STATE OF MICHIGAN
DEPARTMENT OF EDUCATION
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

MICHAEL P. FLANAGAN
SUPERINTENDENT OF
PUBLIC INSTRUCTION

MEMORANDUM

TO: State Board of Education

FROM: Michael P. Flanagan, Chairman

DATE: October 29, 2007

SUBJECT: Presentation of the Revised Science Grade Level Content Expectations

At the May 8, 2007 State Board of Education meeting, the State Board of Education accepted the Draft K-7 Content Expectations for Science, and directed that they be posted to the MDE website for review. These Expectations were developed by a committee co-chaired by two well respected science educators: Larry Casler from Genesee Intermediate School District – Math/Science Center and Liz Niehaus from Niehaus and Associates, Inc. Following the protocol for development of curricular documents, the draft was reviewed by educators, professional organizations, legislators, and community members via the web. In addition, The Council of State Science Supervisors reviewed the content expectations at the national level.

Revision teams led by members of the internal review committee and including members of the original work groups, as well as additional practitioners, reviewed all comments and suggestions from the field and national reviews. They revised the documents to provide a set of expectations that will guide science instruction and assessment in Michigan.

The attached Draft K-7 Content Expectations for Science represents a thorough consideration of input from a variety of stakeholders and is being presented to the State Board for final review. It is anticipated that these Content Expectations will be approved at the December 11, 2007 State Board meeting.

Attachment

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Attachment

SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

Draft v.10.07

MICHIGAN Department of Education

Office of School Improvement

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KINDERGARTEN SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

K SCIENCE

Draft v.10.07

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 Scholar Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006) which had 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.

MICHIGAN Department of Education
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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

Within 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.

Elementary (K-4) Science Organizational Structure

Discipline 1 Science Processes	Discipline 2 Physical Science	Discipline 3 Life Science	Discipline 4 Earth Science
Standards and Statements *(and number of Content Expectations in each Statement)*			
Inquiry Process (IP) **Inquiry Analysis and Communication (IA)** **Reflection and Social Implications (RS)**	**Force and Motion (FM)** Position (2) Gravity (2) Force (8) Speed (3) **Energy (EN)** Forms of Energy (2) Light Properties (2) Sound (2) Energy and Temperature (3) Electrical Circuits (2) **Properties of Matter (PM)** Physical Properties (8) States of Matter (3) Magnets (4) Material Composition (1) Conductive and Reflective Properties (3) **Changes in Matter (CM)** Changes in State (1)	**Organization of Living Things (OL)** Life Requirements (6) Life Cycles (2) Structures and Functions (2) Classification (2) **Heredity (HE)** Observable Characteristics (3) **Evolution (EV)** Environmental Adaptation (2) Survival (2) **Ecosystems (EC)** Interactions (1) Changed Environment Effects (1)	**Earth Systems (ES)** Solar Energy (2) Weather (4) Weather Measurement (2) Natural Resources (4) Human Impact (2) **Solid Earth (SE)** Earth Materials (4) Surface Chages (2) Using Earth Materials (2) **Fluid Earth (FE)** Water (4) Water Movement (2) **Earth in Space and Time (ST)** Characteristics of Objects in the Sky (2) Patterns of Objects in the Sky (5) Fossils (2)

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

Kindergarten presents the initial opportunity for young learners to become engaged in the study of science through their natural curiosity in subject matter that is of high interest. The Grade Level Content Expectations for science at this level are centered on areas where the young learners have begun to form ideas and try to make sense of the world around them. Many of the building blocks of scientific understanding begin to emerge prior to school. Kindergarten students will be guided in the process of scientific inquiry through purposeful observations, raising questions, as well as making sense of their observations, investigations, meaning-making practices, and demonstrating their understanding through various activities. The curriculum builds cumulatively and in developmentally informed ways from students' early knowledge toward scientifically accepted concepts. Included in the inquiry curriculum is the use of the appropriate senses in purposeful observations. It is intended for the five senses to be taught within the content of science, giving the students the opportunity to learn and use their senses for purposeful observation, stressing the very limited use of the sense of taste in the study of science. The use of senses during observations continues to be present in the inquiry expectations for grades first through fourth.

Physical Science: Force and Motion

Prior to entering kindergarten, many students have developed an understanding of the motion of objects. For example, the young learner has discovered that solid objects cannot move through each other, changes in motion and position of objects are the result of a force outside them, and that objects tend to endure over space and time. They learn even though the ball has rolled out of sight, it still exists behind the wall, under the couch, or behind someone's back. They can also make inferences about reasonable causes of motion of inanimate objects. Pre-kindergarteners have their own concept of force that they use to explain what happens in the motion of objects. They think of forces as active pushes and pulls that are needed to explain an object's motion.

The kindergarten content expectations for physical science are meant to build on and use the early learners' ability to correctly sense some of the behaviors of simple mechanical objects and the motion of objects. The central idea is for the young learner to be able to attach appropriate language that describes motion, compares motion, and begin to develop an understanding of forces and their relationship to changes in motion. Finally the students are introduced to the concept that objects fall toward the Earth and that the force that pulls objects toward Earth affects the motion of all objects.

Life Science: Organization of Living Things

The young learner enters kindergarten with a natural wonder and curiosity of the order of living and nonliving things. They are curious about the function of the different body parts of living things. They have a basic understanding that living things need food and that food is somehow changed in a manner that allows the living organism to grow and survive. They do not yet have a generalized understanding of how both plants and animals obtain their food or the process of digestion. At this level students are also beginning to categorize living and non-living things. They will sort plants and animals from toys or artifacts even though they have similarities in their appearance.

The kindergarten content expectations for life science build a greater understanding of the basic needs of all living things and classifying living and nonliving things. Through direct classroom experiences of living things and their habitats, students begin to think beyond movement as the defining characteristic of life and recognize characteristics of living things with eating, breathing, and reproducing.

Earth Science: Solid Earth

Early learners are naturally curious about the objects in their environment – soil, rocks, water, sand, rain, snow, and so on. Kindergarteners enter school with an idea that the Earth is made up of soil, rocks, pebbles, sand, water and living things. They should be encouraged to closely observe materials found on Earth and begin to describe their properties.

The essential learning in Earth science for the kindergarten student is to be able to identify different Earth materials and recognize the Earth materials necessary to grow plants, linking the common thread of understanding in life science and Earth science.

Young students have difficulty understanding the concept that the Earth is round. Their own observations tell them that the Earth is essentially flat. When told that the Earth is round they may interpret that to mean that it is a flat disc or saucer. The introduction of globes as models of the Earth is essential in their beginning to understand the shape of objects in the sky such as the Earth, moon, and sun.

Kindergarten 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 (3)

Standard: Reflection and Social Implications (RS)
1 Statement (1)

Discipline 2: Physical Science (P)

Standard: Force and Motion (FM)
Position (2)
Gravity (1)
Force (4)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Life Requirements (2)

Discipline 4: Earth Science (E)

Standard: Solid Earth (SE)
Earth Materials (1)

SCIENCE PROCESSES

Inquiry Process

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

S.IP.00.11 Make purposeful observation of the natural world using the appropriate senses.
S.IP.00.12 Generate questions based on observations.
S.IP.00.13 Plan and conduct simple investigations.
S.IP.00.14 Manipulate simple tools (for example: hand lens, pencils, balances, non-standard objects for measurement) that aid observation and data collection.
S.IP.00.15 Make accurate measurements with appropriate (non-standard) units for the measurement tool.
S.IP.00.16 Construct simple charts from data and observations.

Inquiry Analysis and Communication

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

S.IA.00.12 Share ideas about science through purposeful conversation.
S.IA.00.13 Communicate and present findings of observations.
S.IA.00.14 Develop strategies for information gathering (ask an expert, use a book, make observations, conduct simple investigations, and watch a video).

Reflection and Social Implications

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

S.RS.00.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.

PHYSICAL SCIENCE

Force and Motion

P.FM.E.1 Position- A position of an object can be described by locating the object relative to other objects or a background. The description of the motion of an object from one observer's view may be different from that reported from a different observer's view.

P.FM.00.11 Compare the position of an object (for example: above, below, in front of, behind, on) in relation to other objects around it.
P.FM.00.12 Describe the motion of an object (for example: away from or closer to) from different observers' views.

P.FM.E.2 Gravity- Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is on the Earth.

P.FM.00.21 Observe how objects fall toward the earth.

P.FM.E.3 Force- A force is either a push or a pull. The motion of objects can be changed by forces. The size of the change is related to the size of the force. The change is also related to the weight (mass) of the object on which the force is being exerted. When an object does not move in response to a force, it is because another force is being applied by the environment.

P.FM.00.31 Demonstrate pushes and pulls.
P.FM.00.32 Observe that objects initially at rest will move in the direction of the push or pull.
P.FM.00.33 Observe how pushes and pulls can change the speed or direction of moving objects.
P.FM.00.34 Observe how shape (for example: cone, cylinder, sphere), size, and weight of an object can affect motion.

