

## **REVIEW MINNESOTA ACADEMIC STANDARDS SCIENCE (First Draft) by Audrey Champagne**

This review addresses the structural organization, content, and ease of translation into assessments of the Science Academic Standards. The review concludes with recommendations for reconsideration of the content and form of the Standards and Benchmarks

### **Background information**

Holds a dual appointment on the faculty of the University at Albany, a unit of the State University of New York. She is a professor in the School of Education and in the Chemistry Department of the School of Arts and Sciences. She is an active researcher and engaged extensively in the application of research to improve science education in grades K through 16. Her current research is funded by the Department of Education's Office of Educational Research and Improvement and the National Science Foundation's Division of Elementary, Secondary, and Informal Education. She frequently serves on review panels for the National Science Foundation's Directorate for Education and Human Resources.

### **Structural Organization**

The structural organization of the Standards is functional. The organization by grade and strand makes it easy to follow (1)the development of knowledge and abilities within a strand across grade levels and (2)the development of knowledge and abilities across strands with in a grade level. The intended development of knowledge and abilities is transparent and gaps in the development within a strand are easily identified.

There are obvious gaps in the development. For instance, a Grade 1 Benchmark is “[s]tudents will observe and describe plant and animal life cycles.” However, the Standards do not show that students are expected to know the differences between plants and animal at the time they are expected to know their life cycles.

Another instance is a Grade 3 Standard, “(t)he student will describe the properties of rocks and minerals.” In this case the Standard does not say that students should know what distinguishes rocks from minerals either on the basis of physical properties or chemical composition, however, the Benchmark for the Standard suggests that a criteria for sorting is to differentiate rocks and minerals.

This problem is especially serious in the History and Nature of Science Strand in the upper grades where constructs such as culture, societal norms, ethical, and moral are used in Standards and Benchmarks absent any suggestion of the development of these ideas in the Standards.

An especially commendable feature of the Standards are the Benchmarks for every grade level. In my experience Standards documents with benchmark level expectations specified only for the grades at which assessments are to be administered, leaves the impression that preparation for state-mandated tests is the sole responsibility of the teachers of the grade at which the students are tested.

### **Content Breadth and Depth**

The framers of the Science Academic Standards are to be complemented on the breadth of science content included especially the inclusion of the History and Nature of Science Strand and Evolution in the Life Science Strand.

Within each Strand the depth of content and difficulty are notable. Overall, the expectations for student performance are very high, even too high if all students are expected to meet the standards. In my judgment, the depth and difficulty of the science content standards for 9-12 may be more than it is reasonable to expect of all 9-12 grade students. The standards strike me as being difficult even for students intending to go on to post secondary academic studies. An example of particularly challenging content (to me at least) is suggested in the Grade 9-12, Life Science, Organisms, Benchmark: “*Students will be able to use scientific evidence, including the fossil record, homologous structures, embryological development, or biochemical similarities to classify organisms showing probable evolutionary relationships and common ancestry.*”

Ideas from the physical sciences, especially those related to Sub-strand D, Motion,(page 25), are conceptually challenging to students in my methods courses who have had at least four semesters of college physics.

Overall, the History and Nature of Science Strand contains many difficult ideas from the history and philosophy of science that may be beyond the general knowledge and reasoning abilities of the students at the grade level in which they are introduced. For instance, the introduction of controlled experiment in grade 5 and understanding the attributes of facts , hypotheses, theories and laws in grade 7 are open to question when the logical reasoning requirements of constructs such as variable, control hypotheses, theory and law are considered in light of the level of cognitive development of typical 10-13 year olds.

On a copy of the Standards I have noted the early introduction of concepts such as gravity and density at grade 1.

I hasten to note that my judgment of the difficulty of the Standards and Benchmarks is based on my interpretation of their meaning. Many of the Standards and Benchmarks are statements of difficult scientific principles. What the Standards do not make clear is depth of understanding that is expected. It is possible the I am inferring a greater depth of understanding than the framers of the Standards intended.

### **Content Consistency and Accuracy Quibbles**

The Standard and Benchmark posed another interpretation challenge. It seems that an attempt has been made to state scientific principles in less formal language than they would appear in a science textbook. I found that in some instances language lacks scientific precision. I have noted examples in the Standards document where I had difficulty interpreting the intended meaning of the statements or felt that the language so lacked precision that the statement was technically incorrect. An example:

“Students will know that the Earth’s gravity pulls objects towards it without touching the objects.” At issue is the idea that the Earth pulls when in fact gravitation force is a force of attraction between two masses.

