Text of Proposed Amendments to 19 TAC

Chapter 112. Texas Essential Knowledge and Skills for Science

Subchapter A. Elementary

§112.10. Implementation of Texas Essential Knowledge and Skills for Science, Elementary, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

The provisions of §§112.11-112.16 of this subchapter shall be implemented by school districts beginning with the **2018-2019** [~~**2017-2018**~~] [~~2010-2011~~] school year.

§112.11. Science, Kindergarten, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

(1) In Kindergarten, students observe and describe the natural world using their senses. Students do science as inquiry in order to develop and enrich their abilities to understand scientific concepts and processes. Students develop vocabulary through their experiences investigating properties of common objects, earth materials, and organisms.

(A) A central theme throughout the study of scientific investigation and reasoning; matter and energy; force, motion, and energy; Earth and space; and organisms and environment is active engagement in asking questions, **creating a method to answer those questions, answering those questions,** communicating ideas, and exploring with scientific tools. Scientific investigation and reasoning involves practicing safe procedures, asking questions about the natural world, and seeking answers to those questions through simple observations **used in** [~~**and**~~] descriptive investigations.

(B) Matter is described in terms of its physical properties, including relative size, **weight,** shape, color, and texture. The importance of light, **thermal** [~~**heat**~~] , and sound energy is identified as it relates to the students' everyday life. The location and motion of objects are explored.

(C) Weather is recorded and discussed on a daily basis so students may begin to recognize patterns in the weather. Other patterns are observed in the appearance of objects in the sky.

(D) In life science, students recognize the interdependence of organisms in the natural world. They understand that all organisms have basic needs that can be satisfied through interactions with living and nonliving things. Students will investigate the life cycle of plants and identify likenesses between parents and offspring.

(2) [~~(1)~~] Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."

(3) [~~(2)~~] Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

(4) [~~(3)~~] The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 80% of instructional time.

(5) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

[~~(4) In Kindergarten, students observe and describe the natural world using their five senses. Students do science as inquiry in order to develop and enrich their abilities to understand scientific concepts and processes. Students develop vocabulary through their experiences investigating properties of common objects, earth materials, and organisms.~~]

[~~(A) A central theme throughout the study of scientific investigation and reasoning; matter and energy; force, motion, and energy; Earth and space; and organisms and environment is active engagement in asking questions, communicating ideas, and exploring with scientific tools. Scientific investigation and reasoning~~

~~involves practicing safe procedures, asking questions about the natural world, and seeking answers to those questions through simple observations and descriptive investigations.~~]

[~~(B) Matter is described in terms of its physical properties, including relative size and mass, shape, color, and texture. The importance of light, heat, and sound energy is identified as it relates to the students' everyday life. The location and motion of objects are explored.~~]

[~~(C) Weather is recorded and discussed on a daily basis so students may begin to recognize patterns in the weather. Other patterns are observed in the appearance of objects in the sky.~~]

[~~(D) In life science, students recognize the interdependence of organisms in the natural world. They understand that all organisms have basic needs that can be satisfied through interactions with living and nonliving things. Students will investigate the life cycle of plants and identify likenesses between parents and offspring.~~]

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and uses environmentally appropriate and responsible practices. The student is expected to:

(A) identify , discuss, and demonstrate safe and healthy practices as outlined [~~described~~] in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] during classroom and outdoor investigations, including wearing safety goggles or chemical splash goggles, as appropriate , washing hands, and using materials appropriately; and

[~~(B) discuss the importance of safe practices to keep self and others safe and healthy; and~~]

(B) [~~(C)~~] demonstrate how to use, conserve, and dispose of natural resources and materials such as conserving water and reusing or recycling paper, plastic, and metal.

(2) Scientific investigation and reasoning. The student develops abilities to ask questions and seek answers in classroom and outdoor investigations. The student is expected to:

(A) ask questions about organisms, objects, and events observed in the natural world;

(B) plan and conduct simple descriptive investigations [~~such as ways objects move~~] ;

(C) collect data and make observations using simple [~~equipment such as hand lenses, primary balances, and non-standard measurement~~] tools;

(D) record and organize data and observations using pictures, numbers, and words; and

(E) communicate observations [~~with others~~] about simple descriptive investigations.

(3) Scientific investigation and reasoning. The student knows that information and critical thinking are used in scientific problem solving. The student is expected to:

(A) identify and explain a problem such as the impact of littering [~~on the playground~~] and propose a solution [~~in his/her own words~~] ;

(B) make predictions based on observable patterns in nature [~~such as the shapes of leaves~~] ; and

(C) explore that scientists investigate different things in the natural world and use tools to help in their investigations.

(4) Scientific investigation and reasoning. The student uses age-appropriate tools and models to investigate the natural world. The student is expected to:

(A) collect information using tools, including **computing devices** [~~**computers**~~] , hand lenses, primary balances, cups, bowls, magnets, collecting nets, and notebooks; timing devices [~~, including clocks and timers~~] ; non-standard measuring items [~~such as paper clips and clothespins~~] ; weather instruments such as demonstration thermometers [~~and wind socks~~] ; and materials to support observations of habitats of organisms such as terrariums and aquariums; and

(B) use the senses as a tool of observation to identify properties and patterns of organisms, objects, and events in the environment.

(5) Matter and energy. The student knows that objects have properties and patterns. The student is expected to:

(A) observe and record properties of objects, including [~~relative size and mass, such as~~] bigger or smaller , [~~and~~] heavier or lighter, shape, color, and texture; and

(B) observe, record, and discuss how materials can be changed by heating or cooling.

(6) Force, motion, and energy. The student knows that energy, force, and motion are related and are a part of their everyday life. The student is expected to:

(A) use the [~~five~~] senses to explore different forms of energy such as light, **thermal** [~~**heat**~~] , and sound;

(B) explore interactions between magnets and various materials;

(C) observe and describe the location of an object in relation to another such as above, below, behind, in front of, and beside; and

(D) observe and describe the ways that objects can move such as in a straight line, zigzag, up and down, back and forth, round and round, and fast and slow.

(7) Earth and space. The student knows that the natural world includes earth materials. The student is expected to:

(A) observe, describe, [~~compare,~~] and sort rocks by size, shape, color, and texture;

(B) observe and describe physical properties of natural sources of water, including color and clarity; and

(C) give examples of ways rocks, soil, and water are useful.

(8) Earth and space. The student knows that there are recognizable patterns in the natural world and among objects in the sky. The student is expected to:

(A) observe and describe weather changes from day to day and over seasons;

(B) identify events that have repeating patterns, including seasons of the year and day and night; and

(C) observe, describe, and illustrate objects in the sky such as the clouds, Moon, and stars, including the Sun.

(9) Organisms and environments. The student knows that plants and animals have basic needs and depend on the living and nonliving things around them for survival. The student is expected to:

(A) differentiate between living [**~~things, once-living things such as fallen leaves,~~**] and nonliving things based upon whether they have [**~~or have had~~**] basic needs and produce offspring; and

(B) examine evidence that living organisms have basic needs such as food, water, and shelter for animals and air, water, nutrients, sunlight, and space for plants.

(10) Organisms and environments. The student knows that organisms resemble their parents and have structures and processes that help them survive within their environments. The student is expected to:

(A) sort plants and animals into groups based on physical characteristics such as color, size, body covering, or leaf shape;

(B) identify basic parts of plants [~~such as roots, stem, and leaves~~] and [~~parts of~~] animals [~~such as head, eyes, and limbs~~] ;

(C) identify ways that young plants resemble the parent plant; and

(D) observe changes that are part of a simple life cycle of a plant: seed, seedling, plant, flower, and fruit.

§112.12. Science, Grade 1, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

(1) In Grade 1, students observe and describe the natural world using their senses. Students do science as inquiry in order to develop and enrich their abilities to understand the world around them in the context of scientific concepts and processes. Students develop vocabulary through their experiences investigating properties of common objects, earth materials, and organisms.

(A) A central theme in first grade science is active engagement in asking questions, **creating a method to answer those questions, answering those questions,** communicating ideas, and exploring with scientific tools in order to explain scientific concepts and processes like scientific investigation and reasoning; matter and energy; force, motion, and energy; Earth and space; and organisms and environment. Scientific investigation and reasoning involves practicing safe procedures, asking questions about the natural world, and seeking answers to those questions through simple observations **used in** [~~**and**~~] descriptive investigations.

(B) Matter is described in terms of its physical properties, including relative size, **weight,** shape, color, and texture. The importance of light, **thermal** [~~**heat**~~] , and sound energy is identified as it relates to the students' everyday life. The location and motion of objects are explored.

(C) Weather is recorded and discussed on a daily basis so students may begin to recognize patterns in the weather. In addition, patterns are observed in the appearance of objects in the sky.

(D) In life science, students recognize the interdependence of organisms in the natural world. They understand that all organisms have basic needs that can be satisfied through interactions with living and nonliving things. Students will investigate life cycles of animals and identify likenesses between parents and offspring.

(2) [~~(1)~~] Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."

(3) [~~(2)~~] Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

(4) [~~(3)~~] The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 80% of instructional time.

(5) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

[~~(4) In Grade 1, students observe and describe the natural world using their five senses. Students do science as inquiry in order to develop and enrich their abilities to understand the world around them in the context of scientific concepts and processes. Students develop vocabulary through their experiences investigating properties of common objects, earth materials, and organisms.~~]

[~~(A) A central theme in first grade science is active engagement in asking questions, communicating ideas, and exploring with scientific tools in order to explain scientific concepts and processes like scientific investigation and reasoning; matter and energy; force, motion, and energy; Earth and space; and organisms and environment. Scientific investigation and reasoning involves practicing safe procedures, asking questions about the natural world, and seeking answers to those questions through simple observations and descriptive investigations.~~]

[~~(B) Matter is described in terms of its physical properties, including relative size and mass, shape, color, and texture. The importance of light, heat, and sound energy is identified as it relates to the students' everyday life. The location and motion of objects are explored.~~]

[~~(C) Weather is recorded and discussed on a daily basis so students may begin to recognize patterns in the weather. In addition, patterns are observed in the appearance of objects in the sky.~~]

[~~(D) In life science, students recognize the interdependence of organisms in the natural world. They understand that all organisms have basic needs that can be satisfied through interactions with living and nonliving things. Students will investigate life cycles of animals and identify likenesses between parents and offspring.~~]

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and uses environmentally appropriate and responsible practices. The student is expected to:

(A) identify, discuss, [~~recognize~~] and demonstrate safe and healthy practices as outlined [~~described~~] in Texas Education agency-approved safety standards [~~the Texas Safety Standards~~] during classroom and outdoor investigations, including wearing safety goggles or chemical splash goggles, as appropriate , washing hands, and using materials appropriately; and

[~~(B) recognize the importance of safe practices to keep self and others safe and healthy; and~~]

(B) [~~(C)~~] identify and learn how to use natural resources and materials, including conservation and reuse or recycling of paper, plastic, and metals.

(2) Scientific investigation and reasoning. The student develops abilities to ask questions and seek answers in classroom and outdoor investigations. The student is expected to:

(A) ask questions about organisms, objects, and events observed in the natural world;

(B) plan and conduct simple descriptive investigations [~~such as ways objects move~~] ;

(C) collect data and make observations using simple [~~equipment such as hand lenses, primary balances, and non-standard measurement~~] tools;

(D) record and organize data using pictures, numbers, and words; and

(E) communicate observations and provide reasons for explanations using student-generated data from simple descriptive investigations.

(3) Scientific investigation and reasoning. The student knows that information and critical thinking are used in scientific problem solving. The student is expected to:

(A) identify and explain a problem [~~such as finding a home for a classroom pet~~] and propose a solution [~~in his/her own words~~] ;

(B) make predictions based on observable patterns; and

(C) describe what scientists do.

(4) Scientific investigation and reasoning. The student uses age-appropriate tools and models to investigate the natural world. The student is expected to:

(A) collect, record, and compare information using tools, including computers, hand lenses, primary balances, cups, bowls, magnets, collecting nets, notebooks, and safety goggles or chemical splash goggles, as appropriate ; timing devices [~~,~~ ~~including clocks and timers~~] ; non-standard measuring items [~~such as paper clips and clothespins~~] ; weather instruments such as [~~classroom~~] demonstration thermometers and wind socks; and materials to support observations of habitats of organisms such as aquariums and terrariums; and

(B) measure and compare organisms and objects using non-standard units.

(5) Matter and energy. The student knows that objects have properties and patterns. The student is expected to:

(A) classify objects by observable properties [~~of the materials from which they are made~~] such as larger and smaller, heavier and lighter, shape, color, **and** [~~and~~] texture [**~~, and the materials from which they are made~~**] ; [**~~and~~**]

(B) predict and identify changes in materials caused by heating and cooling [~~such as ice melting, water freezing, and water evaporating~~] **; and** [~~.~~]

(C) classify objects by the materials from which they are made.

(6) Force, motion, and energy. The student knows that force, motion, and energy are related and are a part of everyday life. The student is expected to:

(A) identify and discuss how different forms of energy such as light, **thermal** [**~~heat~~**] , and sound are important to everyday life;

(B) predict and describe how a magnet can be used to push or pull an object; and

[~~(C) describe the change in the location of an object such as closer to, nearer to, and farther from; and~~]

(C) [~~(D)~~] demonstrate and record the ways that objects can move **such as in a straight line, zig zag, up and down, back and forth, round and round, and fast and slow** [~~such as in a straight line, zig zag, up and down, back and forth, round and round, and fast and slow~~] .