LIFE SCIENCE — Organization of Living Things

L.OL.E.1 Life Requirements- Organisms have basic needs. Animals and plants need air, water, and food. Plants also require light. Plants and animals use food as a source of energy and as a source of building material for growth and repair.

L.OL.00.11 Identify that living things have basic needs.
L.OL.00.12 Identify and compare living and nonliving things.

EARTH SCIENCE — Solid Earth

E.SE.E.1 Earth Materials- Earth materials that occur in nature include rocks, minerals, soils, water, and the gases of the atmosphere. Some Earth materials have properties which sustain plant and animal life.

E.SE.00.11 Identify Earth materials (air, water, soil) that are used to grow plants.

FIRST GRADE SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

1 SCIENCE

Draft v.10.07

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

SCIENCE PROCESSES

PHYSICAL SCIENCE

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

Students entering the first grade should have an understanding of the five senses and how the use of their senses help in science observations and investigations. The continued use of high interest subject matter piqued by their natural curiosity will further develop student understanding and skills in making observations, generating questions, planning and conducting simple investigations, meaning-making, and presentation of findings.

In addition to the skills the students acquired in their kindergarten experience, first grade students will recognize the importance of multiple trials in their investigations before drawing conclusions or presenting findings.

The first grade students, in all three science content disciplines, physical, life, and Earth, will be required to make careful and purposeful observations in order to raise questions, investigate, and make meaning of their findings.

Physical Science: Properties of Matter

The first grade physical science experience is intended to develop the young learners skills in using the senses to sort objects according to their observable physical attributes (color, shape, size, sinking, floating, texture). Young children begin their study of matter by examining and describing objects and their behavior. First grade students will also begin to study states of matter and particularly states of water as found on Earth. They explore water primarily in its liquid state and solid state. The Grade Level Content Expectations do not hold the first grade student responsible for a complete understanding of water in its gaseous state. The introduction of the three states of water on Earth is appropriate at this level, however, developing a complete knowledge base in states of matter requires many experiences over multiple grade levels, providing opportunities to continue children's explorations focused on observations and simple investigations. Elementary students have difficulty understanding that the water they see in a boiling pot evaporates into a gas. A common misconception is that it disappeared or went away. In subsequent grades students will be given the opportunity to conduct simple investigations with heating and evaporation that will help familiarize them with evaporation and gas as a state of matter.

The final area of study in the physical sciences is the observation of magnets and the interaction with magnetic and non-magnetic materials. The study of magnets also provides the opportunity for the young learner to build on their kindergarten experience of pushes and pulls that are required in the motion of an object. The magnets can be used to demonstrate pushes and pulls that are not in direct contact with the moving object, yet provides the force needed for motion.

Life Science: Organization of Living Things and Heredity

The first grade life science curriculum builds on the students' prior knowledge of living and non-living things and the basic needs of all living things. Students are provided with the opportunity to explore and identify the needs of animals and describe the animal life cycle (egg, young, adult; egg, larva, pupa, adult).

Through their study of living things in the classroom, first grade students begin to make connections between young and adult, and are able to make simple identification of characteristics that are passed from parents to young (body coverings, beak shape, number of legs, body parts). They also develop the ability to match young animals with their parent based on similar characteristics (puppies/dogs, kittens/cats, calves/cows, chicks/chickens).

Earth Science: Earth Systems, Weather, and Solid Earth

The Earth science content expectations for first grade focus on two main ideas. The first concept is the importance of the sun providing the warmth and light necessary for plant and animal life, and how plant and animal life are dependent on a variety of earth materials. The students enter first grade with the basic ability to identify simple earth materials and recognize that some earth materials are necessary to grow plants. Building on their prior knowledge, the students will be given the opportunity to demonstrate and describe the importance of sun, air, and soil to plant and animal life.

The second main idea in first grade Earth science focuses on the study of weather and how it changes from day to day and over the seasons. The young learners are given the opportunity to observe, record, and measure weather conditions over a period of time. Student understanding of weather can be obtained through observations, descriptions, and finding patterns. The first grade Earth science content expectations also include the study of severe weather events and precautions that should be taken to ensure their safety if severe weather should occur.

First 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 (3)

Standard: Reflection and Social Implications (RS)
1 Statement (2)

Discipline 2: Physical Science (P)

Standard: Properties of Matter (PM)
Physical Properties (1)
States of Matter (2)
Magnets (2)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Life Requirements (1)
Life Cycles (1)

Standard: Heredity (HE)
Observable Characteristics (2)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)
Solar Energy (2)
Weather (4)
Weather Measurement (2)

Standard: Solid Earth (SE)
Earth Materials (1)

SCIENCE PROCESSES

Inquiry Process

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

S.IP.01.11 Make purposeful observation of the natural world using the appropriate senses.
S.IP.01.12 Generate questions based on observations.
S.IP.01.13 Plan and conduct simple investigations.
S.IP.01.14 Manipulate simple tools (for example: hand lens, pencils, rulers, thermometers, rain gauges, balances, non-standard objects for measurement) that aid observation and data collection.
S.IP.01.15 Make accurate measurements with appropriate (non-standard) units for the measurement tool.
S.IP.01.16 Construct simple charts from data and observations.

Inquiry Analysis and Communication

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

S.IA.01.12 Share ideas about science through purposeful conversation.
S.IA.01.13 Communicate and present findings of observations.
S.IA.01.14 Develop strategies for information gathering (ask an expert, use a book, make observations, conduct simple investigations, and watch a video).

Reflection and Social Implications

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

S.RS.01.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.01.12 Recognize that science investigations are done more than one time.

PHYSICAL SCIENCE

Properties of Matter

P.PM.E.1 Physical Properties- All objects and substances have physical properties that can be measured.

P.PM.01.11 Demonstrate the ability to sort objects according to observable attributes such as color, shape, size, sinking or floating.

P.PM.E.2 States of Matter- Matter exists in several different states: solids, liquids and gases. Each state of matter has unique physical properties. Gases are easily compressed but liquids and solids do not compress easily. Solids have their own particular shapes, but liquids and gases take the shape of the container.

P.PM.01.21 Demonstrate that water as a solid keeps its own shape (ice).
P.PM.01.22 Demonstrate that water as a liquid takes on the shape of various containers.

P.PM.E.3 Magnets- Magnets can repel or attract other magnets. Magnets can also attract certain non-magnetic objects at a distance.

P.PM.01.31 Identify materials that are attracted by magnets.
P.PM.01.32 Observe that like poles of a magnet repel and unlike poles of a magnet attract.

LIFE SCIENCE

Organization of Living Things

L.OL.E.1 Life Requirements- Organisms have basic needs. Animals and plants need air, water, and food. Plants also require light. Plants and animals use food as a source of energy and as a source of building material for growth and repair.

L.OL.01.13 Identify the needs of animals.

L.OL.E.2 Life Cycles- Plants and animals have life cycles. Both plants and animals begin life and develop into adults, reproduce, and eventually die. The details of this life cycle are different for different organisms.

L.OL.01.21 Describe the life cycle of animals including the following stages: egg, young, adult; egg, larva, pupa, adult.

Heredity

L.HE.E.1 Observable Characteristics- Plants and animals share many, but not all, characteristics of their parents.

L.HE.01.11 Identify characteristics (for example: body coverings, beak shape, number of legs, body parts) that are passed on from parents to young.
L.HE.01.12 Classify young animals based on characteristics that are passed on from parents (for example: dogs/puppies, cats/kittens, cows/calves, chicken/chicks).

EARTH SCIENCE

Earth Systems

E.ES.E.1 Solar Energy- The sun warms the land, air and water and helps plants grow.

E.ES.01.11 Identify the sun as the most important source of heat which warms the land, air, and water of the Earth.

E.ES.01.12 Demonstrate the importance of sunlight and warmth in plant growth.

E.ES.E.2 Weather- Weather changes from day to day and over the seasons.

E.ES.01.21 Compare daily changes in the weather related to temperature (cold, hot, warm, cool); cloud cover (cloudy, partly cloudy, foggy) precipitation (rain, snow, hail, freezing rain); wind (breezy, windy, calm).

E.ES.01.22 Describe and compare weather related to the four seasons in terms of temperature, cloud cover, precipitation, and wind.

E.ES.01.23 Describe severe weather events.

E.ES.01.24 Describe precautions that should be taken for human safety during severe weather conditions (thunderstorms, lightning, tornadoes, high winds, blizzards, hurricanes).

E.ES.E.3 Weather Measurement- Scientists use tools for observing, recording, and predicting weather changes.

E.ES.01.31 Identify the tools that might be used to measure temperature, precipitation, cloud cover and wind.

E.ES.01.32 Observe and collect data of weather conditions over a period of time.