**Experiment and Investigation** are used interchangeably through out the Science Standards Document. Some thought should be given to the use of these terms. If they mean the same thing, then use a single term. If the intention is to signal differences in the sophistication of inquiry of younger students doing investigations to answer a question and that of older students doing controlled experiments to test a hypothesis, the distinction should be made and the terms used consistently.

**Technology and Engineering Design-** Technology is a term with at least four distinct meanings in every-day language, tools such as computers, a method of design used by engineers, the products of the design process and the application of science. Technology is used in all these ways in the

Standards document, sometimes sending conflicting information. For instance, notice in the third and fifth bullets below, contradictory statements are made about the relationship of science and technology.

- *Students will use appropriate technology and mathematics skills to access, gather, store, retrieve and organize data.*

**Is the point of this Benchmark that students will use pencils or computers, each of which is a technological tool?**

- *The student will know that science and technology are highly vigorous human efforts that both influence and are influenced by civilizations worldwide.*
- *Students will explain that technology is the application of science in order to find solutions to societies' wants and needs.*

**This statement sends an incorrect message about the relationship of science and technology. Bridges were built long before the principles of statics became a part of science.**

- *The student will understand how scientific discovery, culture, societal norms, and technology have influenced one another in different time periods.*
- *Students will know that the development of technology drives scientific investigation and explanations and that scientific knowledge drives the development of technology.*
- *Students will compare and contrast the goals and career opportunities of engineering/technology and science.*

**Equating engineering and technology in this Benchmark is questionable. While the early technologists functioned using trial and error, (they built cathedrals which often collapsed) , engineers follow formal design principles.**

My recommendation is that the Standards document be reviewed carefully for its use of technology.

### **Challenges to Assessment Design**

I read the Standards document as a person with considerable experience in the design of assessment frameworks, items (multiple choice and constructed response), and performance tasks. For each Benchmark I asked the following questions: What evidence would the users of data from a test designed to measure students attainment of these Standards accept that a student has met this Benchmark? How would I obtain the evidence? In many instances, I found it difficult to answer these questions.

One reason for the difficulty is in the Conceptual Framework document where declarative and procedural knowledge are defined. I struggled to apply these definitions to the Standard and Benchmark statements. In many cases the Standard is stated in terms of understanding but the corresponding Benchmark is stated as a skill. For instance:

Standard: *The student will understand that plants and animals have life cycles.*  
Benchmark: *Students will observe and describe plant and animal life cycles.*

As an item developer, I can develop items to test students' understanding of life cycle but would find it difficult to develop items testing students' ability to observe plant and animal life cycles.

This is a serious matter because all of the Benchmarks for Kindergarten and grade one and many for grade 2 are stated as "observe and describe," but there is no explicit mention of what students will be expected to know, for instance, the difference between living and non-living things, plants and animals or "features" of the body. This leaves me with the impression that the Benchmarks describe what children will be doing in class as learning activities, not knowledge and skills that they are expected to know and be able to do at the end of kindergarten and grades 1 and 2.

Not only is there some inconsistency between the Standards and Benchmarks with regard to the verbs but also the concepts. For instance, consider the Grade 6, Physical Science, Sub-Strand E Forces of Nature Standard and Benchmarks below.

The Standard mentions motion but only forces are addressed in the Benchmarks. With regard to forces, it is not clear which "objects are governed" by which forces. Yes, I realize that motion is addressed in Sub-strand D, but what implications does the separation of the two Sub-strands have for measuring students' attainment of each Sub-strand? Is the intention that the two Sub-strands be tested together? In what contexts will they be assessed: forces on and motion of celestial bodies, automobiles, atoms, electrons in electric circuits, electrons in atoms...?