(7) Earth and space. The student knows that the natural world includes rocks, soil, and water that can be observed in cycles, patterns, and systems. The student is expected to:

(A) observe, compare, describe, and sort components of soil by size, texture, and color;

(B) identify and describe a variety of natural sources of water, including streams, lakes, and oceans; and

(C) identify [~~gather evidence of~~] how rocks, soil, and water are used [~~help~~] to make [~~useful~~] products.

(8) Earth and space. The student knows that the natural world includes the air around us and objects in the sky. The student is expected to:

(A) record weather information, including relative temperature [~~,~~] such as hot or cold, clear or cloudy, calm or windy, and rainy or icy;

(B) observe and record changes in the appearance of objects in the sky such as [~~clouds,~~] the Moon [~~,~~] and stars, including the Sun;

(C) identify characteristics of the seasons of the year and day and night; and

(D) demonstrate that air is all around us and observe that wind is moving air.

(9) Organisms and environments. The student knows that the living environment is composed of relationships between organisms and the life cycles that occur. The student is expected to:

(A) sort and classify living [~~**, once living,**~~] and nonliving things based upon whether [~~or not~~] they have [~~**or have had**~~] basic needs and produce offspring;

(B) analyze and record examples of interdependence found in various situations such as terrariums and aquariums or pet and caregiver; and

(C) gather evidence of interdependence among living organisms such as energy transfer through food chains or [~~and~~] animals using plants for shelter.

(10) Organisms and environments. The student knows that organisms resemble their parents and have structures and processes that help them survive within their environments. The student is expected to:

(A) investigate how the external characteristics of an animal are related to where it lives, how it moves, and what it eats;

(B) identify and compare the parts of plants;

(C) compare ways that young animals resemble their parents; and

(D) observe and record life cycles of animals such as a chicken, frog, or fish.

§112.13. Science, Grade 2, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

(1) In Grade 2, careful observation and investigation are used to learn about the natural world and reveal patterns, changes, and cycles. Students should understand that certain types of questions can be answered by using observation and investigations and that the information gathered in these investigations may change as new observations are made. As students participate in investigation, they develop the skills necessary to do science as well as develop new science concepts.

(A) A central theme throughout the study of scientific investigation and reasoning; matter and energy; force, motion, and energy; Earth and space; and organisms and environment is active engagement in asking questions, **creating a method to answer those questions, answering those questions,** communicating ideas, and exploring with scientific tools. Scientific investigation and reasoning involves practicing safe procedures, asking questions about the natural world, and seeking answers to those questions through simple observations **used in** [~~**and**~~] descriptive investigations.

(B) Within the physical environment, students expand their understanding of the properties of objects such as temperature **, shape,** and flexibility then use those properties to compare, classify, and then combine the objects to do something that they could not do before. Students manipulate objects to demonstrate a change in motion and position.

(C) Within the natural environment, students will observe the properties of earth materials as well as predictable patterns that occur on Earth and in the sky. The students understand that those patterns are used to make choices in clothing, activities, and transportation.

(D) Within the living environment, students explore patterns, systems, and cycles by investigating characteristics of organisms, life cycles, and interactions among all the components within their habitat. Students examine how living organisms depend on each other and on their environment.

(2) [~~(1)~~] Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."

(3) [~~(2)~~] Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

(4) [~~(3)~~] The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 60% of instructional time.

(5) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

[~~(4) In Grade 2, careful observation and investigation are used to learn about the natural world and reveal patterns, changes, and cycles. Students should understand that certain types of questions can be answered by using observation and investigations and that the information gathered in these may change as new observations are made. As~~

~~students participate in investigation, they develop the skills necessary to do science as well as develop new science concepts.~~]

[~~(A) Within the physical environment, students expand their understanding of the properties of objects such as shape, mass, temperature, and flexibility then use those properties to compare, classify, and then combine the objects to do something that they could not do before. Students manipulate objects to demonstrate a change in motion and position.~~]

[~~(B) Within the natural environment, students will observe the properties of earth materials as well as predictable patterns that occur on Earth and in the sky. The students understand that those patterns are used to make choices in clothing, activities, and transportation.~~]

[~~(C) Within the living environment, students explore patterns, systems, and cycles by investigating characteristics of organisms, life cycles, and interactions among all the components within their habitat. Students examine how living organisms depend on each other and on their environment.~~]

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures. The student is expected to:

(A) identify , describe, and demonstrate safe practices as outlined [~~described~~] in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] during classroom and outdoor investigations, including wearing safety goggles or chemical splash goggles, as appropriate , washing hands, and using materials appropriately; and

[~~(B) describe the importance of safe practices; and~~]

(B) [~~(C)~~] identify and demonstrate how to use, conserve, and dispose of natural resources and materials such as conserving water and reuse or recycling of paper, plastic, and metal.

(2) Scientific investigation and reasoning. The student develops abilities necessary to do scientific inquiry in classroom and outdoor investigations. The student is expected to:

(A) ask questions about organisms, objects, and events during observations and investigations;

(B) plan and conduct descriptive investigations [~~such as how organisms grow~~] ;

(C) collect data from observations using scientific [~~simple equipment such as hand lenses, primary balances, thermometers, and non-standard measurement~~] tools;

(D) record and organize data using pictures, numbers, and words;

(E) communicate observations and justify explanations using student-generated data from simple descriptive investigations; and

(F) compare results of investigations with what students and scientists know about the world.

(3) Scientific investigation and reasoning. The student knows that information and critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to:

(A) identify and explain a problem [~~in his/her own words~~] and propose a task and solution for the problem [~~such as lack of water in a habitat~~] ;

(B) make predictions based on observable patterns; and

(C) identify what a scientist is and explore what different scientists do.

(4) Scientific investigation and reasoning. The student uses age-appropriate tools and models to investigate the natural world. The student is expected to:

(A) collect, record, and compare information using tools, including computers, hand lenses, rulers, [~~**primary balances,**~~] plastic beakers, magnets, collecting nets, notebooks, and safety goggles or chemical splash goggles, as appropriate ; timing devices [~~, including clocks and stopwatches~~] ; weather instruments such as thermometers, wind vanes, and rain gauges; and materials to support observations of habitats of organisms such as terrariums and aquariums; and

(B) measure and compare organisms and objects [~~using non-standard units that approximate metric units~~] .

(5) Matter and energy. The student knows that matter has physical properties and those properties determine how it is described, classified, changed, and used. The student is expected to:

(A) classify matter by physical properties, including [~~shape, relative mass,~~] relative temperature, texture, flexibility, and whether material is a solid or liquid;

(B) compare changes in materials caused by heating and cooling;

(C) demonstrate that things can be done to materials such as cutting, folding, sanding, and melting to change their physical properties [~~such as cutting, folding, sanding, and melting~~] ; and

(D) combine materials that when put together can do things that they cannot do by themselves such as building a tower or a bridge and justify the selection of those materials based on their physical properties.

(6) Force, motion, and energy. The student knows that forces cause change and energy exists in many forms. The student is expected to:

(A) investigate the effects on objects [~~an object~~] by increasing or decreasing amounts of light, heat, and sound energy such as how the color of an object appears different in dimmer light or how heat melts butter;

(B) observe and identify how magnets are used in everyday life; and

(C) trace and compare patterns of movement of objects such as sliding, rolling, and spinning [~~the changes in the position of an object~~] over time . [~~such as a cup rolling on the floor and a car rolling down a ramp; and~~]

[~~(D) compare patterns of movement of objects such as sliding, rolling, and spinning.~~]

(7) Earth and space. The student knows that the natural world includes earth materials. The student is expected to:

(A) observe , [~~and~~] describe , and compare rocks by size, texture, and color;

(B) identify and compare the properties of natural sources of freshwater and saltwater; and

(C) distinguish between natural and manmade resources.

(8) Earth and space. The student knows that there are recognizable patterns in the natural world and among objects in the sky. The student is expected to:

(A) measure, record, and graph weather information, including temperature, wind conditions, precipitation, and cloud coverage, in order to identify patterns in the data;

(B) identify the importance of weather and seasonal information to make choices in clothing, activities, and transportation; and

[~~(C) explore the processes in the water cycle, including evaporation, condensation, and precipitation, as connected to weather conditions; and~~]

(C) [~~(D)~~] observe, describe, and record patterns of objects in the sky, including the appearance of the Moon.

(9) Organisms and environments. The student knows that living organisms have basic needs that must be met for them to survive within their environment. The student is expected to:

(A) identify the basic needs of plants and animals;

(B) identify factors in the environment, including temperature and precipitation, that affect growth and behavior such as migration, hibernation, and dormancy of living things; and

(C) compare [~~and give examples of~~] the ways living organisms depend on each other and on their environments such as through food chains [~~within a garden, park, beach, lake, and wooded area~~] .

(10) Organisms and environments. The student knows that organisms resemble their parents and have structures and processes that help them survive within their environments. The student is expected to:

(A) observe, record, and compare how the physical characteristics and behaviors of animals help them meet their basic needs [~~such as fins help fish move and balance in the water~~] ;

(B) observe, record, and compare how the physical characteristics of plants help them meet their basic needs such as stems carry water throughout the plant; and

(C) investigate and record some of the unique stages that insects such as grasshoppers and butterflies undergo during their life cycle.

§112.14. Science, Grade 3, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

(1) In Grade 3, students learn that the study of science uses appropriate tools and safe practices in planning and implementing investigations, asking and answering questions, collecting data by observing and measuring, and using models to support scientific inquiry about the natural world.

(A) Within the physical environment, students recognize that patterns, relationships, and cycles exist in matter. Students will investigate the physical properties of matter and will learn that changes occur. They explore mixtures and investigate light, sound, and thermal energy in everyday life. Students manipulate objects by pushing and pulling to demonstrate changes in motion and position.

(B) Within the natural environment, students investigate how the surface of Earth changes and provides resources that humans use. As students explore objects in the sky, they describe how relationships affect patterns and cycles on Earth. Students will construct models to demonstrate Sun, Earth, and Moon system relationships.

(C) Within the living environment, students explore patterns, systems, and cycles within environments by investigating characteristics of organisms, life cycles, and interactions among all components of the natural environment. Students examine how the environment plays a key role in survival. Students know that when changes in the environment occur organisms may thrive, become ill, or perish.

(2) [~~(1)~~] Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."

(3) [~~(2)~~] Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

(4) [~~(3)~~] The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific **practices** [~~**methods**~~] , analyzing information, making informed decisions, and using tools to collect and record information while addressing the content and vocabulary in physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 60% of instructional time.

(5) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

[~~(4) In Grade 3, students learn that the study of science uses appropriate tools and safe practices in planning and implementing investigations, asking and answering questions, collecting data by observing and measuring, and by using models to support scientific inquiry about the natural world.~~]

[~~(A) Students recognize that patterns, relationships, and cycles exist in matter. Students will investigate the physical properties of matter and will learn that changes occur. They explore mixtures and investigate light, sound, and heat/thermal energy in everyday life. Students manipulate objects by pushing and pulling to demonstrate changes in motion and position.~~]

[~~(B) Students investigate how the surface of Earth changes and provides resources that humans use. As students explore objects in the sky, they describe how relationships affect patterns and cycles on Earth. Students will construct models to demonstrate Sun, Earth, and Moon system relationships and will describe the Sun's role in the water cycle.~~]

[~~(C) Students explore patterns, systems, and cycles within environments by investigating characteristics of organisms, life cycles, and interactions among all components of the natural environment. Students examine how the~~

~~environment plays a key role in survival. Students know that when changes in the environment occur organisms may thrive, become ill, or perish.~~]

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school [~~and home~~] safety procedures and environmentally appropriate practices. The student is expected to:

(A) demonstrate safe practices as described in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] during classroom and outdoor investigations using safety equipment as appropriate, including safety goggles or chemical splash goggles, as appropriate, and gloves [~~, including observing a schoolyard habitat~~] ; and

(B) make informed choices in the use and conservation of natural resources by recycling or reusing materials such as paper, aluminum cans, and plastics.

(2) Scientific investigation and reasoning. The student uses scientific **practices** [~~**inquiry methods**~~] during laboratory and outdoor investigations. The student is expected to:

(A) plan and implement descriptive investigations, including asking and answering questions, making inferences, and selecting and using equipment or technology needed, to solve a specific problem in the natural world;

(B) collect and record data by observing and measuring using the metric system and recognize differences between observed and measured data;

(C) construct maps, graphic organizers, simple tables, charts, and bar graphs using tools and current technology to organize, examine, and evaluate measured data;

(D) analyze and interpret patterns in data to construct reasonable explanations based on evidence from investigations;

(E) demonstrate that repeated investigations may increase the reliability of results; and

(F) communicate valid conclusions supported by data in writing, by drawing pictures, and through verbal discussion.

(3) Scientific investigation and reasoning. The student knows that information, critical thinking, scientific problem solving, and the contributions of scientists are used in making decisions. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using [~~empirical~~] evidence, logical reasoning, and experimental and observational testing [~~, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student~~] ;

[~~(B) draw inferences and evaluate accuracy of product claims found in advertisements and labels such as for toys and food;~~]

(B) [~~(C)~~] represent the natural world using models such as volcanoes or the Sun, Earth, and Moon system and identify their limitations, including size, properties, and materials; and

(C) [~~(D)~~] connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to [:]

[~~(A)~~] collect, record, and analyze information using tools, including [**~~microscopes,~~**] cameras, computers, hand lenses, metric rulers, Celsius thermometers, wind vanes, rain gauges, pan balances, graduated cylinders, beakers, spring scales, hot plates, meter sticks, [~~compasses,~~] magnets, collecting nets, notebooks, [~~sound recorders,~~] and Sun, Earth, and Moon system models; timing devices [~~, including clocks and stopwatches~~] ; and materials to support observation of habitats of organisms such as terrariums and aquariums . [~~; and~~]

[~~(B) use safety equipment as appropriate, including safety goggles and gloves.~~]

(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:

(A) measure, test, and record physical properties of matter, including temperature, mass, magnetism, and the ability to sink or float;

(B) describe and classify samples of matter as solids, liquids, and gases and demonstrate that solids have a definite shape and that liquids and gases take the shape of their container;

(C) predict, observe, and record changes in the state of matter caused by heating or cooling such as ice becoming liquid water **,** [~~**or**~~] condensation forming on the outside of a glass of ice water **, or liquid water being heated to the point of becoming water vapor** ; and

(D) explore and recognize that a mixture is created when two materials are combined such as gravel and sand or [~~and~~] metal and plastic paper clips.