Solid Earth

E.SE.E.1 Earth Materials- Earth materials that occur in nature include rocks, minerals, soils, water, and the gases of the atmosphere. Some Earth materials have properties which sustain plant and animal life.

E.SE.01.12 Describe how Earth materials contribute to the growth of plant and animal life.

SECOND GRADE SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

2 SCIENCE

Draft v.10.07

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 Scholar Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006) which had 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.

MICHIGAN Department of Education
Office of School Improvement

www.michigan.gov/mde

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

Within 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.

Elementary (K-4) Science Organizational Structure

Discipline 1 Science Processes	Discipline 2 Physical Science	Discipline 3 Life Science	Discipline 4 Earth Science
Standards and Statements *(and number of Content Expectations in each Statement)*			
Inquiry Process (IP) **Inquiry Analysis and Communication (IA)** **Reflection and Social Implications (RS)**	**Force and Motion (FM)** Position (2) Gravity (2) Force (8) Speed (3) **Energy (EN)** Forms of Energy (2) Light Properties (2) Sound (2) Energy and Temperature (3) Electrical Circuits (2) **Properties of Matter (PM)** Physical Properties (8) States of Matter (3) Magnets (4) Material Composition (1) Conductive and Reflective Properties (3) **Changes in Matter (CM)** Changes in State (1)	**Organization of Living Things (OL)** Life Requirements (6) Life Cycles (2) Structures and Functions (2) Classification (2) **Heredity (HE)** Observable Characteristics (3) **Evolution (EV)** Environmental Adaptation (2) Survival (2) **Ecosystems (EC)** Interactions (1) Changed Environment Effects (1)	**Earth Systems (ES)** Solar Energy (2) Weather (4) Weather Measurement (2) Natural Resources (4) Human Impact (2) **Solid Earth (SE)** Earth Materials (4) Surface Chages (2) Using Earth Materials (2) **Fluid Earth (FE)** Water (4) Water Movement (2) **Earth in Space and Time (ST)** Characteristics of Objects in the Sky (2) Patterns of Objects in the Sky (5) Fossils (2)

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

These second grade expectations increase students' skills for inquiry by asking them to make quantitative measurements and organize data into charts and graphs that will provide students with evidence when communicating scientific ideas. Second graders are given the opportunity to plan and conduct simple investigations with data collection within the physical, life, and Earth science content. The experiences in the classroom inspire a sense of wonder and enthusiasm that leads to the opportunity for students to generate questions based on observations.

Physical Science: Properties of Matter

Second grade students expand their understanding of describing matter to include state of matter, texture, hardness, and the measure of length, volume, and weight of different substances. Given the opportunity to observe, measure, and describe common objects, student descriptions become more detailed and astute. Young learners realize that they can add to their descriptions of objects when given the measuring tools necessary to record data and provide evidence of their thinking.

Second grade students are introduced to the concept of classifying objects as a single substance and a mixture of one or more substances. The intent of the content expectation is to introduce the young learner to the concept that not all objects are made of one substance, and may be a mixture of two or more substances.

Life Science: Organization of Living Things and Heredity

Second grade students build on their prior knowledge of the needs of animals and the life cycle of animals from their first grade experiences and apply it to plants. The second grade life science curriculum concentrates on the needs of plants, life cycle of flowering plants (seed, plant, flower, fruit, seed), and characteristics of plants that are passed from parent to young. Young learners gain an understanding of the relationship between all living things through direct experience with organisms in the classroom leading to an understanding of how individual organisms maintain and continue life.

Earth Science: Solid Earth and Fluid Earth

The main concept in Earth science for the second grade student is the description and identification of major landforms and bodies of water found on Earth. As children become more familiar with the Earth and its surface features, they will be able to recognize the slow and rapid changes that occur. Students are particularly focused on water in its three states and the motion of water over land. These content expectations give the students the opportunity to observe rapid changes such as movement of water down a soil covered slope, and gradual changes such as the wind erosion of rock and soil.

The second grade content expectations provide a common opportunity for students to use their observation skills. Furthering development of these skills from previous grades, students make observations through measurement providing evidence to substantiate their understandings.

Second 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 (3)

Standard: Reflection and Social Implications (RS)
1 Statement (4)

Discipline 2: Physical Science (P)

Standard: Properties of Matter (PM)
Physical Properties (4)
Material Composition (1)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Life Requirements (1)
Life Cycles (1)

Standard: Heredity (HE)
Observable Characteristics (1)

Discipline 4: Earth Science (E)

Standard: Solid Earth (SE)
Surface Changes (1)

Standard: Fluid Earth (FE)
Water (4)
Water Movement (2)

SCIENCE PROCESSES

Inquiry Process

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

S.IP.02.11 Make purposeful observation of the natural world using the appropriate senses.
S.IP.02.12 Generate questions based on observations.
S.IP.02.13 Plan and conduct simple investigations.
S.IP.02.14 Manipulate simple tools (ruler, meter stick, measuring cups, hand lens, thermometer, balance) that aid observation and data collection.
S.IP.02.15 Make accurate measurements with appropriate units (meter, centimeter) for the measurement tool.
S.IP.02.16 Construct simple charts and graphs from data and observations.

Inquiry Analysis and Communication

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

S.IA.02.12 Share ideas about science through purposeful conversation.
S.IA.02.13 Communicate and present findings of observations.
S.IA.02.14 Develop strategies and skills for information gathering and problem solving (books, internet, ask an expert, observation, investigation, technology tools).

Reflection and Social Implications

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

S.RS.02.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.02.13 Recognize that when a science investigation is done the way it was done before, similar results are expected.
S.RS.02.15 Use evidence when communicating scientific ideas.
S.RS.02.16 Identify technology used in everyday life.

PHYSICAL SCIENCE

Properties of Matter

P.PM.E.1 Physical Properties- All objects and substances have physical properties that can be measured.

P.PM.02.12 Describe objects and substances according to their properties (color, size, shape, texture, hardness, liquid or solid, sinking or floating).

P.PM.02.13 Measure the length of objects using rulers (centimeters) and meter sticks (meters).
P.PM.02.14 Measure the volume of liquids using common measuring tools (measuring cups, measuring spoons).
P.PM.02.15 Compare the weight of objects using balances.

P.PM.E.4 Material Composition- Some objects are composed of a single substance, while other objects are composed of more than one substance.

P.PM.02.41 Classify objects as single substances (ice, silver, sugar, salt) or mixtures (salt and pepper, mixed dry beans).

LIFE SCIENCE

Organization of Living Things

L.OL.E.1 Life Requirements- Organisms have basic needs. Animals and plants need air, water, and food. Plants also require light. Plants and animals use food as a source of energy and as a source of building material for growth and repair.

L.OL.02.14 Identify the needs of plants.

L.OL.E.2 Life Cycles- Plants and animals have life cycles. Both plants and animals begin life and develop into adults, reproduce, and eventually die. The details of this life cycle are different for different organisms.

L.OL.02.22 Describe the life cycle of familiar flowering plants including the following stages: seed, plant, flower, and fruit.

Heredity

L.HE.E.1 Observable Characteristics- Plants and animals share many, but not all, characteristics of their parents.

L.HE.02.13 Identify characteristics of plants (for example: leaf shape, flower type, color, size) that are passed on from parents to young.

EARTH SCIENCE

Solid Earth

E.SE.E.2 Surface Changes- The surface of Earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

E.SE.02.21 Describe the major landforms of the surface of the Earth (mountains, plains, plateaus, valleys, hills).

Fluid Earth

E.FE.E.1 Water- Water is a natural resource and is found under the ground, on the surface of the earth, and in the sky. It exists in three states (liquid, solid, gas) and can go back and forth from one form to another.

E.FE.02.11 Identify water sources (wells, springs, lakes, rivers, oceans).
E.FE.02.12 Identify household uses of water (drinking, cleaning, food preparation).
E.FE.02.13 Describe the properties (visible, flowing, melting, dew) of water as a liquid (lakes, rivers, streams, oceans).
E.FE.02.14 Describe the properties (hard, visible, freezing, ice) of water as a solid (ice, snow, iceberg, sleet, hail).

E.FE.E.2 Water Movement- Water moves in predictable patterns.

E.FE.02.21 Describe how rain collects on the surface of the Earth and flows downhill into bodies of water (streams, rivers, lakes, oceans) or into the ground.
E.FE.02.22 Describe the major bodies of water on the Earth's surface (lakes, ponds, oceans, rivers, streams).

THIRD GRADE

SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

3 SCIENCE

Draft v.10.07

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MICHIGAN Department of Education

Office of School Improvement

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

Students continue building their inquiry and investigation skills through the use of observations and data collection. This learning requires using measurement with appropriate units of measure and conducting simple and fair investigations. Students use their data as evidence to separate fact from opinion, and compare and contrast different sets of data from multiple trials. In the application of what students discover through their investigations, they begin to describe the effect of humans and other organisms on the balance of the natural world and how people contribute to the advancement of science.