Standard: *The student will understand that the structure and motion of objects in the universe are governed by different forces.*  
Benchmarks:

- *Students will know that every object exerts gravitational force on every other object.*
- *Students will know that gravitational force between two objects depends on how much mass the objects have and on how far apart they are.*
- *Students will know that gravitational force is hard to detect unless at least one of the objects has a lot of mass.*
- *Students will know that electric currents and magnets can exert a force on certain objects and each other.*
- *Students will recognize that gravitational forces are weak compared to electric and magnetic.*

Another issue for the item developer is the difference, if any, between understanding and knowing. In some instances the verb, understand, is used and in other instances, know. Did the framers of the Standards mean to distinguish between understanding and knowing? The Standard and Benchmark below illustrate this point. What evidence would the framers of the standards accept that students understand that plants and animals have life cycles? Would that evidence be different from evidence that they know that plants and animals have life cycles? In either case is observing, describing and comparing evidence of knowing or understanding. To make this point I have used relatively simple content. However, the issue also arises at the higher grades.

Standard: *The student will understand that plants and animals have life cycles*

Benchmark: *Students will observe, describe, compare and contrast plant and animal life cycles.*

**Recommendations**

This draft of the Science Standard has much to commend. However, the Standards and Benchmarks are open to wide interpretation. I suggest that the framers begin a review of the Standards and Benchmarks with the following question in mind:

What evidence will they accept that students have attained the Standard and Benchmarks?

Having answered that question, they need to carefully review

- The difficulty of the science content all students are expected to learn
- Alignment of Standards with their associated Benchmarks
- Gaps in the developmental sequence of knowledge and skills
- Precision and accuracy of the statements scientific principles