(6) Force, motion, and energy. The student knows that forces cause change and that energy exists in many forms. The student is expected to:

(A) explore different forms of energy, including mechanical, light, sound, and thermal [~~heat/thermal~~] in everyday life;

(B) demonstrate and observe how position and motion can be changed by pushing and pulling objects [~~to show work being done~~] such as swings, balls, [~~pulleys,~~] and wagons; and

(C) observe forces such as magnetism and gravity acting on objects.

(7) Earth and space. The student knows that Earth consists of natural resources and its surface is constantly changing. The student is expected to:

(A) explore and record how soils are formed by weathering of rock and the decomposition of plant and animal remains;

(B) investigate rapid changes in Earth's surface such as volcanic eruptions, earthquakes, and landslides; and

[~~(C) identify and compare different landforms, including mountains, hills, valleys, and plains; and~~]

(C) [~~(D)~~] explore the characteristics of natural resources that make them useful in products and materials such as clothing and furniture and how resources may be conserved.

(8) Earth and space. The student knows there are recognizable patterns in the natural world and among objects in the sky. The student is expected to:

(A) observe, measure, record, and compare day-to-day weather changes in different locations at the same time that include air temperature, wind direction, and precipitation;

(B) describe and illustrate the Sun as a star composed of gases that provides light and **thermal** [~~**heat**~~] energy [~~for the water cycle~~] ;

(C) construct models that demonstrate the relationship of the Sun, Earth, and Moon, including orbits and positions; and

(D) identify the planets in Earth's solar system and their position in relation to the Sun.

(9) Organisms and environments. The student knows [~~that organisms have characteristics that help them survive~~] and can describe patterns, cycles, systems, and relationships within the environments. The student is expected to:

(A) observe and describe the physical characteristics of environments and how they support populations and communities of plants and animals within an ecosystem;

(B) identify and describe the flow of energy in a food chain and predict how changes in a food chain affect the ecosystem such as removal of frogs from a pond or bees from a field; and

(C) describe environmental changes such as floods and droughts where some organisms thrive and others perish or move to new locations.

(10) Organisms and environments. The student knows that organisms undergo similar life processes and have structures that help them survive within their environments. The student is expected to:

(A) explore how structures and functions of plants and animals allow them to survive in a particular environment; and

[~~(B) explore that some characteristics of organisms are inherited such as the number of limbs on an animal or flower color and recognize that some behaviors are learned in response to living in a certain environment such as animals using tools to get food; and~~]

(B) [~~(C)~~] investigate and compare how animals and plants undergo a series of orderly changes in their diverse life cycles such as tomato plants, frogs, and lady **beetles** [~~**bugs**~~] .

§112.15. Science, Grade 4, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

(1) In Grade 4, investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and, based on new discoveries, are constantly being modified to more closely reflect the natural world.

(A) Within the physical environment, students know about the physical properties of matter including mass, volume, states of matter, temperature, magnetism, and the ability to sink or float. Students will differentiate among forms of energy including mechanical, light, sound, and thermal energy. Students will explore electrical circuits and design descriptive investigations to explore the effect of force on objects.

(B) Within the natural environment, students know that earth materials have properties that are constantly changing due to Earth's forces. The students learn that the natural world consists of resources, including renewable and nonrenewable, and their responsibility to conserve our natural resources for future generations. They will also explore Sun, Earth, and Moon relationships. The students will recognize that our major source of energy is the Sun.

(C) Within the living environment, students know and understand that living organisms within an ecosystem interact with one another and with their environment. The students will recognize that plants and animals have basic needs, and they are met through a flow of energy known as food webs. Students will explore how all living organisms go through a life cycle and have structures that enable organisms to survive in their ecosystem.

(2) [~~(1)~~] Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."

(3) [~~(2)~~] Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

(4) [~~(3)~~] The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 50% of instructional time.

(5) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

[~~(4) In Grade 4, investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.~~]

[~~(A) Within the natural environment, students know that earth materials have properties that are constantly changing due to Earth's forces. The students learn that the natural world consists of resources, including renewable and nonrenewable, and their responsibility to conserve our natural resources for~~

~~future generations. They will also explore Sun, Earth, and Moon relationships. The students will recognize that our major source of energy is the Sun.~~]

[~~(B) Within the living environment, students know and understand that living organisms within an ecosystem interact with one another and with their environment. The students will recognize that plants and animals have basic needs, and they are met through a flow of energy known as food webs. Students will explore how all living organisms go through a life cycle and that adaptations enable organisms to survive in their ecosystem.~~]

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations, following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices and the use of safety equipment as described in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] during classroom and outdoor investigations using safety equipment, including safety goggles or chemical splash goggles, as appropriate, and gloves, as appropriate ; and

(B) make informed choices in the use and conservation of natural resources and reusing and recycling of materials such as paper, aluminum, glass, cans, and plastic.

(2) Scientific investigation and reasoning. The student uses scientific **practices** [~~**inquiry methods**~~] during laboratory and outdoor investigations. The student is expected to:

(A) plan and implement descriptive investigations, including asking well defined [~~well-defined~~] questions, making inferences, and selecting and using appropriate equipment or technology to answer his/her questions;

(B) collect and record data by observing and measuring, using the metric system, and using descriptive words and numerals such as labeled drawings, writing, and concept maps;

(C) construct simple tables, charts, bar graphs, and maps using tools and current technology to organize, examine, and evaluate data;

(D) analyze data and interpret patterns to construct reasonable explanations from data that can be observed and measured;

(E) perform repeated investigations to increase the reliability of results; and

(F) communicate valid [~~,~~] oral [~~,~~] and written results supported by data.

(3) Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using [~~empirical~~] evidence, logical reasoning, and experimental and observational testing [~~, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student~~] ;

[~~(B) draw inferences and evaluate accuracy of services and product claims found in advertisements and labels such as for toys, food, and sunscreen;~~]

(B) [~~(C)~~] represent the natural world using models such as the water cycle and [~~rivers,~~] stream tables [~~, or fossils~~] and identify their limitations, including accuracy and size; and

(C) [~~(D)~~] connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools, materials, equipment, and models to conduct science inquiry. The student is expected to [~~:~~]

[~~(A)~~] collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, mirrors, spring scales, [~~pan balances, triple beam~~] balances, graduated cylinders, beakers, hot plates, meter sticks, [~~compasses,~~] magnets, collecting nets, and notebooks; timing devices [~~, including clocks and stopwatches~~] ; and materials to support observation of habitats of organisms such as terrariums and aquariums . [~~; and~~]

[~~(B) use safety equipment as appropriate, including safety goggles and gloves.~~]

(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:

(A) measure, compare, and contrast physical properties of matter, including [~~size,~~] mass, volume, states (solid, liquid, gas), temperature, magnetism, and the ability to sink or float; and

[~~(B) predict the changes caused by heating and cooling such as ice becoming liquid water and condensation forming on the outside of a glass of ice water; and~~]

(B) [~~(C)~~] compare and contrast a variety of mixtures , including [~~and~~] solutions [~~such as rocks in sand, sand in water, or sugar in water~~] .

(6) Force, motion, and energy. The student knows that energy exists in many forms and can be observed in cycles, patterns, and systems. The student is expected to:

(A) differentiate among forms of energy, including mechanical, sound, electrical, light, and thermal [~~heat/thermal~~] ;

(B) differentiate between conductors and insulators of thermal and electrical energy ;

(C) demonstrate that electricity travels in a closed path, creating an electrical circuit [~~, and explore an electromagnetic field~~] ; and

(D) design a descriptive investigation [~~an experiment~~] to explore [~~test~~] the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.

(7) Earth and space. The students know that Earth consists of useful resources and its surface is constantly changing. The student is expected to:

(A) examine properties of soils, including color and texture, capacity to retain water, and ability to support the growth of plants;

(B) observe and identify slow changes to Earth's surface caused by weathering, erosion, and deposition from water, wind, and ice; and

(C) identify and classify Earth's renewable resources, including air, plants, water, and animals , [;] and nonrenewable resources, including coal, oil, and natural gas , [;] and the importance of conservation.

(8) Earth and space. The student knows that there are recognizable patterns in the natural world and among the Sun, Earth, and Moon system. The student is expected to:

(A) measure , [~~and~~] record , and predict changes in weather [~~and make predictions using weather maps, weather symbols, and a map key~~] ;

(B) describe and illustrate the continuous movement of water above and on the surface of Earth through the water cycle and explain the role of the Sun as a major source of energy in this process; and

(C) collect and analyze data to identify sequences and predict patterns of change in shadows, [~~tides,~~] seasons, and the observable appearance of the Moon over time.

(9) Organisms and environments. The student knows and understands that living organisms within an ecosystem interact with one another and with their environment. The student is expected to:

(A) investigate that most producers need sunlight, water, and carbon dioxide to make their own food, while consumers are dependent on other organisms for food; and

(B) describe the flow of energy through food webs, beginning with the Sun, and predict how changes in the ecosystem affect the food web [~~such as a fire in a forest~~] .

(10) Organisms and environments. The student knows that organisms undergo similar life processes and have structures and behaviors that help them survive within their environment. The student is expected to:

(A) explore how structures and functions [~~adaptations~~] enable organisms to survive in their environment [~~such as comparing birds' beaks and leaves on plants~~] ;

(B) explore and describe examples of traits that [~~demonstrate that some likenesses between parents and offspring~~] are inherited from parents to offspring [~~,~~

~~passed from generation to generation~~] such as eye color and [~~in humans or~~] shapes of leaves and behaviors that are [~~in plants. Other likenesses are~~] learned such as [~~table manners or~~] reading a book and a wolf pack teaching their pups to hunt effectively [~~seals balancing balls on their noses~~] ; and

(C) explore, illustrate, and compare life cycles in living organisms such as [~~butterflies,~~] beetles, crickets, radishes, or lima beans.

§112.16. Science, Grade 5, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

(1) In Grade 5, **scientific** investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(A) Within the physical environment, students learn about the physical properties of matter, including magnetism, **mass,** physical states of matter, relative density, solubility in water, and the ability to conduct or insulate electrical and thermal energy. Students explore the uses of light, thermal, electrical, mechanical, and sound energies.

(B) Within the natural environment, students learn how changes occur on Earth's surface and that predictable patterns occur in the sky. Students learn that the natural world consists of resources, including nonrenewable and renewable.

(C) Within the living environment, students learn that structure and function of organisms can improve the survival of members of a species. Students learn to differentiate between inherited traits and learned behaviors.

(2) [~~(1)~~] Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process."

(3) [~~(2)~~] Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include patterns, cycles, systems, models, and change and constancy.

(4) [~~(3)~~] The study of elementary science includes planning and safely implementing classroom and outdoor investigations using scientific processes, including inquiry methods, analyzing information, making informed decisions, and using tools to collect and record information, while addressing the major concepts and vocabulary, in the context of physical, earth, and life sciences. Districts are encouraged to facilitate classroom and outdoor investigations for at least 50% of instructional time.

(5) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

[~~(4) In Grade 5, investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations and that methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. They have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.~~]

[~~(A) Within the physical environment, students learn about the physical properties of matter, including magnetism, physical states of matter, relative density, solubility in water, and the ability to conduct or insulate electrical and heat energy. Students explore the uses of light, thermal, electrical, and sound energies.~~]

[~~(B) Within the natural environment, students learn how changes occur on Earth's surface and that predictable patterns occur in the sky. Students learn that the natural world consists of resources, including nonrenewable, renewable, and alternative energy sources.~~]

[~~(C) Within the living environment, students learn that structure and function of organisms can improve the survival of members of a species. Students learn to differentiate between inherited traits and learned behaviors. Students learn that life cycles occur in animals and plants and that the carbon dioxide-oxygen cycle occurs naturally to support the living environment.~~]

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student conducts classroom and outdoor investigations following home and school safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices and the use of safety equipment as outlined [~~described~~] in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] during classroom and outdoor investigations using safety equipment, including safety goggles or chemical splash goggles, as appropriate, and gloves, as appropriate ; and

(B) make informed choices in the conservation, disposal, and recycling of materials.

(2) Scientific investigation and reasoning. The student uses scientific **practices** [~~**methods**~~] during laboratory and outdoor investigations. The student is expected to:

(A) describe, plan, and implement simple experimental investigations testing one variable;

(B) ask well defined [~~well-defined~~] questions, formulate testable hypotheses, and select and use appropriate equipment and technology;

(C) collect and record information using [~~by~~] detailed observations and accurate measuring;

(D) analyze and interpret information to construct reasonable explanations from direct (observable) and indirect (inferred) evidence;

(E) demonstrate that repeated investigations may increase the reliability of results;

(F) communicate valid conclusions in both written and verbal forms; and

(G) construct appropriate simple graphs, tables, maps, and charts using technology, including computers, to organize, examine, and evaluate information.