The content expectations for third grade science students presents high interest content that leads to investigations, data collection, raising questions and the identification of current problems in the environment that society faces on Earth.

Physical Science: Motion of Objects, Energy, and Properties of Matter

The previous grades have provided the students with an introduction to the understanding of motion (kindergarten), and properties of matter (first grade and second grade). The study of motion asks for students to compare and contrast motion in terms of direction and speed of an object. Using force as a push or a pull from the kindergarten expectations, now builds toward the idea that when an object does not move in response to a force, it is because another force is acting on it. The force of gravity as the force that pulls objects towards the Earth is the foundation of this learning.

The third grade science content expectations introduce the concept of energy through the study of light and sound. Students explore light and how light travels in a straight path, how shadows are made, and the behavior of light through water. Students discover that different objects interact differently with light; objects can reflect, absorb, or refract light. Objects can also absorb heat energy when exposed to light. Properties of sound are also introduced in the third grade curriculum. Students are given the opportunity to explore how different pitches are produced and sound as a result of vibrations.

Life Science: Organization of Living Things, Evolution

The third grade life science curriculum combines the previous studies of animals and plants from the first and second grades. These studies build toward an understanding of the complex interactions among living and nonliving things and the diversity of life. Children explore the functions of structures in plants and animals that help them to survive in their environment, establish the initial association of organisms within their environments, and develop ideas regarding the dependence of living things on various aspects of behavior within their environment.

Earth Science: Earth Systems and Solid Earth

Initially, the third grade students explore natural causes of change on the Earth's surface, different types of earth materials (rocks, minerals, clay, boulders, gravel, sand, and soil), and identify those materials used to construct common objects. The skills students need to understand and apply their scientific knowledge and develop an awareness of the effects of humans and other organisms on the environment are a primary focus in the third grade Earth science instruction. Students explore natural resources (renewable and non-renewable), and describe how humans protect and harm the environment. Children are asked to employ causal reasoning between human activities and the impact on the environment.

The common idea of the dependency of life on the environment and the effects of humans and other living organisms on the environment, provides the opportunity for students to apply their knowledge to current environmental problems and what the third grader can do to protect the environment.

Third 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 (7)

Discipline 2: Physical Science (P)

Standard: **Force and Motion (FM)**
Gravity (1)
Force (4)
Speed (3)

Standard: **Energy (EN)**
Forms of Energy (1)
Light Properties (2)
Sound (2)

Standard: Properties of Matter (PM)
Conductive and Reflective Properties (2)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Structures and Functions (2)
Classification (2)

Standard: **Evolution (EV)**
Environmental Adaptation (2)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)
Natural Resources (4)
Human Impact (2)

Standard: Solid Earth (SE)
Earth Materials (2)
Surface Changes (1)
Using Earth Materials (2)

SCIENCE PROCESSES

Inquiry Process

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

S.IP.03.11 Make purposeful observation of the natural world using the appropriate senses.
S.IP.03.12 Generate questions based on observations.
S.IP.03.13 Plan and conduct simple and fair investigations.
S.IP.03.14 Manipulate simple tools that aid observation and data collection (for example: hand lens, balance, ruler, meter stick, measuring cup, thermometer, spring scale, stop watch/timer).
S.IP.03.15 Make accurate measurements with appropriate units (centimeters, meters, Celsius, grams, seconds, minutes) for the measurement tool.
S.IP.03.16 Construct simple charts and graphs from data and observations.

Inquiry Analysis and Communication

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

S.IA.03.11 Summarize information from charts and graphs to answer scientific questions.
S.IA.03.12 Share ideas about science through purposeful conversation in collaborative groups.
S.IA.03.13 Communicate and present findings of observations and investigations.
S.IA.03.14 Develop research strategies and skills for information gathering and problem solving.
S.IA.03.15 Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

Reflection and Social Implications

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

S.RS.03.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.03.14 Use data/samples as evidence to separate fact from opinion.
S.RS.03.15 Use evidence when communicating scientific ideas.
S.RS.03.16 Identify technology used in everyday life.
S.RS.03.17 Identify current problems that may be solved through the use of technology.
S.RS.03.18 Describe the effect humans and other organisms have on the balance of the natural world.
S.RS.03.19 Describe how people have contributed to science throughout history and across cultures.

PHYSICAL SCIENCE

Force and Motion

P.FM.E.2 Gravity- Earth pulls down on all objects with a force called gravity. With very few exceptions, objects fall to the ground no matter where the object is on the Earth.

P.FM.03.22 Identify the force that pulls objects towards the Earth.

P.FM.E.3 Force- A force is either a push or a pull. The motion of objects can be changed by forces. The size of the change is related to the size of the force. The change is also related to the weight (mass) of the object on which the force is being exerted. When an object does not move in response to a force, it is because another force is being applied by the environment.

P.FM.03.35 Describe how a push or a pull is a force.
P.FM.03.36 Relate a change in motion of an object to the force that caused the change of motion.
P.FM.03.37 Demonstrate how the change in motion of an object is related to the strength of the force acting upon the object and to the mass of the object.
P.FM.03.38 Demonstrate when an object does not move in response to a force, it is because another force is acting on it.

P.FM.E.4 Speed- An object is in motion when its position is changing. The speed of an object is defined by how far it travels divided by the amount of time it took to travel that far.

P.FM.03.41 Compare and contrast the motion of objects in terms of direction.
P.FM.03.42 Identify changes in motion (change direction, speeding up, slowing down).
P.FM.03.43 Calculate the speed of an object based on the distance it travels divided by the amount of time it took to travel that distance.

Energy

P.EN.E.1 Forms of Energy- Heat, electricity, light, and sound are forms of energy.

P.EN.03.11 Identify light and sound as forms of energy.

P.EN.E.2 Light Properties- Light travels in straight lines. Shadows result from light not being able to pass through an object. When light travels at an angle from one substance to another (air and water), it changes direction.

P.EN.03.21 Demonstrate that light travels in a straight line and that shadows are made by placing an object in a path of light.

P.EN.03.22 Demonstrate what happens to light when it travels from water to air. (straw half in water looks bent).

P.EN.E.3 Sound- Vibrating objects produce sound. The pitch of sound varies by changing the rate of vibration.

P.EN.03.31 Relate sounds to their sources of vibrations (for example: a musical note produced by a vibrating guitar string, the sounds of a drum made by the vibrating drum head).

P.EN.03.32 Distinguish the effect of fast or slow vibrations as pitch.

Properties of Matter

P.PM.E.5 Conductive and Reflective Properties- Objects vary to the extent they absorb and reflect light energy and conduct heat and electricity.

P.PM.03.51 Demonstrate how some materials are heated more than others by light that shines on them.

P.PM.03.52 Explain how we need light to see objects: light from a source reflects off objects and enters our eyes.

LIFE SCIENCE

Organization of Living Things

L.OL.E.3 Structures and Functions- Organisms have different structures that serve different functions in growth, survival, and reproduction.

L.OL.03.31 Describe the function of the following plant parts: flower, stem, root and leaf.

L.OL.03.32 Identify and compare structures in animals used for controlling body temperature, support, movement, food-getting, and protection (for example: fur, wings, teeth, claws).

L.OL.E.4 Classification- Organisms can be classified on the basis of observable characteristics.

L.OL.03.41 Classify plants on the basis of observable physical characteristics (roots, leaves, stems, and flowers).
L.OL.03.42 Classify animals on the basis of observable physical characteristics (backbone, skin, shell, limbs, scales).

Evolution

L.EV.E.1 Environmental Adaptation- Different kinds of organisms have characteristics that help them to live in different environments.

L.EV.03.11 Relate characteristics and functions of observable parts in a variety of plants that allow them to live in their environment (for example: leaf shape, thorns, odor, color).
L.EV.03.12 Relate characteristics and functions of observable body parts to the ability of animals to live in their environment (for example: sharp teeth, claws, color, body covers).

EARTH SCIENCE

Earth Systems

E.ES.E.4 Natural Resources- The supply of many natural resources is limited. Humans have devised methods for extending their use of natural resources through recycling, reuse, and renewal.

E.ES.03.41 Identify natural resources (metals, fuels, fresh water, farmland, and forests).
E.ES.03.42 Classify renewable (fresh water, farmland, forests) and non-renewable (fuels, metals) resources.
E.ES.03.43 Describe ways humans are protecting, extending, and restoring resources (recycle, reuse, reduce, renewal).
E.ES.03.44 Recognize that paper, metal, glass, and some plastics can be recycled.

E.ES.E.5 Human Impact- Humans depend on their natural and constructed environment. Humans change environments in ways that are helpful or harmful for themselves and other organisms.

E.ES.03.51 Describe ways humans are dependent on the natural environment (forests, water, clean air, earth materials) and constructed environments (homes, neighborhoods, shopping malls, factories, and industry).
E.ES.03.52 Describe helpful or harmful effects of humans on the environment (garbage, habitat destruction, land management, renewable and non-renewable resources).