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Grade Level	Strand	Sub-Strand	Standard	Benchmarks
KINDER GARTEN	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will raise questions about the world around them, <b>make careful observations</b> , and seek answers to them. <i>I assume this means seek answers to the questions not the observations</i>	<ul style="list-style-type: none"> <li>▪ Students will observe and describe common objects using simple tools.</li> <li>▪ <b>Students will follow appropriate safety behavior in their investigations. For example, the use of goggles, heat sources, electricity, glass, and chemicals and biological materials.</b></li> </ul> <p><i>It seems to me that this is a teacher responsibility If it is deemed necessary to have a safety benchmark at different levels, a more reasonable benchmark is have students able to argue for the reasonableness of the safety standards.</i></p>
KINDER GARTEN	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand weather changes.	<ul style="list-style-type: none"> <li>▪ Students will observe and describe daily and seasonal changes in weather.</li> </ul>
KINDER GARTEN	IV. LIFE SCIENCE	B. Organisms	The student will understand that there are living and nonliving things.	<ul style="list-style-type: none"> <li>▪ Students will compare and contrast living and nonliving things.</li> </ul>
KINDER GARTEN	IV. LIFE SCIENCE	G. Human Organism	The student will understand that they have five senses.	<ul style="list-style-type: none"> <li>▪ Students will observe and describe the environment through their five senses.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 1	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will raise questions about the world around them, make careful observations, and seek answers to them.	<ul style="list-style-type: none"> <li>Students will observe, describe, measure, compare, and contrast common objects using simple tools.</li> </ul>
GRADE 1	II. PHYSICAL SCIENCE	A. Structure of Matter	The student will understand that <b>materials</b> have physical properties.	<ul style="list-style-type: none"> <li>Students will observe and describe properties of <b>objects</b>, (e.g., color, size, shape, weight, texture, flexibility, attraction to magnets and density (floating and sinking)) <i>Is it materials or object or both. Distinguishing between an object- a plastic jar and the material it is made from is a challenging concept. Students and elementary teachers find it a challenge to distinguish the density of a glass jar and the density of the glass from which it made. Surely the intention is not to introduce density in kindergarten!</i></li> </ul>
GRADE 1	II. PHYSICAL SCIENCE	E. Forces of Nature	The student will understand that forces can act at a distance with no <i>substance</i> in between. <i>Is the intention to distinguish between substance and material?</i>	<ul style="list-style-type: none"> <li>Students will observe and describe that magnetism and <b>gravity</b> can affect objects without being touched. <i>At grade 1!</i></li> </ul>
GRADE 1	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	Student will understand weather changes.	<ul style="list-style-type: none"> <li>Students will observe, record, and describe characteristics in daily weather and seasonal cycles. <i>Which features of the weather? Temperature, clouds, precipitation, barometric pressure... I assume that the intention is yearly cycle?</i></li> </ul>
GRADE 1	IV. LIFE SCIENCE	B. Organisms	The student will understand that plants and animals have life cycles.	<ul style="list-style-type: none"> <li>Students will observe and describe plant and animal life cycles. <i>Are the students expected to know about life cycles and offspring before they are introduced to the difference between plants and animals?</i></li> </ul>
GRADE 1	IV. LIFE SCIENCE	D. Heredity	The student will understand there is variation among individuals of one kind within a population and offspring are very much but not exactly like their parents and like one another.	<ul style="list-style-type: none"> <li>Students will describe ways in which many plants and animals closely resemble their parents.</li> <li>Students will match adult animals and plants to their offspring. <i>The first benchmark that is stated in a way that can be measured.</i></li> </ul>
GRADE 1	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will understand that organisms have basic needs.	<ul style="list-style-type: none"> <li>Students will observe and describe basic needs of organisms, including, but not limited to, <b>nutrients</b>, air, water and <b>shelter</b>. <i>How are you defining nutrient? Plants need minerals but not other compounds called nutrients that are required by animals. Shelter is not a basic need of all organisms.</i></li> </ul>
GRADE 1	IV. LIFE SCIENCE	G. Human Organism	The student will <b>understand</b> that the human body is made up of parts. <i>Or know?</i>	<ul style="list-style-type: none"> <li>Students will observe and describe major parts of the body, including, but not limited to, lungs, heart, skin, bones, muscles, and brain. <i>Several of these are difficult to observe!</i></li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 2	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will understand that science is a human endeavor practiced by civilizations throughout the world.	<ul style="list-style-type: none"> <li>Students will know that when a science investigation or experiment is repeated, we expect to get a very similar result.</li> </ul> <i>A very sophisticated idea for grade 2 students.</i>
GRADE 2	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will raise questions about the world around them, make careful observations, and seek answers to them.	<ul style="list-style-type: none"> <li>Students will observe, describe, measure, compare and contrast common objects using simple tools.</li> <li>Students will organize <b>observable</b> data and describe patterns.</li> </ul> <i>I guess that they will need to see the data to describe patterns.</i> <ul style="list-style-type: none"> <li>Students will follow appropriate safety behavior in their investigations. For example, the use of goggles, heat sources, electricity, glass, and chemicals and biological materials.</li> </ul>