(3) Scientific investigation and reasoning. The student uses critical thinking and scientific problem solving to make informed decisions. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using [~~empirical~~] evidence, logical reasoning, and experimental and observational testing [~~, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student~~] ;

[~~(B) evaluate the accuracy of the information related to promotional materials for products and services such as nutritional labels;~~]

(B) [~~(C)~~] draw or develop a model that represents how something [~~works or looks~~] that cannot be seen such as the Sun, Earth, and Moon system and formation of sedimentary rock [~~how a soda dispensing machine~~] works or looks ; and

(C) [~~(D)~~] connect grade-level appropriate science concepts with the history of science, science careers, and contributions of scientists.

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and methods to conduct science inquiry. The student is expected to [~~:~~]

[~~(A)~~] collect, record, and analyze information using tools, including calculators, microscopes, cameras, computers, hand lenses, metric rulers, Celsius thermometers, prisms, mirrors, [~~pan balances, triple beam~~] balances, spring scales, graduated cylinders, beakers, hot plates, meter sticks, magnets, collecting nets, and notebooks; timing devices [~~, including clocks and stopwatches~~] ; and materials to support observations of habitats or organisms such as terrariums and aquariums . [~~; and~~]

[~~(B) use safety equipment, including safety goggles and gloves.~~]

(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:

(A) classify matter based on measurable, testable, and observable physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating using water as a reference point), solubility in water, and the ability to conduct or insulate thermal energy or electric energy;

[~~(B) identify the boiling and freezing/melting points of water on the Celsius scale;~~]

(B) [~~(C)~~] demonstrate that some mixtures maintain physical properties of their ingredients such as iron filings and sand **and** [~~**or**~~] sand and water ; and

(C) [~~(D)~~] identify changes that can occur in the physical properties of the ingredients of **solutions** [~~**mixtures**~~] [~~solutions~~] such as [~~**creating solutions by**~~] dissolving salt in water or adding lemon juice to water.

(6) Force, motion, and energy. The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to:

(A) explore the uses of energy, including mechanical, light, thermal, electrical, and sound energy;

(B) demonstrate that the flow of electricity in closed circuits [~~requires a complete path through which an electric current can pass and~~] can produce light, heat, or [~~and~~] sound;

(C) demonstrate that light travels in a straight line until it strikes an object and is reflected or travels through one medium to another [~~and demonstrate that light can be reflected such as the use of mirrors or other shiny surfaces~~] and is refracted [~~such as the appearance of an object when observed through water~~] ; and

(D) design a simple experimental investigation [~~an experiment~~] that tests the effect of force on an object.

(7) Earth and space. The student knows Earth's surface is constantly changing and consists of useful resources. The student is expected to:

(A) explore the processes that led to the formation of sedimentary rocks and fossil fuels; and

(B) recognize how landforms such as deltas, canyons, and sand dunes are the result of changes to Earth's surface by wind, water, or [~~and~~] ice . [~~;~~]

[~~(C) identify alternative energy resources such as wind, solar, hydroelectric, geothermal, and biofuels; and~~]

[~~(D) identify fossils as evidence of past living organisms and the nature of the environments at the time using models.~~]

(8) Earth and space. The student knows that there are recognizable patterns in the natural world and among the Sun, Earth, and Moon system. The student is expected to:

(A) differentiate between weather and climate;

(B) explain how the Sun and the ocean interact in the water cycle;

(C) demonstrate that Earth rotates on its axis once approximately every 24 hours causing the day/night cycle and the apparent movement of the Sun across the sky; and

(D) identify and compare the physical characteristics of the Sun, Earth, and Moon.

(9) Organisms and environments. The student knows that there are relationships, systems, and cycles within environments. The student is expected to:

(A) observe the way organisms live and survive in their ecosystem by interacting with the living [~~**(includes once-living)**~~] and nonliving [~~non-living~~] **components** [~~**elements**~~] ;

(B) describe [~~how~~] the flow of energy within a food web, including the roles of [~~derived from~~] the Sun, [~~used by~~] producers [~~to create their own food~~] , [~~is transferred through a food chain and food web to~~] consumers , and decomposers;

(C) predict the effects of changes in ecosystems caused by living organisms, including humans, such as the overpopulation of grazers or the building of highways; and

(D) identify fossils as evidence of past living organisms and the nature of the environments at the time using models.

[~~(D) identify the significance of the carbon dioxide-oxygen cycle to the survival of plants and animals.~~]

(10) Organisms and environments. The student knows that organisms [~~undergo similar life processes and~~] have structures and behaviors that help them survive within their environments. The student is expected to:

(A) compare the structures and functions of different species that help them live and survive **in a specific environment** such as hooves on prairie animals or webbed feet in aquatic animals; and

(B) differentiate between inherited traits of plants and animals such as spines on a cactus or shape of a beak and learned behaviors such as an animal learning tricks or a child riding a bicycle . [~~; and~~]

[~~(C) describe the differences between complete and incomplete metamorphosis of insects.~~]

Subchapter B. Middle School

§112.17. Implementation of Texas Essential Knowledge and Skills for Science, Middle School, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

The provisions of §§112.18-112.20 of this subchapter shall be implemented by school districts beginning with the **2018-2019** [~~**2017-2018**~~] [~~2010-2011~~] school year.

§112.18. Science, Grade 6, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

[~~(1) Science, as defined by the National Academy of Science, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.~~]

[~~(2) Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple, independent researchers. Students should know that scientific theories, unlike hypotheses, are well-established and highly reliable, but they may still be subject to change as new information and technologies are developed. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.~~]

(1) [~~(3)~~] Grade 6 science is interdisciplinary in nature; however, much of the content focus is on physical science. National standards in science are organized as multi-grade blocks such as Grades 5-8 rather than individual grade levels. In order to follow the grade level format used in Texas, the various national standards are found among Grades 6, 7, and 8. Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include change and constancy, patterns, cycles, systems, models, and scale.

[~~(4)~~] The strands for Grade 6 include the following. [~~:~~]

(A) Scientific investigations and reasoning.

(i) To develop a rich knowledge of science and the natural world, students must become familiar with different modes of scientific inquiry, rules of evidence, ways of formulating questions, ways of proposing explanations, and the diverse ways scientists study the natural world and propose explanations based on evidence derived from their work.

(ii) Scientific investigations are conducted for different reasons. All investigations require a research question, careful observations, data gathering, and analysis of the data to identify the patterns that will explain the findings. Descriptive investigations are used to explore new phenomena such as conducting surveys of organisms or measuring the abiotic components in a given habitat. Descriptive statistics include frequency, range, mean, median, and mode. A hypothesis is not required in a descriptive investigation. On the other hand, when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation. Students should experience both types of investigations and understand that different scientific research questions require different research designs.

(iii) Scientific investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and the methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. Models have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(B) Matter and energy.

(i) Matter can be classified as elements, compounds, or mixtures. Students have already had experience with mixtures in Grade 5, so Grade 6 will concentrate on developing an understanding of elements and compounds. It is important that students learn the differences between elements and compounds based on observations, description of physical properties, and chemical reactions. Elements are represented

by chemical symbols, while compounds are represented by chemical formulas. Subsequent grades will learn about the differences at the molecular and atomic level.

(ii) Elements are classified as metals, nonmetals, and metalloids based on their physical properties. The elements are divided into three groups on the Periodic Table. Each different substance usually has a different density, so density can be used as an identifying property. Therefore, calculating density aids classification of substances.

(iii) Energy resources are available on a renewable **or** [**,**] nonrenewable [**~~, or indefinite~~**] basis. Understanding the origins and uses of these resources enables informed decision making. Students should consider the ethical/social issues surrounding Earth's natural energy resources, while looking at the advantages and disadvantages of their long-term uses.

(C) Force, motion, and energy. Energy occurs in two types, potential and kinetic, and can take several forms. Thermal energy can be transferred by conduction, convection, or radiation. It can also be changed from one form to another. Students will investigate the relationship between force and motion using a variety of means, including calculations and measurements.

(D) Earth and space. The focus of this strand is on introducing Earth's processes. Students should develop an understanding of Earth as part of our solar system. The topics include organization of our solar system, the role of gravity, and space exploration.

(E) Organisms and environments. Students will gain an understanding of the broadest taxonomic classifications of organisms and how characteristics determine their classification. The other major topics developed in this strand include the interdependence between organisms and their environments and the levels of organization within an ecosystem.

(2) Science, as defined by the National Academy of Science, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Students should know that scientific theories, unlike hypotheses, are well established and highly reliable, but they may still be subject to change as new information and technologies are developed. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.

(4) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations as outlined in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] ; and

(B) practice appropriate use and conservation of resources, including disposal, reuse, or recycling of materials.

(2) Scientific investigation and reasoning. The student uses scientific **practices** [~~**inquiry methods**~~] during laboratory and field investigations. The student is expected to:

(A) plan and implement comparative and descriptive investigations by making observations, asking well defined [~~well-defined~~] questions, and using appropriate equipment and technology;

(B) design and implement experimental investigations by making observations, asking well defined [~~well-defined~~] questions, formulating testable hypotheses, and using appropriate equipment and technology;

(C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;

(D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and

(E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A) [~~**in all fields of science,**~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, [~~**including examining all sides of scientific evidence of those scientific explanations,**~~] so as to encourage critical thinking by the student;

(B) use models to represent aspects of the natural world such as a model of Earth's layers;

(C) identify advantages and limitations of models such as size, scale, properties, and materials; and

(D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:

(A) use appropriate tools [~~to collect, record, and analyze information~~] , including journals/notebooks, beakers, Petri dishes, meter sticks, graduated cylinders, hot plates, test tubes, [~~triple beam~~] balances, microscopes, thermometers, calculators, computers, timing devices, and other necessary equipment to collect, record, and analyze information [~~as needed to teach the curriculum~~] ; and

(B) use preventative safety equipment, including chemical splash goggles, aprons, and gloves, and be prepared to use emergency safety equipment, including an eye/face wash, a fire blanket, and a fire extinguisher.

(5) Matter and energy. The student knows the differences between elements and compounds. The student is expected to:

(A) know that an element is a pure substance represented by a chemical symbol and that a compound is a pure substance represented by a chemical formula [~~symbols~~] ;

(B) recognize that a limited number of the many known elements comprise the largest portion of solid Earth, living matter, oceans, and the atmosphere; and

[~~(C) differentiate between elements and compounds on the most basic level; and~~]

(C) [~~(D)~~] identify the formation of a new substance by using the evidence of a possible chemical change such as production of a gas, change in temperature, production of a precipitate, or color change.

(6) Matter and energy. The student knows matter has physical properties that can be used for classification. The student is expected to:

(A) compare metals, nonmetals, and metalloids using physical properties such as luster, conductivity, or malleability;

(B) calculate density to identify an unknown substance; and

(C) test the physical properties of minerals, including hardness, color, luster, and streak.

(7) Matter and energy. The student knows that some of Earth's energy resources are available on a nearly perpetual basis, while others can be renewed over a relatively short period of time. Some energy resources, once depleted, are essentially nonrenewable. The student is expected to [~~:~~]

[~~(A)~~] research and discuss [~~debate~~] the advantages and disadvantages of using coal, oil, natural gas, nuclear power, biomass, wind, hydropower, geothermal, and solar resources . [~~; and~~]

[~~(B) design a logical plan to manage energy resources in the home, school, or community.~~]

(8) Force, motion, and energy. The student knows force and motion are related to potential and kinetic energy. The student is expected to:

(A) compare and contrast potential and kinetic energy;

(B) identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces;

(C) calculate average speed using distance and time measurements;

(D) measure and graph changes in motion; and

(E) investigate how inclined planes [~~and pulleys~~] can be used to change the amount of force to move an object.

(9) Force, motion, and energy. The student knows that the Law of Conservation of Energy states that energy can neither be created nor destroyed, it just changes form. The student is expected to:

(A) investigate methods of thermal energy transfer, including conduction, convection, and radiation;

(B) verify through investigations that thermal energy moves in a predictable pattern from warmer to cooler until all the substances attain the same temperature such as an ice cube melting; and

(C) demonstrate energy transformations such as energy in a flashlight battery changes from chemical energy to electrical energy to light energy.

(10) Earth and space. The student understands the structure of Earth, the rock cycle, and plate tectonics. The student is expected to:

(A) build a model to illustrate the compositional and mechanical [~~structural~~] layers of Earth, including the inner core, outer core, mantle, crust, asthenosphere, and lithosphere;

(B) classify rocks as metamorphic, igneous, or sedimentary by the processes of their formation;

(C) identify the major tectonic plates, including Eurasian, African, Indo-Australian, Pacific, North American, and South American; and

(D) describe how plate tectonics causes major geological events such as ocean basin formation [~~basins~~] , earthquakes, volcanic eruptions, and mountain building.

(11) Earth and space. The student understands the organization of our solar system and the relationships among the various bodies that comprise it. The student is expected to:

(A) describe the physical properties, locations, and movements of the Sun, planets, [~~Galilean~~] moons, meteors, asteroids, and comets;

(B) understand that gravity is the force that governs the motion of our solar system; and

(C) describe the history and future of space exploration, including the types of equipment and transportation needed for space travel.