Solid Earth

E.SE.E.1 Earth Materials- Earth materials that occur in nature include rocks, minerals, soils, water, and the gases of the atmosphere. Some Earth materials have properties which sustain plant and animal life.

E.SE.03.13 Recognize and describe different types of earth materials (mineral, rock, clay, boulder, gravel, sand, soil).
E.SE.03.14 Recognize that rocks are made up of minerals.

E.SE.E.2 Surface Changes- The surface of Earth changes. Some changes are due to slow processes, such as erosion and weathering, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

E.SE.03.22 Identify and describe natural causes of change in the Earth's surface (erosion, glaciers, volcanoes, landslides, and earthquakes).

E.SE.E.3 Using Earth Materials- Some Earth materials have properties that make them useful either in their present form or designed and modified to solve human problems. They can enhance the quality of life as in the case of materials used for building or fuels used for heating and transportation.

E.SE.03.31 Identify Earth materials used to construct some common objects (for example: bricks, buildings, roads, glass).
E.SE.03.32 Describe how materials taken from the Earth can be used as fuels for heating and transportation.

FOURTH GRADE SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

4 SCIENCE

Draft v.10.07

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 Scholar Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006) which had 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.

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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

Within 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.

Elementary (K-4) Science Organizational Structure

Discipline 1 Science Processes	Discipline 2 Physical Science	Discipline 3 Life Science	Discipline 4 Earth Science
Standards and Statements *(and number of Content Expectations in each Statement)*			
Inquiry Process (IP) **Inquiry Analysis and Communication (IA)** **Reflection and Social Implications (RS)**	**Force and Motion (FM)** Position (2) Gravity (2) Force (8) Speed (3) **Energy (EN)** Forms of Energy (2) Light Properties (2) Sound (2) Energy and Temperature (3) Electrical Circuits (2) **Properties of Matter (PM)** Physical Properties (8) States of Matter (3) Magnets (4) Material Composition (1) Conductive and Reflective Properties (3) **Changes in Matter (CM)** Changes in State (1)	**Organization of Living Things (OL)** Life Requirements (6) Life Cycles (2) Structures and Functions (2) Classification (2) **Heredity (HE)** Observable Characteristics (3) **Evolution (EV)** Environmental Adaptation (2) Survival (2) **Ecosystems (EC)** Interactions (1) Changed Environment Effects (1)	**Earth Systems (ES)** Solar Energy (2) Weather (4) Weather Measurement (2) Natural Resources (4) Human Impact (2) **Solid Earth (SE)** Earth Materials (4) Surface Chages (2) Using Earth Materials (2) **Fluid Earth (FE)** Water (4) Water Movement (2) **Earth in Space and Time (ST)** Characteristics of Objects in the Sky (2) Patterns of Objects in the Sky (5) Fossils (2)

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

As students enter the fourth grade, they have developed their skills in observation, measurement, data collection and analysis, real-world application, and finally presentations of their findings to others. New science processes are not introduced at this level, but it is the intent of the expectations to provide content in which the students can practice and apply their inquiry skills as a process of testing their ideas and logically use evidence to formulate explanations.

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

Students enter the fourth grade with prior knowledge regarding energy in the context of sound and light as examples of energy. Heat and electricity are introduced as additional forms of energy, as well as describing energy in terms of evidence of change or transfer. Students have intuitive notions that energy is necessary to get things done and that humans get energy from food. Children are not expected to understand the complex concept of energy at this level. By experimenting with light and sound (third grade) and heat, electricity and magnetism in fourth grade, students begin to recognize evidence of energy through observation and measurement of change. Through multiple experiences with simple electrical circuits, heat transfer, and magnetism, students make simple correlations and describe how heat is produced through electricity, identify conductors of heat and electricity, and explain the conditions necessary to make an electromagnet.

The content expectations for physical science conclude with the study of properties of matter that can be measured and observed, states of matter, and changes in states of matter through heating and cooling.

Life Science: Organization of Living Things, Evolution, and Ecosystems

The role of different organisms and the flow of energy within an ecosystem is the main concept in fourth grade life science. Students explore the life requirements of living organisms and their source of energy for growth and repair. In their investigations, students study individual differences in organisms of the same kind and identify how those differences of organisms may give them an advantage for survival and reproduction. Students conclude their elementary life science exploration by investigating food chains or webs and how environmental changes can produce a change in the food web and species survival.

Earth Science: Earth in Space and Time

The identification and comparison of common objects in the sky begins the study of Earth in space. Through long term observations of the sun and moon, students identify patterns in movement and collect data to summarize information regarding the orbit of the Earth around the sun, and the moon around the Earth. Models and activities provide the tools to demonstrate the orbits and explain the predictable cycle of one month in the phases of the moon, and day and night as the apparent movement of the sun and moon across the sky.

Students explore the history of the Earth through evidence from fossils and compare fossils of life forms with organisms that exist today.

The underlying theme within the physical, life, and Earth science is energy and specifically energy from the sun. Students can make connections between the heat and light energy from the sun and the dependency of all living things on the sun.

Fourth 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 (7)

Discipline 2: Physical Science (P)

Standard: **Energy (EN)**
Forms of Energy (1)
Energy and Temperature (3)
Electrical Circuits (2)

Standard: Properties of Matter (PM)
Physical Properties (3)
States of Matter (1)
Magnets (2)
Conductive and Reflective Properties (1)

Standard: **Changes in Matter (CM)**
Changes in State (1)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Life Requirements (2)

Standard: **Evolution (EV)**
Survival (2)

Standard: **Ecosystems (EC)**
Interactions (1)
Changed Environment Effects (1)

Discipline 4: Earth Science (E)

Standard: **Earth in Space and Time (ST)**
Characteristics of Objects in the Sky (2)
Patterns of Objects in the Sky (5)
Fossils (2)

SCIENCE PROCESSES

Inquiry Process

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

S.IP.04.11 Make purposeful observation of the natural world using the appropriate senses.
S.IP.04.12 Generate questions based on observations.
S.IP.04.13 Plan and conduct simple and fair investigations.
S.IP.04.14 Manipulate simple tools that aid observation and data collection (for example: hand lens, balance, ruler, meter stick, measuring cup, thermometer, spring scale, stop watch/timer, graduated cylinder/beaker).
S.IP.04.15 Make accurate measurements with appropriate units (millimeters centimeters, meters, milliliters, liters, Celsius, grams, seconds, minutes) for the measurement tool.
S.IP.04.16 Construct simple charts and graphs from data and observations.

Inquiry Analysis and Communication

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

S.IA.04.11 Summarize information from charts and graphs to answer scientific questions.
S.IA.04.12 Share ideas about science through purposeful conversation in collaborative groups.
S.IA.04.13 Communicate and present findings of observations and investigations.
S.IA.04.14 Develop research strategies and skills for information gathering and problem solving.
S.IA.04.15 Compare and contrast sets of data from multiple trials of a science investigation to explain reasons for differences.

Reflection and Social Implications

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

S.RS.04.11 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.04.14 Use data/samples as evidence to separate fact from opinion.
S.RS.04.15 Use evidence when communicating scientific ideas.
S.RS.04.16 Identify technology used in everyday life.
S.RS.04.17 Identify current problems that may be solved through the use of technology.
S.RS.04.18 Describe the effect humans and other organisms have on the balance of the natural world.
S.RS.04.19 Describe how people have contributed to science throughout history and across cultures.

P.EN.E.1 Forms of Energy- Heat, electricity, light, and sound are forms of energy.

P.EN.04.12 Identify heat and electricity as forms of energy.

P.EN.E.4 Energy and Temperature- Increasing the temperature of any substance requires the addition of energy.

P.EN.04.41 Demonstrate how temperature can be increased in a substance by adding energy.
P.EN.04.42 Describe heat as the energy produced when substances burn, certain kinds of materials rub against each other, and when electricity flows through wire.
P.EN.04.43 Describe how heat is produced through electricity, rubbing, and burning.

P.EN.E.5 Electrical Circuits- Electrical circuits transfer electrical energy and produce magnetic fields.

P.EN.04.51 Explain how electrical energy is transferred and changed through the use of a simple circuit.
P.EN.04.52 Create a simple working electromagnet and explain the conditions necessary to make the electromagnet.

Properties of Matter

P.PM.E.1 Physical Properties- All objects and substances have physical properties that can be measured.

P.PM.04.16 Measure the weight (spring scale) and mass (balances in grams or kilograms) of objects.
P.PM.04.17 Measure volumes of liquids and capacities of containers in milliliters and liters.
P.PM.04.18 Demonstrate the use of centimeter cubes poured into a container to estimate the container's capacity.