GRADE 2	II. PHYSICAL SCIENCE	A. Structure of Matter	The student will understand that <b>materials</b> exist in the basic states of matter. <i>The materials/matter distinction is confusing.</i>	<ul style="list-style-type: none"> <li>Students will observe and describe three states of matter (e.g., solid, liquid or gas).</li> <li>Students will observe that solids have a definite shape and that liquids and gases take the shape of their container.</li> </ul>
GRADE 2	II. PHYSICAL SCIENCE	D. Motion	The student will understand that objects move in various ways.  <b>How are skills of observing and describing measures of understanding?</b>	<ul style="list-style-type: none"> <li>Students will observe and describe how objects move (e.g., straight line, zigzag, back-and-forth, round-and-round, and fast and slow).</li> <li>Students will observe and describe different forces that can make objects move, (e.g., push, pull, and spin).</li> </ul>
GRADE 2	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will understand basic earth materials. <i>Earth or earth?</i> <i>What does it mean to understand Earth materials?</i>	<ul style="list-style-type: none"> <li>Students will observe and describe the basic earth materials, such as rocks, soils, waters and gases.</li> </ul>
GRADE 2	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand the water cycle.	<ul style="list-style-type: none"> <li>Students will observe and describe the cycle of water as it moves through the environment.</li> </ul> <i>Does the cycle move through the environment or the water?</i> <ul style="list-style-type: none"> <li>Students will observe and describe the relationship between the water cycle and the weather.</li> </ul> <i>Quite sophisticated for second graders.</i>
GRADE 2	III. EARTH AND SPACE SCIENCE	C. The Solar System	The student will understand some relationships between the earth, moon and sun.	<ul style="list-style-type: none"> <li>Students will observe that the sun supplies heat and light to the earth.</li> <li>Students will observe that the sun and the moon are not always in the same place.</li> </ul>
GRADE 2	IV. LIFE SCIENCE	B. Organisms	The student will understand that plants and animals have life cycles.	<ul style="list-style-type: none"> <li>Students will observe, describe, compare and contrast plant and animal life cycles.</li> </ul> <i>Which plants and which animals and what features of differences are students expected to know?</i>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 2	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	The student will understand that organisms live in different environments that are suited to their needs.	<ul style="list-style-type: none"> <li>Students will observe and describe some features that plants and animals have that allow them to live in specific environments.</li> </ul> <i>Which features at grade 2?</i>
GRADE 2	IV. LIFE SCIENCE	E. Biological Populations Change Over Time	The student will understand that biological populations change over time.	<ul style="list-style-type: none"> <li>Students will observe that some kinds of organisms that once lived on earth have completely disappeared, including, but not limited to, dinosaurs, trilobites, mammoths, giant tree ferns, and horsetail trees.</li> </ul> <i>At grade 2? How can they observe this?</i>
GRADE 2	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will understand some relationships among organisms.	<ul style="list-style-type: none"> <li>Students will observe and describe predator and prey relationships.</li> <li>Students will compare and contrast plant eaters, and meat eaters.</li> </ul>
GRADE 2	IV. LIFE SCIENCE	G. Human Organism	The student will understand that the human body is made up of organs and systems.	<ul style="list-style-type: none"> <li>Students will observe and describe major organs, and understand that they work together as systems.</li> </ul> <i>Lungs, heart ? More instances of the understand/observe describe</i>
GRADE 3	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will understand the relationship between science and the environment.	<ul style="list-style-type: none"> <li>Students will understand that science should be used responsibly.</li> <li>Students will understand that science is a tool that can help investigate and solve environmental concerns.</li> </ul> <i>At grade 3?</i>
GRADE 3	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will understand the nature of scientific investigations.	<ul style="list-style-type: none"> <li>Students will ask questions that can be investigated scientifically.</li> <li>Students will participate in a scientific investigation.</li> <li>Students choose appropriate tools and materials for measurement, and/or observation and/or construction in scientific investigation.</li> <li>Students will follow appropriate safety behavior in their investigations. For example, the use of goggles, heat sources, electricity, glass, and chemicals and biological materials.</li> </ul>
GRADE 3	II. PHYSICAL SCIENCE	C. Energy Transformations	Students understand the characteristics and properties of sound.	<ul style="list-style-type: none"> <li>Students will know that sound is produced by vibrating objects.</li> <li>Students will know that sound travels through air, water and other materials.</li> <li>Students will know that sound can be reflected as an echo.</li> <li>Students will know that something can be heard when sounds enter the ear.</li> </ul> <i>Sound or ai</i>
GRADE 3	II. PHYSICAL SCIENCE	C. Energy Transformations	The student will understand the characteristics and properties of light.	<ul style="list-style-type: none"> <li>Students will know that light travels in a straight line until it stopped by an object.</li> <li>Students will know that light can be reflected.</li> <li>Students will know that light can cause change.</li> <li>Students will know that an object is seen when light from the object enters the eye.</li> </ul>