(12) Organisms and environments. The student knows all organisms are classified into domains [~~Domains~~] and kingdoms [~~Kingdoms~~] . Organisms within these taxonomic groups share similar characteristics that [~~which~~] allow them to interact with the living and nonliving parts of their ecosystem. The student is expected to:

(A) understand that all organisms are composed of one or more cells;

(B) recognize that the presence of a nucleus is a key factor used to determine [~~determines~~] whether a cell is prokaryotic or eukaryotic;

(C) recognize that the broadest taxonomic classification of living organisms is divided into currently recognized domains [~~Domains~~] ;

(D) identify the basic characteristics of organisms, including prokaryotic or eukaryotic, unicellular or multicellular, autotrophic or heterotrophic, and mode of reproduction, that further classify them in the currently recognized kingdoms [~~Kingdoms~~] ;

(E) describe biotic and abiotic parts of an ecosystem in which organisms interact; and

(F) diagram the levels of organization within an ecosystem, including organism, population, community, and ecosystem.

§112.19. Science, Grade 7, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

[~~(1) Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.~~]

[~~(2) Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple, independent researchers. Students should know that scientific theories, unlike hypotheses, are well-established and highly reliable, but they may still be subject to change as new information and technologies are developed. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.~~]

(1) [~~(3)~~] Grade 7 science is interdisciplinary in nature; however, much of the content focus is on organisms and the environment. National standards in science are organized as [~~a~~] multi-grade blocks such as Grades 5-8 rather than individual grade levels. In order to follow the grade level format used in Texas, the various national standards are found among Grades 6, 7, and 8. Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include change and constancy, patterns, cycles, systems, models, and scale.

[~~(4)~~] The strands for Grade 7 include the following. [~~:~~]

(A) Scientific investigation and reasoning.

(i) To develop a rich knowledge of science and the natural world, students must become familiar with different modes of scientific inquiry, rules of evidence, ways of formulating questions, ways of proposing explanations, and the diverse ways scientists study the natural world and propose explanations based on evidence derived from their work.

(ii) Scientific investigations are conducted for different reasons. All investigations require a research question, careful observations, data gathering, and analysis of the data to identify the patterns that will explain the findings. Descriptive investigations are used to explore new phenomena such as conducting surveys of organisms or measuring the abiotic components in a given habitat. Descriptive statistics include frequency, range, mean, median, and mode. A hypothesis is not required in a descriptive investigation. On the other hand, when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation. Students should experience both types of investigations and understand that different scientific research questions require different research designs.

(iii) Scientific investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and the methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. Models have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(B) Matter and energy. Matter and energy are conserved throughout living systems. Radiant energy from the Sun drives much of the flow of energy throughout living systems due to the process of photosynthesis in organisms described as producers. Most consumers then depend on producers to meet their energy needs. [~~Decomposers play an important role in recycling matter. Organic compounds are composed of carbon and other elements that are recycled due to chemical changes that rearrange the elements for the particular needs of that living system. Large molecules such as carbohydrates are composed of chains of smaller units such as sugars, similar to a train being~~

~~composed of multiple box cars.~~] Subsequent grade levels will learn about the differences at the molecular and atomic level.

(C) Force, motion, and energy. Force, motion, and energy are observed in living systems and the environment in several ways. Interactions between muscular and skeletal systems allow the body to apply forces and transform energy both internally and externally. Force and motion can also describe the direction and growth of seedlings, turgor pressure, and geotropism. Catastrophic events of weather systems such as hurricanes, floods, and tornadoes can shape and restructure the environment through the force and motion evident in them. Weathering, erosion, and deposition occur in environments due to the forces of gravity, wind, ice, and water.

(D) Earth and space. Earth and space phenomena can be observed in a variety of settings. Both natural events and human activities can impact Earth systems. There are characteristics of Earth and relationships to objects in our solar system that allow life to exist.

(E) Organisms and environments.

(i) Students will understand the relationship between living organisms and their environment. Different environments support different living organisms that are adapted to that region of Earth. Organisms are living systems that maintain a steady state with that environment and whose balance may be disrupted by internal and external stimuli. External stimuli include human activity or the environment. Successful organisms can reestablish a balance through different processes such as a feedback mechanism. Ecological succession can be seen on a broad or small scale.

(ii) Students learn that all organisms obtain energy, get rid of wastes, grow, and reproduce. During both sexual and asexual reproduction, traits are passed onto the next generation. These traits are contained in genetic material that is found on genes within a chromosome from the parent. Changes in traits sometimes occur in a population over many generations. One of the ways a change can occur is through the process of natural selection. Students extend their understanding of structures in living systems from a previous focus on external structures to an understanding of internal structures and functions within living things.

(iii) All living organisms are made up of smaller units called cells. All cells use energy, get rid of wastes, and contain genetic material. Students will compare plant and animal cells and understand the internal structures within them that allow them to obtain energy, get rid of wastes, grow, and reproduce in different ways. Cells can organize into tissues, tissues into organs, and organs into organ systems. Students will learn the major functions of human body systems such as the ability of the integumentary system to protect against infection, injury, and ultraviolet (UV) radiation; regulate body temperature; and remove waste.

(2) Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Students should know that scientific theories, unlike hypotheses, are well established and highly reliable, but they may still be subject to change as new information and technologies are developed. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.

(4) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student, for at least 40% of the instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations as outlined in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] ; and

(B) practice appropriate use and conservation of resources, including disposal, reuse, or recycling of materials.

(2) Scientific investigation and reasoning. The student uses scientific **practices** [~~**inquiry methods**~~] during laboratory and field investigations. The student is expected to:

(A) plan and implement comparative and descriptive investigations by making observations, asking well defined [~~well-defined~~] questions, and using appropriate equipment and technology;

(B) design and implement experimental investigations by making observations, asking well defined [~~well-defined~~] questions, formulating testable hypotheses, and using appropriate equipment and technology;

(C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;

(D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and

(E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A) [~~**in all fields of science,**~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, [~~**including examining all sides of scientific evidence of those scientific explanations,**~~] so as to encourage critical thinking by the student;

(B) use models to represent aspects of the natural world such as human body systems and plant and animal cells;

(C) identify advantages and limitations of models such as size, scale, properties, and materials; and

(D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

(4) Science investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:

(A) use appropriate tools [~~to collect, record, and analyze information~~] , including life science models, hand lenses [~~lens~~] , stereoscopes, microscopes, beakers, Petri dishes, microscope slides, graduated cylinders, test tubes, meter sticks, metric rulers, metric tape measures, timing devices, hot plates, balances, thermometers, calculators, water test kits, computers, temperature and pH probes, collecting nets, insect traps, globes, digital cameras, journals/notebooks, and other necessary equipment to collect, record, and analyze information [~~as needed to teach the curriculum~~] ; and

(B) use preventative safety equipment, including chemical splash goggles, aprons, and gloves, and be prepared to use emergency safety equipment, including an eye/face wash, a fire blanket, and a fire extinguisher.

(5) Matter and energy. The student knows that interactions occur between matter and energy. The student is expected to:

(A) recognize that radiant energy from the Sun is transformed into chemical energy through the process of photosynthesis; and

[~~(B) demonstrate and explain the cycling of matter within living systems such as in the decay of biomass in a compost bin; and~~]

(B) [~~(C)~~] diagram the flow of energy through living systems, including food chains, food webs, and energy pyramids.

(6) Matter and energy. The student knows that matter has physical and chemical properties and can undergo physical and chemical changes. The student is expected to [~~:~~]

[~~(A) identify that organic compounds contain carbon and other elements such as hydrogen, oxygen, phosphorus, nitrogen, or sulfur;~~]

[~~(B)~~] distinguish between physical and chemical changes in matter [**~~in the digestive system~~**] . [~~; and~~]

[~~(C) recognize how large molecules are broken down into smaller molecules such as carbohydrates can be broken down into sugars.~~]

(7) Force, motion, and energy. The student knows that there is a relationship among force, motion, and energy. The student is expected to:

[~~(A) contrast situations where work is done with different amounts of force to situations where no work is done such as moving a box with a ramp and without a ramp, or standing still;~~]

(A) [~~(B)~~] illustrate the transformation of energy within an organism such as the transfer from chemical energy to [**~~heat and~~**] thermal energy [**~~in digestion~~**] ; and

(B) [~~(C)~~] demonstrate and illustrate forces that affect motion in organisms [~~everyday life~~] such as emergence of seedlings, turgor pressure, [~~and~~] geotropism , and circulation of blood .

(8) Earth and space. The student knows that natural events and human activity can impact Earth systems. The student is expected to:

(A) predict and describe how [~~different types of~~] catastrophic events such as floods, hurricanes, or tornadoes impact ecosystems [~~such as floods, hurricanes, or tornadoes~~] ;

(B) analyze the effects of weathering, erosion, and deposition on the environment in ecoregions of Texas; and

(C) model the effects of human activity on groundwater and surface water in a watershed.

(9) Earth and space. The student knows components of our solar system. The student is expected to:

(A) analyze the characteristics of objects in our solar system that allow life to exist such as the proximity of the Sun, presence of water, and composition of the atmosphere; and

(B) identify the accommodations, considering the characteristics of our solar system, that enabled manned space exploration.

(10) Organisms and environments. The student knows that there is a relationship between organisms and the environment. The student is expected to:

(A) observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms;

(B) describe how biodiversity contributes to the sustainability of an ecosystem; and

(C) observe, record, and describe the role of ecological succession such as in a microhabitat of a garden with weeds.

(11) Organisms and environments. The student knows that populations and species demonstrate variation and inherit many of their unique traits through gradual processes over many generations. The student is expected to:

(A) examine organisms or their structures such as insects or leaves and use dichotomous keys for identification;

(B) explain variation within a population or species by comparing external features, behaviors, or physiology of organisms that enhance their survival such as migration, hibernation, or storage of food in a bulb; and

(C) identify some changes in genetic traits that have occurred over several generations through natural selection and selective breeding such as the Galapagos Medium Ground Finch (*Geospiza fortis*) or domestic animals and hybrid plants .

(12) Organisms and environments. The student knows that living systems at all levels of organization demonstrate the complementary nature of structure and function. The student is expected to:

(A) investigate and explain how internal structures of organisms have adaptations that allow specific functions such as gills in fish, hollow bones in birds, or xylem in plants;

(B) identify the main functions of the systems of the human organism, including the circulatory, respiratory, skeletal, muscular, digestive, excretory, reproductive, integumentary, nervous, and endocrine systems;

(C) recognize levels of organization in plants and animals, including cells, tissues, organs, organ systems, and organisms;

(D) differentiate between structure and function in plant and animal cell organelles, including cell membrane, cell wall, nucleus, cytoplasm, mitochondrion, chloroplast, and vacuole;

(E) compare the functions of [~~a~~] cell organelles to the functions of an organ system [~~organisms such as waste removal~~] ; and

(F) recognize the components of [~~that according to~~] cell theory [~~all organisms are composed of cells and cells carry on similar functions such as extracting energy from food to sustain life~~] .

(13) Organisms and environments. The student knows that a living organism must be able to maintain balance in stable internal conditions in response to external and internal stimuli. The student is expected to:

(A) investigate how organisms respond to external stimuli found in the environment such as phototropism and fight or flight; and

(B) describe and relate responses in organisms that may result from internal stimuli such as wilting in plants and fever or vomiting in animals that allow them to maintain balance.

(14) Organisms and environments. The student knows that reproduction is a characteristic of living organisms and that the instructions for traits are governed in the genetic material. The student is expected to:

(A) define heredity as the passage of genetic instructions from one generation to the next generation;

(B) compare the results of uniform or diverse offspring from asexual or sexual reproduction [~~or asexual reproduction~~] ; and

(C) recognize that inherited traits of individuals are governed in the genetic material found in the genes within chromosomes in the nucleus.

§112.20. Science, Grade 8, Adopted 2017 [~~Beginning with School Year 2010-2011~~] .

(a) Introduction.

[~~(1) Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.~~]

[~~(2) Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple, independent researchers. Students should know that scientific theories, unlike hypotheses, are well-established and highly reliable, but they may still be subject to change as new information and technologies are developed. Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.~~]

(1) [~~(3)~~] Grade 8 science is interdisciplinary in nature; however, much of the content focus is on earth and space science. National standards in science are organized as multi-grade blocks such as Grades 5-8 rather than individual grade levels. In order to follow the grade level format used in Texas, the various national standards are found among Grades 6, 7, and 8. Recurring themes are pervasive in sciences, mathematics, and technology. These ideas transcend disciplinary boundaries and include change and constancy, patterns, cycles, systems, models, and scale.

[~~(4)~~] The strands for Grade 8 include the following. [~~:~~]

(A) Scientific investigation and reasoning.

(i) To develop a rich knowledge of science and the natural world, students must become familiar with different modes of scientific inquiry, rules of evidence, ways of formulating questions, ways of proposing explanations, and the diverse ways scientists study the natural world and propose explanations based on evidence derived from their work.

(ii) Scientific investigations are conducted for different reasons. All investigations require a research question, careful observations, data gathering, and analysis of the data to identify the patterns that will explain the findings. Descriptive investigations are used to explore new phenomena such as conducting surveys of organisms or measuring the abiotic components in a given habitat. Descriptive statistics include frequency, range, mean, median, and mode. A hypothesis is not required in a descriptive investigation. On the other hand, when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation. Students should experience both types of investigations and understand that different scientific research questions require different research designs.

(iii) Scientific investigations are used to learn about the natural world. Students should understand that certain types of questions can be answered by investigations, and the methods, models, and conclusions built from these investigations change as new observations are made. Models of objects and events are tools for understanding the natural world and can show how systems work. Models have limitations and based on new discoveries are constantly being modified to more closely reflect the natural world.

(B) Matter and energy. Students recognize that matter is composed of atoms. Students examine information on the Periodic Table to recognize that elements are grouped into families. In addition, students understand the basic concept of conservation of mass. Lab activities will allow students to demonstrate evidence of chemical reactions. They will use chemical formulas to identify [~~and balanced equations to show chemical reactions and the formation of new~~] substances.