P.PM.E.2 States of Matter- Matter exists in several different states: solids, liquids, and gases. Each state of matter has unique physical properties. Gases are easily compressed, but liquids and solids do not compress easily. Solids have their own particular shapes, but liquids and gases take the shape of the container.

P.PM.04.23 Compare and contrast the states (solids, liquids, gases) of matter.

P.PM.E.3 Magnets- Magnets can repel or attract other magnets. Magnets can also attract certain non-magnetic objects at a distance.

P.PM.04.33 Demonstrate magnetic field by observing the patterns formed with iron filings using a variety of magnets.

P.PM.04.34 Demonstrate why non-magnetic objects are affected by the strength of the magnet and the distance away from the magnet.

P.PM.E.5 Conductive and Reflective Properties- Objects vary to the extent they absorb and reflect light energy and conduct heat and electricity.

P.PM.04.53 Identify objects that are good conductors or poor conductors of heat and electricity.

Changes in Matter

P.CM.E.1 Changes in State- Matter can be changed from one state (liquid, solid, gas) to another and then back again. This may be caused by heating and cooling.

P.CM.04.11 Explain how matter can change from one state (liquid, solid, gas) to another by heating and cooling.

LIFE SCIENCE

Organization of Living Things

L.OL.E.1 Life Requirements- Organisms have basic needs. Animals and plants need air, water, and a source of energy. Plants also require light. Plants and animals require a source of energy and building material for growth and repair.

L.OL.04.15 Determine that plants require air, water, light, and a source of energy and building material for growth and repair.

L.OL.04.16 Determine that animals require air, water, and a source of energy and building material for growth and repair.

Evolution

L.EV.E.2 Survival- Individuals of the same kind differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing.

L.EV.04.21 Identify individual differences (for example: color, leg length, size, wing size) in organisms of the same kind.

L.EV.04.22 Identify how variations in physical characteristics of individual organisms give them an advantage for survival and reproduction.

Ecosystems

L.EC.E.1 Interactions- Organisms interact in various ways including providing food and shelter to one another. Some interactions are helpful: others are harmful to the organism and other organisms.

L.EC.04.11 Identify organisms as part of a food chain or food web.

L.EC.E.2 Changed Environment Effects- When the environment changes, some plants and animals survive to reproduce; others die or move to new locations.

L.EC.04.21 Explain how environmental changes can produce a change in the food web.

EARTH SCIENCE

Earth in Space and Time

E.ST.E.1 Characteristics of Objects in the Sky- Common objects in the sky have observable characteristics.

E.ST.04.11 Identify common objects in the sky, such as the sun and the moon.

E.ST.04.12 Compare and contrast the characteristics of the sun, moon and Earth, including relative distances and abilities to support life.

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E.ST.E.2 Patterns of Objects in the Sky- Common objects in the sky have observable characteristics and predictable patterns of movement.

E.ST.04.21 Describe the orbit of the Earth around the sun as it defines a year.

E.ST.04.22 Explain that the spin of the Earth creates day and night.

E.ST.04.23 Describe the motion of the moon around the Earth.

E.ST.04.24 Explain how the visible shape of the moon follows a predictable cycle which takes approximately one month.

E.ST.04.25 Describe the apparent movement of the sun and moon across the sky through day/night and the seasons.

E.ST.E.3 Fossils- Fossils provide evidence about the plants and animals that lived long ago and the nature of the environment at that time.

E.ST.04.31 Explain how fossils provide evidence of the history of the Earth.

E.ST.04.32 Compare and contrast life forms found in fossils and organisms that exist today.

FIFTH GRADE SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

5 SCIENCE

Draft v.10.07

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

SCIENCE PROCESSES

PHYSICAL SCIENCE

LIFE SCIENCE

EARTH SCIENCE

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Development

In developing these expectations, the Scholar Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006) which had 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:

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Within 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.

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 *(and number of Content Expectations in each Statement)*			
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 (1) Biotic and Abiotoc 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 science processes in middle school expand the students' inquiry abilities from simply raising questions based on observations, to generating scientific questions based on observations, investigations, and research. Students begin to recognize the question they are asking, the background knowledge that framed the question, and what steps they take to answer their question. Fifth grade students will design and conduct their own scientific investigations, with consideration of fair tests, variables, and multiple trials and sets of data. Students are expected to use data and research in their analysis and evaluation of data, claims, and information, and relate their findings to different situations and real-world problems. The instructional activities of a scientific inquiry should involve students in establishing and refining procedures, materials, and data they will collect. It is crucial for students to recognize the benefit of cooperating with their peers and sharing data and experiences through collaborative science discourse.

Physical Science: Forces and Motion

Students participate in an in-depth study of motion as related to a point of reference, distance, time, and direction. Their exploration into motion also presents high interest content for students to hone their skills in metric measurement and the use of tools and equipment appropriate to scientific investigations. The middle school experience of investigating balanced and unbalanced forces, and their relationship to the size of change in motion, provide concrete experiences on which a more comprehensive understanding of force can be based at the high school level. Students can move from qualitative descriptions of moving objects in the elementary to quantitative descriptions of moving objects and the identification of the forces acting on the objects.

The completion of the study in motion involves the exploration and identification of contact and non-contact forces and how they change the motion of objects. Students' everyday experiences in motion lead them to believe that friction causes all moving objects to slow down and stop. In-depth explorations into reducing the force of friction can help the students understand and demonstrate that a moving object requires friction to keep it moving. The understanding of objects at rest requires the students recognize that there are balanced forces in equilibrium, such as a book on a table or chair on the floor.

Life Science: Organization of Living Things, Heredity, Evolution

Fifth grade presents an appropriate time for introducing the study of human biology. Students develop an understanding of the main function of specialized animal systems (digestive, circulatory, respiratory, skeletal, muscular, nervous, excretory, and reproductive) and how animal systems work together to perform life's activities.

Students explore the traits of individuals and examine how traits are influenced by the environment and genetics of the individual. They distinguish between acquired and inherited traits of humans as well as other living things.

Further study of organisms' individual traits demonstrates how behavioral and physical characteristics help them survive in their environments. In the investigation of physical characteristics, students relate similarities in anatomical features to the classification of contemporary organisms.

Students conclude their investigations into animal characteristics and evidence of change by analyzing the relationship of environmental change and catastrophic events to species extinction and survival. They explore fossils to provide evidence of previously living things and environmental conditions, and how both have changed over long periods of time.

Earth Science: Earth Systems and Earth in Space and Time

In the fourth grade students were introduced to the relationship between the sun, moon, and Earth. They have a general understanding how the visible shape of the moon defines a month and the spin of the Earth defines a day. Fifth grade students explore seasons and their relationship to the tilt of the Earth on its axis and revolution around the sun. They define a year as one revolution of the Earth around the sun, explain lunar and solar eclipses based on the relative positions of the sun, moon, and Earth and finally, the effect of the moon's gravity on the ocean's tides. Students study the universe beyond the sun, moon, and Earth and describe the position, motion, and relationship of the planets and other objects in the sky to the sun.

Fifth 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 (7)

Discipline 2: Physical Science (P)

Standard: Force and Motion (FM)
Force Interactions (2)
Force (4)
Speed (3)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Animal Systems (2)

Standard: Heredity (HE)
Inherited and Acquired Traits (2)

Standard: **Evolution (EV)**
Species Adaptation and Survival (4)
Relationships Among Organisms (1)

Discipline 4: Earth Science (E)

Standard: Earth Systems (ES)
Seasons (2)

Standard: **Earth in Space and Time (ST)**
Solar System (1)
Solar System Motion (5)

SCIENCE PROCESSES

Inquiry Process

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

S.IP.05.11 Generate scientific questions based on observations, investigations, and research.
S.IP.05.12 Design and conduct scientific investigations.
S.IP.05.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens) appropriate to scientific investigations.
S.IP.05.14 Use metric measurement devices in an investigation.
S.IP.05.15 Construct charts and graphs from data and observations.
S.IP.05.16 Identify patterns in data.

Inquiry Analysis and Communication

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

S.IA.05.11 Analyze information from data tables and graphs to answer scientific questions.
S.IA.05.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.05.13 Communicate and defend findings of observations and investigations using evidence.
S.IA.05.14 Draw conclusions from sets of data from multiple trials of a scientific investigation.
S.IA.05.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

Reflection and Social Implications

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

S.RS.05.11 Evaluate the strengths and weaknesses of claims, arguments, and data.
S.RS.05.12 Describe limitations in personal and scientific knowledge.
S.RS.05.13 Identify the need for evidence in making scientific decisions.
S.RS.05.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.05.16 Design solutions to problems using technology.
S.RS.05.17 Describe the effect humans and other organisms have on the balance in the natural world.
S.RS.05.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

P.FM.M.2 Force Interactions- Some forces between objects act when the objects are in direct contact (touching), such as friction and air resistance, or when they are not in direct contact (not touching), such as magnetic force, electrical force, and gravitational force.

