L.OL.07.63 Describe evidence that plants make, use and store food.

* Revised expectations marked by an asterisk.

Heredity

K-7 Standard L.HE: *Develop an understanding that all life forms must reproduce to survive. Understand that characteristics of mature plants and animals may be inherited or acquired and that only inherited traits are passed on to their young. Understand that inherited traits can be influenced by changes in the environment and by genetics.*

L.HE.M.2 Reproduction- Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually.

L.HE.07.21 Compare how characteristics of living things are passed on through generations, both asexually and sexually.

L.HE.07.22 Compare and contrast the advantages and disadvantages of sexual vs. asexual reproduction.

EARTH SCIENCE

Earth Systems

K-7 Standard E.ES: *Develop an understanding of the warming of the Earth by the sun as the major source of energy for phenomenon on Earth and how the sun's warming relates to weather, climate, seasons, and the water cycle. Understand how human interaction and use of natural resources affects the environment.*

E.ES.M.1 Solar Energy- The sun is the major source of energy for phenomena on the surface of the Earth.

E.ES.07.11 Demonstrate, using a model or drawing, the relationship between the warming by the sun of the Earth and the water cycle as it applies to the atmosphere (evaporation, water vapor, warm air rising, cooling, condensation, clouds).

E.ES.07.12 Describe the relationship between the warming of the atmosphere of the Earth by the sun and convection within the atmosphere and oceans.

E.ES.07.13 Describe how the warming of the Earth by the sun produces winds and ocean currents.

E.ES.M.4 Human Consequences- Human activities have changed the land, oceans, and atmosphere of the Earth resulting in the reduction of the number and variety of wild plants and animals, sometimes causing extinction of species.

E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

E.ES.M.7 Weather and Climate- Global patterns of atmospheric and oceanic movement influence weather and climate.

E.ES.07.71 Compare and contrast the difference and relationship between climate and weather.

E.ES.07.72 Describe how different weather occurs due to the constant motion of the atmosphere from the energy of the sun reaching the surface of the Earth.

E.ES.07.73 Explain how the temperature of the oceans affects the different climates on Earth because water in the oceans holds a large amount of heat.

E.ES.07.74 Describe weather conditions associated with frontal boundaries (cold, warm, stationary, and occluded) and the movement of major air masses and the jet stream across North America using a weather map.

E.ES.M.8 Water Cycle- Water circulates through the four spheres of the Earth in what is known as the “water cycle.”

E.ES.07.81 Explain the water cycle and describe how evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff, ground water, and absorption occur within the cycle.

E.ES.07.82 Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater.

Fluid Earth

K-7 Standard E.FE: *Develop an understanding that Earth is a planet nearly covered with water and that water on Earth can be found in three states, solid, liquid, and gas. Understand how water on Earth moves in predictable patterns. Understand Earth’s atmosphere as a mixture of gases and water vapor.*

E.FE.M.1 Atmosphere- **The atmosphere is a mixture of nitrogen, oxygen, and trace gases that include water vapor. The atmosphere has different physical and chemical composition at different elevations.**

E.FE.07.11 Describe the atmosphere as a mixture of gases.

E.FE.07.12 Compare and contrast the composition of the atmosphere at different elevations.