(C) Force, motion, and energy. Students experiment with the relationship between forces and motion through the study of Newton's three laws. Students learn

how these forces relate to geologic processes and astronomical phenomena. In addition, students recognize that these laws are evident in everyday objects and activities. Mathematics is used to calculate speed using distance and time measurements.

(D) Earth and space. Students identify the role of natural events in altering Earth systems. Cycles within Sun, Earth, and Moon systems are studied as students learn about seasons, tides, and lunar phases. Students learn that stars and galaxies are part of the universe [~~and that distances in space are measured by using light waves~~] . In addition, students use data to research scientific theories of the origin of the universe. Students will illustrate how Earth features change over time by plate tectonics. They will interpret land and erosional features on topographic maps and satellite views . Students learn how interactions in solar, weather, and ocean systems create changes in weather patterns and climate.

(E) Organisms and environments. In studies of living systems, students explore the interdependence between these systems. [~~Interactions between organisms in ecosystems, including producer/consumer, predator/prey, and parasite/host relationships, are investigated in aquatic and terrestrial systems.~~] Students describe how biotic and abiotic factors affect the number of organisms and populations present in an ecosystem. In addition, students explore how organisms and their populations respond to short- and long-term environmental changes, including those caused by human activities.

(2) Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) Scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions become theories. Scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Students should know that scientific theories, unlike hypotheses, are well established and highly reliable, but they may still be subject to change as new information and technologies are developed.

Students should be able to distinguish between scientific decision-making methods and ethical/social decisions that involve the application of scientific information.

(4) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and skills.

(1) Scientific investigation and reasoning. The student, for at least 40% of instructional time, conducts laboratory and field investigations following safety procedures and environmentally appropriate and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations as outlined in Texas Education Agency-approved safety standards [~~the Texas Safety Standards~~] ; and

(B) practice appropriate use and conservation of resources, including disposal, reuse, or recycling of materials.

(2) Scientific investigation and reasoning. The student uses scientific **practices** [~~**inquiry methods**~~] during laboratory and field investigations. The student is expected to:

(A) plan and implement comparative and descriptive investigations by making observations, asking well defined [~~well-defined~~] questions, and using appropriate equipment and technology;

(B) design and implement [~~comparative and~~] experimental investigations by making observations, asking well defined [~~well-defined~~] questions, formulating testable hypotheses, and using appropriate equipment and technology;

(C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;

(D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and

(E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.

(3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:

(A) [~~**in all fields of science,**~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, [~~**including examining all sides of scientific evidence of those scientific explanations,**~~] so as to encourage critical thinking by the student;

(B) use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature;

(C) identify advantages and limitations of models such as size, scale, properties, and materials; and

(D) relate the impact of research on scientific thought and society, including the history of science and contributions of scientists as related to the content.

(4) Scientific investigation and reasoning. The student knows how to use a variety of tools and safety equipment to conduct science inquiry. The student is expected to:

(A) use appropriate tools [~~to collect, record, and analyze information~~] , including lab journals/notebooks, beakers, meter sticks, graduated cylinders, anemometers, psychrometers, hot plates, test tubes, spring scales, balances, microscopes, thermometers, calculators, computers, spectroscopes, timing devices, and other necessary equipment to collect, record, and analyze information [~~as needed to teach the curriculum~~] ; and

(B) use preventative safety equipment, including chemical splash goggles, aprons, and gloves, and be prepared to use emergency safety equipment, including an eye/face wash, a fire blanket, and a fire extinguisher.

(5) Matter and energy. The student knows that matter is composed of atoms and has chemical and physical properties. The student is expected to:

(A) describe the structure of atoms, including the masses, electrical charges, and locations, of protons and neutrons in the nucleus and electrons in the electron cloud;

(B) identify that protons determine an element's identity and valence electrons determine its chemical properties, including reactivity;

(C) interpret the arrangement of the Periodic Table, including groups and periods, to explain how properties are used to classify elements;

(D) recognize that chemical formulas are used to identify substances and determine the number of atoms of each element in chemical formulas containing subscripts; and

(E) investigate how evidence of chemical reactions indicates [~~indicate~~] that new substances with different properties are formed and how that relates to the law of conservation of mass. [~~; and~~]

[~~(F) recognize whether a chemical equation containing coefficients is balanced or not and how that relates to the law of conservation of mass.~~]

(6) Force, motion, and energy. The student knows that there is a relationship between force, motion, and energy. The student is expected to:

(A) demonstrate and calculate how unbalanced forces change the speed or direction of an object's motion;

(B) differentiate between speed, velocity, and acceleration; and

(C) investigate and describe applications of Newton's three laws of motion [~~law of inertia, law of force and acceleration, and law of action-reaction~~] such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches.

(7) Earth and space. The student knows the effects resulting from cyclical movements of the Sun, Earth, and Moon. The student is expected to:

(A) model and illustrate how the tilted Earth rotates on its axis, causing day and night, and revolves around the Sun , causing changes in seasons;

(B) demonstrate and predict the sequence of events in the lunar cycle; and

(C) relate the positions [~~position~~] of the Moon and Sun to their effect on ocean tides.

(8) Earth and space. The student knows characteristics of the universe. The student is expected to:

(A) describe components of the universe, including stars, nebulae, and galaxies, and use models such as the **Hertzsprung-Russell** [~~**Herztsprung-Russell**~~] diagram for classification;

(B) recognize that the Sun is a medium-sized star located in a spiral arm of the Milky Way [~~near the edge of a disc-shaped~~] galaxy [~~of stars~~] and that the Sun is many thousands of times closer to Earth than any other star;

(C) identify [~~explore~~] how different wavelengths of the electromagnetic spectrum such as visible light and radio waves are used to gain information about [~~distances and properties of~~] components in the universe; and

[~~(D) model and describe how light years are used to measure distances and sizes in the universe; and~~]

(D) [~~(E)~~] research how scientific data are used as evidence to develop scientific theories to describe the origin of the universe.

(9) Earth and space. The student knows that natural events can impact Earth systems. The student is expected to:

(A) describe the historical development of evidence that supports plate tectonic theory;

(B) relate plate tectonics to the formation of crustal features; and

(C) interpret topographic maps and satellite views to identify land and erosional features and predict how these features may be reshaped by weathering.

(10) Earth and space. The student knows that climatic interactions exist among Earth, ocean, and weather systems. The student is expected to:

(A) recognize that the Sun provides the energy that drives convection within the atmosphere and oceans, producing winds [~~and ocean currents~~] ;

(B) identify how global patterns of atmospheric movement influence local weather using weather maps that show high and low pressures and fronts; and

(C) identify the role of the oceans in the formation of weather systems such as hurricanes.

(11) Organisms and environments. The student knows that interdependence occurs among living systems and the environment and that human activities can affect these systems. The student is expected to:

[~~(A) describe producer/consumer, predator/prey, and parasite/host relationships as they occur in food webs within marine, freshwater, and terrestrial ecosystems;~~]

(A) [~~(B)~~] investigate how organisms and populations in an ecosystem depend on and may compete for biotic factors such as food and abiotic factors such as quantity of light, water, range of temperatures, or soil composition;

(B) [~~(C)~~] explore how short- and long-term environmental changes affect organisms and traits in subsequent populations; and

(C) [~~(D)~~] recognize human dependence on ocean systems and explain how human activities such as runoff, artificial reefs, or use of resources have modified these systems.

Subchapter C. High School

§112.31. Implementation of Texas Essential Knowledge and Skills for Science, High School [~~, Beginning with School Year 2010-2011~~] .

(a) The provisions of [~~§§112.32-112.39 of~~] this subchapter shall be implemented by school districts [~~beginning with the 2010-2011 school year~~] .

(b) The provisions of §§112.34, 112.35, 112.38, and 112.39 of this subchapter adopted in 2017 shall be implemented by school districts beginning with the **2018-2019** [~~**2017-2018**~~] school year.

§112.34. Biology [~~, Beginning with School Year 2010-2011~~] (One Credit) , Adopted 2017 .

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grade 9, 10, or 11.

(b) Introduction.

(1) Biology. In Biology, students conduct laboratory and field investigations, use scientific **practices** [~~**methods**~~] during investigations, and make informed decisions using critical thinking and scientific problem solving. Students in Biology study a variety of topics that include: structures and functions of cells and viruses; growth and development of organisms; cells, tissues, and organs; nucleic acids and genetics; biological evolution; taxonomy; metabolism and energy transfers in living organisms; living systems; homeostasis; and ecosystems and the environment.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).

(5) Science, systems, and models. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations; and

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific **practices** [~~**methods**~~] and equipment during laboratory and field investigations. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

(B) know that hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that [~~which~~] have been tested over a wide variety of conditions are incorporated into theories;

(C) know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established [~~well-established~~] and highly reliable [~~highly-reliable~~] explanations, but they may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;

(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as [~~calculators, spreadsheet software,~~] data-collecting probes, [~~computers,~~] standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, [~~electronic~~] balances, gel electrophoresis apparatuses, micropipettes [~~micropipettors~~] , hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, [~~cameras,~~] Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;

(G) analyze, evaluate, make inferences, and predict trends from data; and

(H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, [~~including examining all sides of scientific evidence of those scientific explanations,~~] so as to encourage critical thinking by the student;

(B) communicate and apply scientific information extracted from various sources such as current events, [~~news reports,~~] published journal articles, and marketing materials;

(C) draw inferences based on data related to promotional materials for products and services;

(D) evaluate the impact of scientific research on society and the environment;

(E) evaluate models according to their limitations in representing biological objects or events; and

(F) research and describe the history of biology and contributions of scientists.

(4) Science concepts. The student knows that cells are the basic structures of all living things with specialized parts that perform specific functions and that viruses are different from cells. The student is expected to:

(A) compare and contrast prokaryotic and eukaryotic cells **, including their complexity,** and **compare and contrast** [~~**evaluate**~~] scientific explanations for **cellular** [~~**their**~~] complexity ;

(B) investigate and explain cellular processes, including homeostasis and [~~, energy conversions,~~] transport of molecules [~~, and synthesis of new molecules~~] ; and

(C) compare the structures of viruses to cells, describe viral reproduction, and describe the role of viruses in causing diseases such as human immunodeficiency virus (HIV) and influenza.

(5) Science concepts. The student knows how an organism grows and the importance of cell differentiation. The student is expected to:

(A) describe the stages of the cell cycle, including deoxyribonucleic acid (DNA) replication and mitosis, and the importance of the cell cycle to the growth of organisms;

[~~(B) examine specialized cells, including roots, stems, and leaves of plants; and animal cells such as blood, muscle, and epithelium;~~]

(B) [~~(C)~~] describe the roles of DNA, ribonucleic acid (RNA), and environmental factors in cell differentiation; and

(C) [~~(D)~~] recognize that disruptions of the cell cycle lead to diseases such as cancer.

(6) Science concepts. The student knows the mechanisms of genetics such as [~~, including~~] the role of nucleic acids and the principles of Mendelian and non-Mendelian genetics [~~Genetics~~] . The student is expected to:

(A) identify components of DNA, **identify** [~~and~~] [~~**describe**~~] how information for specifying the traits of an organism is carried in the DNA **,** and **examine** [~~**evaluate**~~] scientific explanations for the origin of DNA ;

(B) recognize that components that make up the genetic code are common to all organisms;

(C) explain the purpose and process of transcription and translation using models of DNA and RNA;

(D) recognize that gene expression is a regulated process;

(E) identify and illustrate changes in DNA and evaluate the significance of these changes;

(F) predict possible outcomes of various genetic combinations such as monohybrid crosses, dihybrid crosses **,** and non-Mendelian inheritance; and

(G) recognize the significance of meiosis to sexual reproduction **.** [~~; and~~]

[~~(H) describe how techniques such as DNA fingerprinting, genetic modifications, and chromosomal analysis are used to study the genomes of organisms.~~]

(7) Science concepts. The student knows evolutionary theory is a scientific explanation for the unity and diversity of life. The student is expected to:

(A) analyze and evaluate how evidence of common ancestry among groups is provided by the fossil record, biogeography, and homologies, including anatomical, molecular, and developmental;

(B) examine [~~analyze and evaluate~~] scientific explanations [~~concerning any data~~] of abrupt [~~sudden~~] appearance and [~~,~~] stasis [~~, and sequential nature of groups~~] in the fossil record;

(C) analyze and evaluate how natural selection produces change in populations, not individuals;

(D) analyze and evaluate how the elements of natural selection, including inherited variation, the potential of a population to produce more offspring than can survive, and a finite supply of environmental resources, result in differential reproductive success;

(E) analyze and evaluate the relationship of natural selection to adaptation and to the development of diversity in and among species; and

(F) analyze [~~and evaluate the effects of~~] other evolutionary mechanisms, including genetic drift, gene flow, mutation, and recombination . [~~; and~~]

[~~(G) analyze and evaluate scientific explanations concerning the complexity of the cell.~~]

(8) Science concepts. The student knows that taxonomy is a branching classification based on the shared characteristics of organisms and can change as new discoveries are made. The student is expected to:

(A) define taxonomy and recognize the importance of a standardized taxonomic system to the scientific community;

(B) categorize organisms using a hierarchical classification system based on similarities and differences shared among groups; and

(C) compare characteristics of taxonomic groups, including archaea, bacteria, protists, fungi, plants, and animals.