P.FM.05.21 Distinguish between contact forces and non-contact forces.
P.FM.05.22 Demonstrate contact and non-contact forces to change the motion of an object.

P.FM.M.3 Force- Forces have a magnitude and direction. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The speed and/or direction of motion of an object changes when a non-zero net force is applied to it. A balanced force on an object does not change the motion of the object (the object either remains at rest or continues to move at a constant speed in a straight line).

P.FM.05.31 Describe what happens when two forces act on an object in the same or opposing directions.
P.FM.05.32 Describe how constant motion is the result of balanced (zero net) forces.
P.FM.05.33 Describe how changes in the motion of objects are caused by a non-zero net (unbalanced) force.
P.FM.05.34 Relate the size of change in motion to the strength of unbalanced forces and the mass of the object.

P.FM.M.4 Speed- Motion can be described by a change in position relative to a point of reference. The motion of an object can be described by its speed and the direction it is moving. The position and speed of an object can be measured and graphed as a function of time.

P.FM.05.41 Explain the motion of an object relative to its point of reference.
P.FM.05.42 Describe the motion of an object in terms of distance, time and direction, as the object moves, and in relationship to other objects.
P.FM.05.43 Illustrate how motion can be measured and represented on a graph.

LIFE SCIENCE

Organization of Living Things

L.OL.M.4 Animal Systems- Multicellular organisms may have specialized systems that perform functions which serve the needs of the organism.

L.OL.05.41 Identify the general purpose of selected animal systems (digestive, circulatory, respiratory, skeletal, muscular, nervous, excretory, and reproductive).

L.OL.05.42 Explain how animal systems (digestive, circulatory, respiratory, skeletal, muscular, nervous, excretory, and reproductive) work together to perform selected activities.

Heredity

L.HE.M.1 Inherited and Acquired Traits - The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important; for other characteristics, interactions with the environment are more important.

L.HE.05.11 Explain that the traits of an individual are influenced by both the environment and the genetics of the individual.

L.HE.05.12 Distinguish between inherited and acquired traits.

Evolution

L.EV.M.1 Species Adaptation and Survival- Species with certain traits are more likely than others to survive and have offspring in particular environments. When an environment changes, the advantage or disadvantage of the species' characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival.

L.EV.05.11 Explain how behavioral characteristics (adaptation, instinct, learning, habit) of animals help them to survive in their environment.

L.EV.05.12 Describe the physical characteristics (traits) of organisms that help them survive in their environment.

L.EV.05.13 Describe how fossils provide evidence about how living things and environmental conditions have changed.

L.EV.05.14 Analyze the relationship of environmental change and catastrophic events (for example: volcanic eruption, floods, asteroid impacts, tsunami) to species extinction.

L.EV.M.2 Relationships Among Organisms- Similarities among organisms are found in anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.

L.EV.05.21 Relate degree of similarity in anatomical features to the classification of contemporary organisms.

EARTH SCIENCE

Earth Systems

E.ES.M.6 Seasons- Seasons result from annual variations in the intensity of sunlight and length of day due to the tilt of the axis of the Earth relative to the plane of its yearly orbit around the sun.

E.ES.05.61 Demonstrate using a model, seasons as the result of variations in the intensity of sunlight caused by the tilt of the Earth on its axis, and revolution around the sun.

E.ES.05.62 Explain how the revolution of the Earth around the sun defines a year.

Earth in Space and Time

E.ST.M.1 Solar System- The sun is the central and largest body in our solar system. Earth is the third planet from the sun in a system that includes other planets and their moons, as well as smaller objects, such as asteroids and comets.

E.ST.05.11 Design a model that describes the position and relationship of the planets and other objects (comets and asteroids) to the sun.

E.ST.M.2 Solar System Motion- Gravity is the force that keeps most objects in the solar system in regular and predictable motion.

E.ST.05.21 Describe the motion of planets and moons in terms of rotation on axis and orbits due to gravity.

E.ST.05.22 Explain moon phases as they relate to the position of the moon in its orbit around the Earth, resulting in the amount of observable reflected light.

E.ST.05.23 Recognize that nighttime objects (stars and constellations) and the sun appear to move because the Earth rotates on its axis and orbits the sun.

E.ST.05.24 Explain lunar and solar eclipses based on the relative positions of the Earth, moon, and sun, and the orbit of the moon.

E.ST.05.25 Explain the tides of the oceans as they relate to the gravitational pull and orbit of the moon.

SIXTH GRADE SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

6 SCIENCE

Draft v.10.07

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 Scholar Work Group depended heavily on the *Science Framework for the 2009 National Assessment of Educational Progress* (National Assessment Governing Board, 2006) which had 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.

MICHIGAN Department of Education
Office of School Improvement

www.michigan.gov/mde

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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

Within 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.

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 *(and number of Content Expectations in each Statement)*			
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 (1) Biotic and Abiotoc 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

Sixth grade students have had multiple experiences in science inquiry, practice in investigating a question, and the selection of a variety of resources for information gathering and problem solving. Through the grade level science processes, students gain a greater understanding of the nature and structure of scientific knowledge and the process of its development. Throughout the middle school years, students should be provided with the opportunity to engage in full inquiry experiences that include raising a question based on observations, data sets, and/or research, designing an investigation, gathering information through observation and data collection, analyzing and evaluating information, engaging in science discourse, and formally presenting their findings. Sixth grade students need guidance and practice in the identification of variables and controlling more than one variable in an investigation. They need clarification in recognizing the difference between a scientific explanation and evidence.

With appropriate guidance and experiences, sixth grade students can recognize science as a means of gathering information and confirming or challenging their current beliefs about the natural world, the effect humans and other organisms have on the natural world, and begin to design solutions through science and technology to world challenges.

Physical Science: Energy and Changes in Matter

Students enter the sixth grade with the knowledge of different forms of energy (sound, light, heat, electrical, and magnetic). They have had the opportunity to explore properties of sound and light, observe heat transfer, construct a simple circuit, observe the interaction between magnetic and non-magnetic material, and finally make an electro-magnetic motor. Sixth grade students deepen their understanding of energy through investigations into kinetic and potential energy and the demonstration of the transformation of kinetic energy. Through the investigation of energy transfer by radiation, conduction, or convection, students are introduced to the concept that energy can be transferred while no energy is lost or gained. Students begin to see the connections among light, heat, sound, electricity, and magnetism. They gain an understanding that energy is an important property of substances and that most changes observed involve an energy transfer. Students will understand energy by observing multiple forms of energy transfer and begin to dispel the misconception that energy is linked to fuel or something that is stored, ready to use, and gets consumed.

Sixth grade students also build on their understanding of changes in matter by exploring states in terms of the arrangement and motion of atoms and molecules. They are given the opportunity to design investigations that provide evidence that mass is conserved as it changes from state to state.

Life Science: Organization of Living Things and Ecosystems

The study of life science in the elementary curriculum has introduced students to roles organisms play in a food web, their needs to survive, and the physical and behavioral characteristics that help them survive. The elementary student has a beginning understanding of the dependency of organisms on one another and balance in an ecosystem's food web. Sixth grade students build on their prior knowledge by exploring classifications of organisms based on their source of energy (producers, consumers, and decomposers) and distinguish between ways in which organisms obtain energy. The study of ecosystems at this level includes interactions of organisms within populations, communities, and ecosystems including examples in the Great Lakes region. Students recognize patterns in ecosystems and broaden their understanding from the way one species lives in an environment to how populations and communities interact. They explore how populations can be mutually beneficial and how that relationship can lead to interdependency.

The final course of study in ecosystems for the sixth grader includes biotic and abiotic factors in an ecosystem that influence change. Included is the consequence of overpopulation of a species, including humans. Students explore how humans affect change, purposefully and accidentally, and recognize possible consequences for activity and development.

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Earth Science: Solid Earth, Earth in Space and Time

Sixth grade students develop a deeper understanding of the Earth through the exploration of the rock cycle, phenomena that shape the Earth, and Earth's history. In the elementary curriculum, students observed a variety of earth materials and identified different properties that help sustain life. Sixth grade students explore the formation and weathering of rocks and how different soil types are formed. Their knowledge continues through study of movement of lithospheric plates, major geological events, and layers of the earth. Students are introduced to the concept of the Earth as a magnet.

The Earth science curriculum includes a deeper exploration into rocks, rock layers, and fossils. They provide evidence of the history of the Earth and are used to measure geologic time. Fossils provide evidence of how life and environmental conditions have changed over long periods of time.

The concept of energy in the sixth grade curriculum is integral throughout the study in physical, life, and earth science. Students gain a deeper understanding of the concept when encouraged to apply what they know about energy transfer to energy in ecosystems and the rapid and gradual changes on Earth.