GRADE 3	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will describe the properties of rocks and minerals.	<ul style="list-style-type: none"> <li>Students will group rocks and minerals based on shared physical characteristics.</li> </ul> <i>Which properties? How will they distinguish rocks from minerals?</i>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 3	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will observe the weather in terms of temperatures, wind speed, wind direction, precipitation, and sky cover.	<ul style="list-style-type: none"> <li>Students will measure and record weather conditions using classical, non-digital instruments.</li> <li>Students will identify major cloud types such as cumulus, cirrus, and stratus.</li> </ul>
GRADE 3	III. EARTH AND SPACE SCIENCE	C. The Solar System	The student will understand the characteristics and relationships of objects in the Solar System.	<ul style="list-style-type: none"> <li>Students will know that the earth is one of several planets that orbit the sun, and the moon orbits around the earth.</li> <li>Students will recognize the changes of the appearance of the moon over the month.</li> <li>Students will understand difference between rotation and revolution and their connection to day and night and the year.</li> <li>Students will identify the relative sizes, distances, movement and basic characteristics of objects in the Solar System.</li> <li>Students will know that the Earth's gravity pulls objects towards it without touching the objects.</li> </ul> <p><i>Gravity doesn't "pull." Gravity is a force of attraction. Language Precision</i></p>
GRADE 3	IV. LIFE SCIENCE	B. Organisms	The student will recognize that plants and animals have different structures that serve different functions.	<ul style="list-style-type: none"> <li>Students will know plants and animals have structures that serve different functions in growth, survival, and reproduction.</li> <li>Students will know that plants have different structures from animals that serve the same necessary functions in growth, survival and reproduction.</li> <li>Students will know examples of diverse life forms in different biomes, such as oceans, deserts, tundra, forests, grasslands, wetlands and some of the structures that allow them to survive in that biome.</li> </ul> <p><i>At grade 3?</i></p>
GRADE 3	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	The student will understand an organism's patterns of behavior are related to the nature of that organism's environment.	<ul style="list-style-type: none"> <li>Students will know that many organisms depend on living and dead plants and animals for food.</li> </ul> <p><i>Bacteria?</i></p> <ul style="list-style-type: none"> <li>Students will know organisms interact with one another in various ways besides providing food including, but not limited to, pollination, seed dispersal, and parasite removal.</li> <li>Students will know changes in an organism's habitat are sometimes beneficial to it and sometimes harmful.</li> </ul>
GRADE 3	IV. LIFE SCIENCE	D. Heredity	The student will understand many characteristics of an organism are inherited from the parents of the organism, but other characteristics result from an individual's interactions with the environment	<ul style="list-style-type: none"> <li>Students will differentiate between observed characteristics of plants and animals that are fully inherited and characteristics that are affected by the climate or environment.</li> </ul> <p><i>Difficult for 3<sup>rd</sup> grade.</i></p> <ul style="list-style-type: none"> <li>Students will identify similarities and differences between parent and offspring.</li> </ul>
GRADE 3	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will understand some relationships among organisms.	<ul style="list-style-type: none"> <li>Students will know energy is transferred through food chains.</li> </ul> <p><i>At this point students have only been introduced to light, sound .</i></p> <ul style="list-style-type: none"> <li>Students will compare and contrast herbivores, carnivores, and omnivores.</li> <li>Students will know that the food animals consume can be traced back to plants.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 4	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will understand the relationship between science and the environment.	<ul style="list-style-type: none"> <li>Students will understand that science should be used responsibly.</li> <li>Students will understand that science is a tool that can help investigate <b>solutions</b> to environmental problems.</li> </ul> <p><i>Typically, environmental problems don't have solutions!</i></p>
GRADE 4	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will participate in scientific investigations.	<ul style="list-style-type: none"> <li>Students will collect, organize, analyze and present data.</li> <li>Students will understand that conditions must be kept the same in order to compare investigations.</li> <li>Students will recognize that <b>evidence and logic</b>, not merely opinion, are necessary to support scientific understandings.</li> </ul> <p><i>At grade 4?</i></p> <ul style="list-style-type: none"> <li>Students will choose appropriate tools and materials for measurement, and/or observation and/or construction in scientific investigation.</li> <li>Students will follow appropriate safety behavior in their investigations. For example, the use of goggles, heat sources, electricity, glass, and chemicals and biological materials.</li> </ul>
GRADE 4	II. PHYSICAL SCIENCE	A. Structure of Matter	The student will know that materials exist in different states (e.g., solid liquid and gas) and can change from one to another.	<ul style="list-style-type: none"> <li>Students will identify three states of matter.</li> <li>Students will know that matter can change and exist in one or more states (e.g., water).</li> <li>Students will know that heating and cooling can cause a change <b>between</b> states.</li> </ul> <p><i>Or change of state?</i></p>