(9) Science concepts. The student knows the significance of various molecules involved in metabolic processes and energy conversions that occur in living organisms. The student is expected to:

(A) compare the [~~structures and~~] functions of different types of biomolecules, including carbohydrates, lipids, proteins, and nucleic acids;

(B) compare the reactants and products of photosynthesis and cellular respiration in terms of energy , energy conversions, and matter; and

(C) identify and investigate the role of enzymes . [~~; and~~]

[~~(D) analyze and evaluate the evidence regarding formation of simple organic molecules and their organization into long complex molecules having information such as the DNA molecule for self-replicating life.~~]

(10) Science concepts. The student knows that biological systems are composed of multiple levels. The student is expected to:

(A) describe the interactions that occur among systems that perform the functions of regulation, nutrient absorption, reproduction, and defense from injury or illness in animals;

(B) describe the interactions that occur among systems that perform the functions of transport, reproduction, and response in plants; and

(C) analyze the levels of organization in biological systems and relate the levels to each other and to the whole system.

(11) Science concepts. The student knows that biological systems work to achieve and maintain balance. The student is expected to:

[~~(A) describe the role of internal feedback mechanisms in the maintenance of homeostasis;~~]

[~~(B) investigate and analyze how organisms, populations, and communities respond to external factors;~~]

(A) [~~(C)~~] summarize the role of microorganisms in both maintaining and disrupting the health of both organisms and ecosystems; and

(B) [~~(D)~~] describe how events and processes that occur during ecological succession can change populations and species diversity.

(12) Science concepts. The student knows that interdependence and interactions occur within an environmental system. The student is expected to:

(A) interpret relationships, including predation, parasitism, commensalism, mutualism, and competition , among organisms;

(B) compare variations and adaptations of organisms in different ecosystems;

(C) analyze the flow of matter and energy through trophic levels using various models, including food chains, food webs, and ecological pyramids;

[~~(D) recognize that long-term survival of species is dependent on changing resource bases that are limited;~~]

(D) [~~(E)~~] describe the flow of matter through the carbon and nitrogen cycles and explain the consequences of disrupting these cycles; and

(E) [~~(F)~~] describe how environmental change can impact ecosystem stability.

§112.35. Chemistry [~~, Beginning with School Year 2010-2011~~] (One Credit) , Adopted 2017 .

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Required prerequisites: one unit of high school science and Algebra I. Suggested prerequisite: completion of or concurrent enrollment in a second year of mathematics [~~math~~] . This course is recommended for students in Grade 10, 11, or 12.

(b) Introduction.

(1) Chemistry. In Chemistry, students conduct laboratory and field investigations, use scientific **practices** [~~**methods**~~] during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include characteristics of matter, use of the Periodic Table, development of atomic theory and chemical bonding, chemical stoichiometry, gas laws, solution chemistry, thermochemistry, and nuclear chemistry. Students will investigate how chemistry is an integral part of our daily lives.

(2) Nature of science [~~Science~~] . Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body

of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific **practices** [~~**methods**~~] of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.

(5) Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations, including the appropriate use of safety showers, eyewash fountains, safety goggles or chemical splash goggles, as appropriate , and fire extinguishers;

(B) know specific hazards of chemical substances such as flammability, corrosiveness, and radioactivity as summarized on the [~~Material~~] Safety Data Sheets (SDS) [~~(MSDS)~~] ; and

(C) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific **practices** [~~**methods**~~] to solve investigative questions. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

(B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that [~~which~~] have been tested over a wide variety of conditions are incorporated into theories;

(C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established [~~well-established~~] and highly reliable [~~highly-reliable~~] explanations, but may be subject to change as new areas of science and new technologies are developed;

(D) distinguish between scientific hypotheses and scientific theories;

(E) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including graphing calculators, computers and probes, electronic balances, an adequate supply of consumable chemicals, and sufficient scientific glassware such as beakers, Erlenmeyer flasks, pipettes, graduated cylinders, volumetric flasks, [~~safety goggles,~~] and burettes [~~, electronic balances, and an adequate supply of consumable chemicals~~] ;

(F) collect data and make measurements with accuracy and precision;

(G) express and manipulate chemical quantities using scientific conventions and mathematical procedures, including dimensional analysis, scientific notation, and significant figures;

(H) organize, analyze, evaluate, make inferences, and predict trends from data; and

(I) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing **, so as to encourage critical thinking by the student** [~~, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student~~] ;

(B) communicate and apply scientific information extracted from various sources such as current events, [~~news reports,~~] published journal articles, and marketing materials;

(C) draw inferences based on data related to promotional materials for products and services;

(D) evaluate the impact of research on scientific thought, society, and the environment;

(E) describe the connection between chemistry and future careers; and

(F) [~~research and~~] describe the history of chemistry and contributions of scientists.

(4) Science concepts. The student knows the characteristics of matter and can analyze the relationships between chemical and physical changes and properties. The student is expected to:

(A) differentiate between physical and chemical changes and properties;

(B) identify extensive properties such as mass and volume and intensive properties such as density and melting point ;

(C) compare solids, liquids, and gases in terms of compressibility, structure, shape, and volume; and

(D) classify matter as pure substances or mixtures through investigation of their properties.

(5) Science concepts. The student understands the historical development of the Periodic Table and can apply its predictive power. The student is expected to:

(A) explain the use of chemical and physical properties in the historical development of the Periodic Table;

(B) [~~use the Periodic Table to~~] identify and explain the properties of chemical families, including alkali metals, alkaline earth metals, halogens, noble gases, and transition metals , using the Periodic Table ; and

(C) interpret [~~use the Periodic Table to identify and explain~~] periodic trends, including atomic radius [~~and ionic radii~~] , electronegativity, and ionization energy , using the Periodic Table .

(6) Science concepts. The student knows and understands the historical development of atomic theory. The student is expected to:

(A) describe [~~understand~~] the experimental design and conclusions used in the development of modern atomic theory, including Dalton's Postulates, Thomson's discovery of electron properties, Rutherford's nuclear atom, and Bohr's nuclear atom;

(B) describe [~~understand the electromagnetic spectrum and~~] the mathematical relationships between energy, frequency, and wavelength of light using the electromagnetic spectrum ;

[~~(C) calculate the wavelength, frequency, and energy of light using Planck's constant and the speed of light;~~]

(C) [~~(D)~~] [~~use isotopic composition to~~] calculate average atomic mass of an element using isotopic composition ; and

(D) [~~(E)~~] express the arrangement of electrons in atoms of representative elements using [~~through~~] electron configurations and Lewis valence electron dot structures.

(7) Science concepts. The student knows how atoms form ionic, covalent, and metallic [~~,~~ ~~and covalent~~] bonds. The student is expected to:

(A) name ionic compounds containing main group or transition metals, covalent compounds, acids, and bases [~~,~~] using International Union of Pure and Applied Chemistry (IUPAC) nomenclature rules;

(B) write the chemical formulas of [~~common polyatomic ions,~~] ionic compounds containing representative elements, [~~main group or~~] transition metals and common polyatomic ions , covalent compounds, and acids [~~,~~] and bases;

(C) construct electron dot formulas to illustrate ionic and covalent bonds;

(D) describe [~~the nature of~~] metallic bonding and [~~apply the theory to~~] explain metallic properties such as thermal and electrical conductivity, malleability, and ductility; and

(E) classify [~~predict~~] molecular structure for molecules with linear, trigonal planar, and [~~or~~] tetrahedral electron pair geometries as explained by [~~using~~] Valence Shell Electron Pair Repulsion (VSEPR) theory.

(8) Science concepts. The student can quantify the changes that occur during chemical reactions. The student is expected to:

(A) define and use the concept of a mole;

(B) [~~use the mole concept to~~] calculate the number of atoms [~~, ions,~~] or molecules in a sample of material using Avogadro's number ;

(C) calculate percent composition of compounds [~~and empirical and molecular formulas~~] ;

(D) differentiate between empirical and molecular formulas;

(E) [~~(D)~~] [~~use the law of conservation of mass to~~] write and balance chemical equations using the law of conservation of mass ; [~~and~~]

(F) differentiate among double replacement [~~**(ion swap)**~~] reactions, including acid-base reactions and precipitation reactions, and oxidation-reduction reactions

such as synthesis, decomposition, single replacement, and combustion reactions;

(G) [~~(E)~~] perform stoichiometric calculations, including determination of mass and gas volume relationships between reactants and products [~~, calculation of limiting reagents,~~] and percent yield ; and [~~.~~]

(H) describe the concept of limiting reactants in a balanced chemical equation.

(9) Science concepts. The student understands the principles of ideal gas behavior, kinetic molecular theory, and the conditions that influence the behavior of gases. The student is expected to:

(A) describe and calculate the relations between volume, pressure, number of moles, and temperature for an ideal gas as described by Boyle's law, Charles' law, Avogadro's law, Dalton's law of partial pressure, and the ideal gas law; and

[~~(B) perform stoichiometric calculations, including determination of mass and volume relationships between reactants and products for reactions involving gases; and~~]

(B) [~~(C)~~] describe the postulates of kinetic molecular theory.

(10) Science concepts. The student understands and can apply the factors that influence the behavior of solutions. The student is expected to:

(A) describe the unique role of water in solutions in terms of polarity [~~chemical and biological systems~~] ;

(B) apply the [~~develop and use~~] general rules regarding solubility through investigations with aqueous solutions;

(C) calculate the concentration of solutions in units of molarity;

(D) [~~use molarity to~~] calculate the dilutions of solutions using molarity ;

(E) distinguish among [~~between~~] types of solutions such as electrolytes and nonelectrolytes ; [~~and~~] unsaturated, saturated, and supersaturated solutions ; and strong and weak acids and bases ;

(F) investigate factors that influence solid and gas solubilities and rates of dissolution such as temperature, agitation, and surface area;

(G) define acids and bases and distinguish between Arrhenius and Bronsted-Lowry definitions and predict products in acid-base [~~acid base~~] reactions that form water; and

[~~(H) understand and differentiate among acid-base reactions, precipitation reactions, and oxidation-reduction reactions;~~]

(H) [~~(I)~~] define pH and [~~use the hydrogen or hydroxide ion concentrations to~~] calculate the pH of a solution using the hydrogen ion concentration. [~~; and~~]

[~~(J) distinguish between degrees of dissociation for strong and weak acids and bases.~~]

(11) Science concepts. The student understands the energy changes that occur in chemical reactions. The student is expected to:

(A) describe [~~understand~~] energy and its forms, including kinetic, potential, chemical, and thermal energies;

(B) describe [~~understand~~] the law of conservation of energy and the processes of heat transfer in terms of calorimetry ;

(C) classify reactions as exothermic or endothermic and represent energy changes that occur in chemical reactions using [~~use~~] thermochemical equations or graphical analysis [~~to calculate energy changes that occur in chemical reactions and classify reactions as exothermic or endothermic~~] ; and

(D) perform calculations involving heat, mass, temperature change, and specific heat . [~~; and~~]

[~~(E) use calorimetry to calculate the heat of a chemical process.~~]

(12) Science concepts. The student understands the basic processes of nuclear chemistry. The student is expected to:

(A) describe the characteristics of alpha, beta, and gamma radioactive decay processes in terms of balanced nuclear equations [~~radiation~~]; and

[~~(B) describe radioactive decay process in terms of balanced nuclear equations; and~~]

(B) [~~(C)~~] compare fission and fusion reactions.

§112.38. Integrated Physics and Chemistry [~~, Beginning with School Year 2010-2011~~] (One Credit) , Adopted 2017 .

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Prerequisites: none. This course is recommended for students in Grade 9 or 10.

(b) Introduction.

(1) Integrated Physics and Chemistry. In Integrated Physics and Chemistry, students conduct laboratory and field investigations, use scientific **practices** [~~**methods**~~] during investigation, and make informed decisions using critical thinking and scientific problem solving. This course integrates the disciplines of physics and chemistry in the following topics: force, motion, energy, and matter.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable.

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation are experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods (scientific practices) and ethical and social decisions that involve science (the application of scientific information).

(5) Science, systems, and models. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in

space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations , including the appropriate use of safety showers, eyewash fountains, safety goggles or chemical splash goggles, as appropriate, and fire extinguishers ; [~~and~~]

(B) know specific hazards of chemical substances such as flammability, corrosiveness, and radioactivity as summarized on the Safety Data Sheets (SDS); and

(C) [~~(B)~~] demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific **practices** [~~**methods**~~] during laboratory and field investigations. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

(B) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology;

(C) collect data and make measurements with accuracy and precision;

(D) organize, analyze, evaluate, make inferences, and predict trends from data; and

(E) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphs, journals, summaries, oral reports, and technology-based reports .

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing **, so as to encourage critical thinking by the student** [~~, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student~~] ;

(B) communicate and apply scientific information extracted from various sources such as current events, [~~news reports,~~] published journal articles, and marketing materials;

(C) draw inferences based on data related to promotional materials for products and services;

(D) evaluate the impact of research on scientific thought, society, and the environment;

(E) describe connections between physics and chemistry and future careers; and

(F) research and describe the history of physics and chemistry and contributions of scientists.

(4) Science concepts. The student knows concepts of force and motion evident in everyday life. The student is expected to:

(A) describe and calculate an object's motion in terms of position, displacement, speed, and acceleration;

(B) measure and graph distance and speed as a function of time [~~using moving toys~~] ;

(C) investigate how an object's motion changes only when a net force is applied, including activities and equipment such as toy cars, vehicle restraints, sports activities, and classroom objects;

(D) describe and calculate [~~assess~~] the relationship between force, mass, and acceleration [~~, noting the relationship is independent of the nature of the force,~~] using equipment such as dynamic carts, moving toys, vehicles, and falling objects;

(E) explain [~~apply~~] the concept of conservation of momentum using action and reaction forces [~~such as students on skateboards~~] ;

(F) describe the gravitational attraction between objects of different masses at different distances [~~, including satellites~~] ; and

(G) examine electrical force as a universal force between any two charged objects [~~and compare the relative strength of the electrical force and gravitational force~~] .