Sixth 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)**
Kinetic and Potential Energy (2)
Energy Transfer (2)

Standard: **Changes in Matter (CM)**
Changes in State (2)

Discipline 3: Life Science (L)

Standard: Organization of Living Things (OL)
Producers, Consumers, and Decomposers (2)

Standard: Ecosystems (EC)
Interactions of Organisms (1)
Relationships of Organisms (3)
Biotic and Abiotic Factors (2)
Environmental Impact of Organisms (2)

Discipline 4: Earth Science (E)

Standard: Solid Earth (SE)
Soil (4)
Rock Formation (1)
Plate Tectonics (3)
Magnetic Field of Earth (2)

Standard: **Earth in Space and Time (ST)**
Fossils (1)
Geologic Time (2)

SCIENCE PROCESSES | Inquiry Process

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

S.IP.06.11 Generate scientific questions based on observations, investigations, and research.
S.IP.06.12 Design and conduct scientific investigations.
S.IP.06.13 Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes) appropriate to scientific investigations.
S.IP.06.14 Use metric measurement devices in an investigation.
S.IP.06.15 Construct charts and graphs from data and observations.
S.IP.06.16 Identify patterns in data.

Inquiry Analysis and Communication

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

S.IA.06.11 Analyze information from data tables and graphs to answer scientific questions.
S.IA.06.12 Evaluate data, claims, and personal knowledge through collaborative science discourse.
S.IA.06.13 Communicate and defend findings of observations and investigations using evidence.
S.IA.06.14 Draw conclusions from sets of data from multiple trials of a scientific investigation.
S.IA.06.15 Use multiple sources of information to evaluate strengths and weaknesses of claims, arguments, or data.

Reflection and Social Implications

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

S.RS.06.11 Evaluate the strengths and weaknesses of claims, arguments, and data.
S.RS.06.12 Describe limitations in personal and scientific knowledge.
S.RS.06.13 Identify the need for evidence in making scientific decisions.
S.RS.06.14 Evaluate scientific explanations based on current evidence and scientific principles.
S.RS.06.15 Demonstrate scientific concepts through various illustrations, performances, models, exhibits, and activities.
S.RS.06.16 Design solutions to problems using technology.
S.RS.06.17 Describe the effect humans and other organisms have on the balance of the natural world.
S.RS.06.18 Describe what science and technology can and cannot reasonably contribute to society.
S.RS.06.19 Describe how science and technology have advanced because of the contributions of many people throughout history and across cultures.

P.EN.M.1 Kinetic and Potential Energy- Objects and substances in motion have kinetic energy. Objects and substances may have potential energy due to their relative positions in a system. Gravitational, elastic, and chemical energy are all forms of potential energy.

P.EN.06.11 Identify kinetic or potential energy in everyday situations (for example: stretched rubber band, objects in motion, ball on a hill, food energy).

P.EN.06.12 Demonstrate the transformation between potential and kinetic energy in simple mechanical systems (for example: roller coasters, pendulums).

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 a source to a receiver, the quantity of energy before the transfer is equal to the quantity of energy after the transfer.

P.EN.06.41 Explain how different forms of energy can be transferred from one place to another by radiation, conduction, or convection.

P.EN.06.42 Illustrate how energy can be transferred while no energy is lost or gained in the transfer.

Changes in Matter

P.CM.M.1 Changes in State- Matter changing from state to state can be explained by using models which show that matter is composed of tiny particles in motion. When changes of state occur, the atoms and/or molecules are not changed in structure. When the changes in state occur, mass is conserved because matter is not created or destroyed.

P.CM.06.11 Describe and illustrate changes in state, in terms of the arrangement and relative motion of the atoms or molecules.

P.CM.06.12 Explain how mass is conserved as it changes from state to state in a closed system.

L.OL.M.5 Producers, Consumers, and Decomposers- All animals, including humans, are consumers that meet their energy by eating other organisms or their products. Consumers break down the structures of the organisms they eat to make the materials they need to grow and function. Decomposers, including bacteria and fungi, use dead organisms or their products to meet their energy needs.

L.OL.06.51 Classify organisms (producers, consumers, and decomposers) based on their source of energy for growth and development.

L.OL.06.52 Distinguish between the ways in which consumers and decomposers obtain energy.

Ecosystems

L.EC.M.1 Interactions of Organisms- Organisms of one species form a population. Populations of different organisms interact and form communities. Living communities and nonliving factors that interact with them form ecosystems.

L.EC.06.11 List examples of populations, communities, and ecosystems including the Great Lakes region.

L.EC.M.2 Relationships of Organisms- Two types of organisms may interact with one another in several ways: They may be in a producer/consumer, predator/prey, or parasite/host relationship. Some organisms may scavenge or decompose another. Relationships may be competitive or mutually beneficial. Some species have become so adapted to each other that neither could survive without the other.

L.EC.06.21 Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).

L.EC.06.22 Explain how two populations of organisms can be mutually beneficial and how that can lead to interdependency.

L.EC.06.23 Predict how changes in one population might affect other populations based upon their relationships in the food web.

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L.EC.M.3 Biotic and Abiotic Factors- The number of organisms and populations an ecosystem can support depends on the biotic (living) resources available and abiotic (nonliving) factors, such as quality of light and water, range of temperatures and soil composition.

L.EC.06.31 Identify the living (biotic) and nonliving (abiotic) components of an ecosystem.

L.EC.06.32 Identify the factors in an ecosystem that influence changes in population size.

L.EC.M.4 Environmental Impact of Organisms- All organisms (including humans) cause change in the environment where they live. Some of the changes are harmful to the organism or other organisms, whereas others are helpful.

L.EC.06.41 Describe how human beings are part of the ecosystem of the Earth and that human activity can purposefully, or accidentally, alter the balance in ecosystems.

L.EC.06.42 Predict possible consequences of overpopulation of organisms, including humans, (for example: species extinction, resource depletion, climate change, pollution).

EARTH SCIENCE — Solid Earth

E.SE.M.1 Soil- Soils consist of weathered rocks and decomposed organic materials from dead plants, animals, and bacteria. Soils are often found in layers with each having a different chemical composition and texture.

E.SE.06.11 Explain how physical and chemical weathering lead to erosion and the formation of soils and sediments.

E.SE.06.12 Explain how waves, wind, water, and glacier movement, shape and reshape the land surface of the Earth by eroding rock in some areas and depositing sediments in other areas.

E.SE.06.13 Describe how soil is a mixture, made up of weather eroded rock and decomposed organic material.

E.SE.06.14 Compare different soil samples based on particle size and texture.

E.SE.M.4 Rock Formation- Rocks and rock formations bear evidence of the minerals, materials, temperature/pressure conditions, and forces that created them.

E.SE.06.41 Compare and contrast the formation of rock types (igneous, metamorphic, and sedimentary) and demonstrate the similarities and differences using the rock cycle model.

E.SE.M.5 Plate Tectonics- The lithospheric plates of the Earth constantly move, resulting in major geological events, such as earthquakes, volcanic eruptions, and mountain building.

E.SE.06.51 Explain plate tectonic movement and how the lithospheric plates move centimeters each year.
E.SE.06.52 Demonstrate how major geological events (earthquakes, volcanic eruptions, mountain building) result from these plate motions.
E.SE.06.53 Describe layers of the Earth as a lithosphere (crust and upper mantle), convecting mantle, and dense metallic core.

E.SE.M.6 Magnetic Field of Earth- Earth as a whole has a magnetic field that is detectable at the surface with a compass.

E.SE.06.61 Describe the Earth as a magnet and compare the magnetic properties of the Earth to that of a natural or man-made magnet.
E.SE.06.62 Explain how a compass works using the magnetic field of the Earth, and how a compass is used for navigation on land and sea.

Earth in Space and Time

E.ST.M.3 Fossils- Fossils provide important evidence of how life and environmental conditions have changed in a given location.

E.ST.06.31 Explain how rocks and fossils are used to understand the age and geological history of the earth (timelines and relative dating, rock layers).

E.ST.M.4 Geologic Time- Earth processes seen today (erosion, mountain building, and glacier movement) make possible the measurement of geologic time through methods such as observing rock sequences and using fossils to correlate the sequences at various locations.

E.ST.06.41 Explain how Earth processes (erosion, mountain building, and glacier movement) are used for the measurement of geologic time through observing rock layers.
E.ST.06.42 Describe how fossils provide important evidence of how life and environmental conditions have changed.

SEVENTH GRADE SCIENCE

GRADE LEVEL CONTENT EXPECTATIONS

7 SCIENCE

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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 learner 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 multi-cellular 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)

SCIENCE PROCESSES

Inquiry Process

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

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

S.RS.M.1 Reflecting knowledge is the application of scientific knowledge to new and different situations. Reflecting 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.

Energy

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 a source to a receiver, 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.

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

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, acid-base indicators, 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, salt).

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

Changes in Matter

P.CM.M.2 Chemical Changes- Chemical changes occur when two elements and/or compounds react and 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.

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 an embryo.

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.

Heredity

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

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

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.