GRADE 4	II. PHYSICAL SCIENCE	C. Energy Transformations	The student will understand basic electricity and its application in everyday life.	<ul style="list-style-type: none"> <li>Students will know that an electrical circuit requires a complete loop through which an electric current can pass.</li> <li>Students will demonstrate simple electrical circuits using components such as wires, batteries and bulbs.</li> <li>Students will identify objects and materials that conduct electricity and objects and materials that are insulators.</li> <li>Students will know how to produce and study the effects of static electricity.</li> </ul>
GRADE 4	II. PHYSICAL SCIENCE	E. Forces of Nature	The student will understand that electric currents produce electromagnetic fields.	<ul style="list-style-type: none"> <li>Students will know how to build a simple electromagnet.</li> </ul>
GRADE 4	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand that water on Earth cycles and exists in many forms.	<ul style="list-style-type: none"> <li>Students will be able to explain and describe the water cycle involving the processes of evaporation, condensation, precipitation, and collection.</li> <li>Students will describe the role of the sun in the water cycle.</li> <li>Students will describe the distribution of water on Earth.</li> <li>Students will describe the quality of water using physical characteristics.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 4	III. EARTH AND SPACE SCIENCE	D. The Universe	The student will understand the patterns and movements of celestial objects in the sky.	<ul style="list-style-type: none"> <li>▪ Students will observe that the patterns of stars in the sky appear to slowly move from east to west across the sky nightly and different stars can be seen in different seasons and locations. <i>Nightly and yearly changes in position?</i></li> <li>▪ Students will know that planets look like stars but over time they appear to wander among the constellations.</li> <li>▪ Students will understand that stars are like the Sun, some being smaller and some larger, but so far away that they look like points of light.</li> <li>▪ Students will know that telescopes magnify distant objects in the sky and dramatically increase the number of stars we can see.</li> </ul>
GRADE 4	IV. LIFE SCIENCE	A. Cells	The student will know that all organisms are composed of cells, which are the fundamental units of life, some organisms are single cells, but other organisms are multi-cellular	<ul style="list-style-type: none"> <li>▪ Students will understand that cells are very small and will utilize a microscope to observe single cell organisms and single cells within a multi-celled organism</li> <li>▪ Students will know that all living things consist of one or more cells.</li> <li>▪ Students will know that cells need food, water and air; a way to dispose of waste; and an environment that they can live in.</li> <li>▪ Students will know that cells vary greatly in appearance and perform very different roles in an organism.</li> </ul>
GRADE 4	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	The student will know that living things can be sorted into groups in many ways according to their varied characteristics and structures.	<ul style="list-style-type: none"> <li>▪ Students classify plants and animals according to their physical characteristics.</li> <li>▪ Students learn that features used for grouping depend on the purpose of the grouping.</li> </ul>
GRADE 4	IV. LIFE SCIENCE	G. Human Organism	The student will understand the function of basic organs, major systems, growth and development of the human body.	<ul style="list-style-type: none"> <li>▪ Students will identify the major organs of the following systems: digestive, circulatory, nervous, skeletal/muscular, and respiratory, within the human body.</li> <li>▪ Students will identify the functions of the major organs and the systems of the human body.</li> <li>▪ Students will know there is a usual sequence of physical and mental development among human beings. <i>Will they be expected to know the sequence?</i></li> </ul>
GRADE 5	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will develop an expectation that there is order in the natural world and it is discoverable.	<ul style="list-style-type: none"> <li>▪ Students will understand that when a science investigation or experiment is repeated, a similar result is expected. <i>What is evidence of understanding? Or is it knowing?</i></li> </ul>
			The student will understand the usefulness and consequences of science in our interaction with the natural world.	<ul style="list-style-type: none"> <li>▪ Students will understand that science is a tool that can help investigate solutions to environmental problems.</li> <li>▪ Students will understand that science should be used responsibly.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 5	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will understand the process of scientific investigations.	<ul style="list-style-type: none"> <li>Students will perform a <b>controlled experiment</b> using a specific step-by-step procedure.</li> </ul> <p><i>Does this mean follow directions describing a controlled experiment?</i></p> <ul style="list-style-type: none"> <li>Students will support their statements with facts from various sources.</li> <li>Students will choose appropriate tools and materials for measurement, and/or observation and/or construction in scientific investigation.</li> <li>Students will follow appropriate safety behavior in their investigations. For example, the use of goggles, heat sources, electricity, glass, and chemicals and biological materials.</li> </ul>