(5) Science concepts. The student recognizes multiple forms of energy and knows the impact of energy transfer and energy conservation in everyday life. The student is expected to:

(A) recognize and demonstrate that objects and substances in motion have kinetic energy such as vibration of atoms, water flowing down a stream moving pebbles, and bowling balls knocking down pins;

(B) recognize and demonstrate common forms of potential energy, including gravitational, elastic, and chemical, such as a ball on an inclined plane, springs, and batteries;

(C) demonstrate that moving electric charges produce magnetic forces and moving magnets produce electric forces;

(D) investigate the law of conservation of energy;

(E) investigate and demonstrate the movement of thermal energy through solids, liquids, and gases by convection, conduction, and radiation such as in weather, living, and mechanical systems;

(F) evaluate the transfer of electrical energy in series and parallel circuits and conductive materials;

(G) explore the characteristics and behaviors of energy transferred by waves, including acoustic, seismic, light, and waves on water , as they reflect, refract, diffract, interfere with [~~superpose on~~] one another, and [~~bend around corners, reflect off surfaces,~~] are absorbed by materials [~~, and change direction when entering new materials~~] ;

(H) analyze energy transformations of renewable and nonrenewable resources [~~conversions such as those from radiant, nuclear, and geothermal sources; fossil fuels such as coal, gas, oil; and the movement of water or wind~~] ; and

(I) critique the advantages and disadvantages of various energy sources and their impact on society and the environment.

(6) Science concepts. The student knows that relationships exist between the structure and properties of matter. The student is expected to:

(A) examine differences in physical properties of solids, liquids, and gases as explained by the arrangement and motion of atoms [~~, ions,~~] or molecules [~~of the substances and the strength of the forces of attraction between those particles~~] ;

(B) relate chemical properties of substances to the arrangement of their atoms [~~or molecules~~] ;

(C) analyze physical and chemical properties of elements and compounds such as color, density, viscosity, buoyancy, boiling point, freezing point, conductivity, and reactivity;

(D) relate the placement of an element on the Periodic Table to its physical and chemical behavior [~~of an element~~] , including bonding and classification [~~, to its placement on the Periodic Table~~] ; [~~and~~]

(E) relate the structure of water to its function as a solvent ; and [~~and investigate the properties of solutions and factors affecting gas and solid solubility, including nature of solute, temperature, pressure, pH, and concentration.~~]

(F) investigate the properties of water solutions and factors affecting solid solubility, including nature of solute, temperature, and concentration.

(7) Science concepts. The student knows that changes in matter affect everyday life. The student is expected to:

(A) investigate changes of state as it relates to the arrangement of particles of matter and energy transfer;

(B) recognize that chemical changes can occur when substances react to form different substances and that these interactions are largely determined by the valence electrons;

(C) demonstrate that mass is conserved when substances undergo chemical change and that the number and kind of atoms are the same in the reactants and products;

(D) classify [~~analyze~~] energy changes that accompany chemical reactions such as those occurring in heat packs, cold packs, and glow sticks [~~and classify them~~] as exothermic or endothermic reactions;

(E) describe types of nuclear reactions such as fission and fusion and their roles in applications such as medicine and energy production; and

(F) research and describe the environmental and economic impact of the end-products of chemical reactions such as those that may result in acid rain, degradation of water and air quality, and ozone depletion.

§112.39. Physics [~~, Beginning with School Year 2010-2011~~] (One Credit) , Adopted 2017 .

(a) General requirements. Students shall be awarded one credit for successful completion of this course. Algebra I is suggested as a prerequisite or corequisite [~~co-requisite~~] . This course is recommended for students in Grade 9, 10, 11, or 12.

(b) Introduction.

(1) Physics. In Physics, students conduct laboratory and field investigations, use scientific **practices** [~~**methods**~~] during investigations, and make informed decisions using critical thinking and scientific problem solving. Students study a variety of topics that include:

laws of motion; changes within physical systems and conservation of energy and momentum; forces; thermodynamics; characteristics and behavior of waves; and atomic, nuclear, and quantum physics. Students who successfully complete Physics will acquire factual knowledge within a conceptual framework, practice experimental design and interpretation, work collaboratively with colleagues, and develop critical-thinking [~~critical thinking~~] skills.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not currently scientifically testable by empirical science .

(3) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world. Scientific methods of investigation can be experimental, descriptive, or comparative. The method chosen should be appropriate to the question being asked.

(4) Science and social ethics. Scientific decision making is a way of answering questions about the natural world. Students should be able to distinguish between scientific decision-making methods and ethical and social decisions that involve the application of scientific information.

(5) Scientific systems. A system is a collection of cycles, structures, and processes that interact. All systems have basic properties that can be described in terms of space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(6) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

(1) Scientific processes. The student conducts investigations, for at least 40% of instructional time, using safe, environmentally appropriate, and ethical practices. These investigations must involve actively obtaining and analyzing data with physical equipment [~~,~~] but may also involve experimentation in a simulated environment as well as field observations that extend beyond the classroom. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations; and

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses a systematic approach to answer scientific laboratory and field investigative questions. The student is expected to:

(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;

(B) know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence [~~.~~ ~~Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories~~] ;

(C) know that scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established [~~well-established~~] and highly reliable [~~highly-reliable~~] explanations, but may be subject to change [~~as new areas of science and new technologies are developed~~] ;

[~~(D) distinguish between scientific hypotheses and scientific theories;~~]

(D) [~~(E)~~] design and implement investigative procedures, including making observations, asking well defined [~~well-defined~~] questions, formulating testable **hypotheses** , identifying variables, selecting appropriate equipment and technology, [~~and~~] evaluating numerical answers for reasonableness , and identifying causes and effects of uncertainties in measured data ;

(E) [~~(F)~~] demonstrate the use of course apparatus, equipment, techniques, and procedures, including multimeters (current, voltage, resistance), [~~triple beam~~] balances, batteries, [~~clamps,~~] dynamics demonstration equipment, collision

apparatus, [~~data acquisition probes, discharge tubes with power supply (H, He, Ne, Ar), hand-held visual spectroscopes, hot plates, slotted and hooked~~] lab masses, [~~bar~~] magnets, [~~horseshoe magnets,~~] plane mirrors, convex lenses, [~~pendulum support, power supply, ring clamps, ring stands,~~] stopwatches, trajectory apparatus, [~~tuning forks, carbon paper,~~] graph paper, magnetic compasses, [~~polarized film, prisms,~~] protractors, [~~resistors, friction blocks, mini-lamps (bulbs) and sockets, electrostatics kits, 90-degree rod clamps,~~] metric rulers, spring scales, [~~knife blade switches, Celsius~~] thermometers, [~~meter sticks, scientific calculators, graphing technology, computers, cathode ray tubes with horseshoe magnets, ballistic carts or equivalent, resonance tubes, spools of nylon thread or string, containers of iron filings, rolls of white craft paper, copper wire, Periodic Table, electromagnetic spectrum charts,~~] slinky springs, and/or other equipment and materials that will produce the same results [~~wave motion ropes, and laser pointers~~] ;

(F) [~~(G)~~] use a wide variety of additional course apparatus, equipment, techniques, materials, and procedures as appropriate such as ripple tank with wave generator, wave motion rope, tuning forks, hand-held visual spectroscopes, discharge tubes with power supply (H, He, Ne, Ar), electromagnetic spectrum charts, laser pointers, micrometer, caliper, [~~radiation monitor,~~] computer, data acquisition probes, scientific calculators, graphing technology, electrostatic kits, [~~ballistic pendulum,~~] electroscope, inclined plane, optics bench, optics kit, polarized film, prisms, pulley with table clamp, motion detectors, photogates, friction blocks, ballistic carts or equivalent, resonance tube, [~~ring stand screen, four inch ring,~~] stroboscope, resistors, copper wire, switches, iron filings, and/or other equipment and materials that will produce the same results [~~graduated cylinders, and ticker timer~~] ;

(G) [~~(H)~~] make measurements with accuracy and precision and record data using scientific notation and International System (SI) units;

[~~(I) identify and quantify causes and effects of uncertainties in measured data;~~]

(H) [~~(J)~~] organize , [~~and~~] evaluate , [~~data~~] and make inferences from data, including the use of tables, charts, and graphs;

(I) [~~(K)~~] communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports; and

(J) [~~(L)~~] express [~~and manipulate~~] relationships among physical variables quantitatively, including the use of graphs, charts, and equations.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(A) [~~in all fields of science,~~] analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing **, so as to encourage critical thinking by the student** [~~, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student~~] ;

(B) communicate and apply scientific information extracted from various sources such as current events, news reports, published journal articles, and marketing materials;

[~~(C) draw inferences based on data related to promotional materials for products and services;~~]

(C) [~~(D)~~] explain the impacts of the scientific contributions of a variety of historical and contemporary scientists on scientific thought and society;

(D) [~~(E)~~] research and describe the connections between physics and future careers; and

(E) [~~(F)~~] express , manipulate, and interpret relationships symbolically in accordance with accepted theories to make predictions and solve problems mathematically [~~, including problems requiring proportional reasoning and graphical vector addition~~] .

(4) Science concepts. The student knows and applies the laws governing motion in a variety of situations. The student is expected to:

(A) generate and interpret graphs and charts describing different types of motion, including investigations using [~~the use of~~] real-time technology such as motion detectors or photogates;

(B) describe and analyze motion in one dimension using equations and graphical vector addition with the concepts of distance, displacement, speed, average velocity, instantaneous velocity, frames of reference, and acceleration;

(C) analyze and describe accelerated motion in two dimensions , including using equations, graphical vector addition, and [~~including~~] projectile and circular examples; and

(D) calculate the effect of forces on objects, including the law of inertia, the relationship between force and acceleration, and the nature of force pairs between objects using methods, including free-body force diagrams. [~~;~~]

[~~(E) develop and interpret free-body force diagrams; and~~]

[~~(F) identify and describe motion relative to different frames of reference.~~]

(5) Science concepts. The student knows the nature of forces in the physical world. The student is expected to:

(A) [~~research and~~] describe the [~~historical development of the~~] concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces;

(B) describe and calculate how the magnitude of the gravitational force between two objects depends on their masses and the distance between their centers;

(C) describe and calculate how the magnitude of the electric [~~electrical~~] force between two objects depends on their charges and the distance between their centers [~~them~~] ;

(D) identify and describe examples of electric and magnetic forces and fields in everyday life such as generators, motors, and transformers ;

(E) characterize materials as conductors or insulators based on their electric [~~electrical~~] properties; and

(F) investigate [~~design, construct,~~] and calculate [~~in terms of~~] current through, potential difference across, resistance of, and power used by electric circuit elements connected in both series and parallel combinations . [~~;~~]

[~~(G) investigate and describe the relationship between electric and magnetic fields in applications such as generators, motors, and transformers; and~~]

[~~(H) describe evidence for and effects of the strong and weak nuclear forces in nature.~~]

(6) Science concepts. The student knows that changes occur within a physical system and applies the laws of conservation of energy and momentum. The student is expected to:

(A) investigate and calculate quantities using the work-energy theorem in various situations;

(B) investigate examples of kinetic and potential energy and their transformations;

(C) calculate the mechanical energy of, power generated within, impulse applied to, and momentum of a physical system;

(D) demonstrate and apply the laws of conservation of energy and conservation of momentum in one dimension; and

[~~(E) describe how the macroscopic properties of a thermodynamic system such as temperature, specific heat, and pressure are related to the molecular level of matter, including kinetic or potential energy of atoms;~~]

[~~(F) contrast and give examples of different processes of thermal energy transfer, including conduction, convection, and radiation; and~~]

(E) [~~(G)~~] [~~analyze and~~] explain everyday examples that illustrate the four laws of thermodynamics and the processes of thermal energy transfer [~~, including the law of conservation of energy and the law of entropy~~] .

(7) Science concepts. The student knows the characteristics and behavior of waves. The student is expected to:

(A) examine and describe oscillatory motion and wave propagation in various types of media;

(B) investigate and analyze characteristics of waves, including velocity, frequency, amplitude, and wavelength, and calculate using the relationship between wavespeed, frequency, and wavelength;

(C) compare characteristics and behaviors of transverse waves, including electromagnetic waves and the electromagnetic spectrum, and characteristics and behaviors of longitudinal waves, including sound waves;

(D) investigate behaviors of waves, including reflection, refraction, diffraction, interference, resonance, and the Doppler effect; and

(E) describe and predict image formation as a consequence of reflection from a plane mirror and refraction through a thin convex lens . [~~; and~~]

[~~(F) describe the role of wave characteristics and behaviors in medical and industrial applications.~~]

(8) Science concepts. The student knows simple examples of atomic, nuclear, and quantum phenomena. The student is expected to:

(A) describe the photoelectric effect and the dual nature of light;

(B) compare and explain the emission spectra produced by various atoms;

(C) calculate and describe the applications [~~significance~~] of mass-energy equivalence [~~and apply it in explanations of phenomena such as nuclear stability, fission, and fusion~~] ; and

(D) give examples of applications of atomic and nuclear phenomena using the standard model such as nuclear stability, fission and fusion, radiation therapy, diagnostic imaging, semiconductors, superconductors, solar cells, and nuclear power and examples of applications of quantum phenomena [~~such as digital cameras~~] .