GRADE 5	II. PHYSICAL SCIENCE	C. Energy Transformations	The student will understand that energy exists in many forms and can be transferred in many ways.	<ul style="list-style-type: none"> <li>Students will know that energy is stored in many ways, including fuel and food can be released for use by machines or living things.</li> <li>Students will know that heat can move from one object to another by conduction and that some materials conduct heat better than others</li> <li>Students will know that things that give off light also give off heat and things that absorb light collect that heat and may become warmer.</li> </ul>
GRADE 5	II. PHYSICAL SCIENCE	D. Motion	The student will understand the parameters of motion and the relationship of force to change in motion.	<ul style="list-style-type: none"> <li>Students will describe the motion of an object in terms of change of position or orientation such as velocity (i.e., speed and direction), rotation or revolution.</li> </ul> <p><i>How do students distinguish between rotation and revolution/ Our NYS Earth and Space scientists suggest using orbits in place of revolve.</i></p> <ul style="list-style-type: none"> <li>Students will know that objects travel at a wide range of velocities: some are so slow that motion may not be perceived, and some are so fast that people cannot even see them.</li> <li>Students will know that changes in the velocity of an object are caused by forces; the greater the force, the greater the change; and, the more massive the object, the less the change.</li> </ul>
			The student will understand the principles and advantages provided by simple machines.	<ul style="list-style-type: none"> <li>Students will know and use the principle of a simple machine (e.g., levers, incline plane, wheel and axle).</li> </ul> <p><i>Can they do this without knowing the scientific definition of work?</i></p>
GRADE 5	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will understand that the surface of the earth changes due to slow processes, such as erosion and weathering, and rapid processes, such as landslides, volcano eruptions, and earthquakes.	<ul style="list-style-type: none"> <li>Students will recognize the natural processes that cause rocks to break down into smaller pieces.</li> <li>Students will explain how waves, wind, water, and ice shape and reshape the earth's surface.</li> <li>Students will describe how humans prepare for and react to rapid Earth processes such as floods, tornadoes, earthquakes, and volcanoes.</li> <li>Students will recognize the different composition and properties of soil.</li> <li>Students will describe how humans prepare for and react to erosion.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 5	IV. LIFE SCIENCE	E. Biological Populations Change Over Time	The student will know biological populations change over time.	<ul style="list-style-type: none"> <li>▪ Students will know that individuals of the same species differ in their characteristics, and sometimes the differences give individuals an advantage in surviving and reproducing and pass those differences on to successive generation.</li> <li>▪ Students will know <b>extinction of a species</b> occurs when the environment changes and adaptive characteristics of a species are insufficient to allow its survival</li> </ul> <p><i>Grade 5- species is a difficult concept</i></p> <ul style="list-style-type: none"> <li>▪ Students will know that fossils can be compared to one another and to living organisms according to their similarities and differences.</li> </ul>
GRADE 5	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will know that matter and energy flow into, out of, and within a biological system.	<ul style="list-style-type: none"> <li>▪ For a given ecosystem in Minnesota, students will identify major living and non-living components.</li> <li>▪ Students will understand some source of “energy” is needed for all organisms to stay alive and grow.</li> <li>▪ Students will understand that food webs describe the relationships among producers, consumers, and decomposers in an ecosystem.</li> </ul> <p><i>Or is it the flow of energy and chemicals?</i></p> <ul style="list-style-type: none"> <li>▪ Students will know organisms are growing, dying, and decaying, and their matter is recycled.</li> </ul>
GRADE 6	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will understand that science is a way of knowing about the world that is characterized by empirical criteria, logical argument, and skeptical review.	<ul style="list-style-type: none"> <li>▪ Students will distinguish between scientific evidence and personal opinion.</li> <li>▪ Students will explain why scientists often repeat each other’s investigations to be sure of their results.</li> <li>▪ Students will know that scientists assume that nature is the same everywhere and that it is understandable and predictable.</li> </ul>
GRADE 6	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will understand that scientific inquiry is used by scientists to investigate the natural world in systematic ways.	<ul style="list-style-type: none"> <li>▪ Students will identify questions that can be answered through scientific investigation and those that cannot.</li> <li>▪ Students will give examples of how different domains of science use differing bodies of scientific knowledge and employ different methods to investigate questions.</li> <li>▪ Students will know that observations and explanations can be affected by bias or strong beliefs about what should happen in particular circumstances.</li> <li>▪ Students will understand that a system is an organized group of related objects or components that form a whole.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 6	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	Conduct scientific investigations.	<ul style="list-style-type: none"> <li>▪ Students will use appropriate tools and SI units for measuring length, time, mass, volume, and temperature with suitable precision and accuracy.</li> </ul> <p><i>What of weight?</i></p> <ul style="list-style-type: none"> <li>▪ Students will follow a specific step-by-step procedure for a scientific investigation.</li> <li>▪ Students will present and explain data and findings using multiple representations including tables, graphs, physical models, and demonstrations.</li> <li>▪ Students will use appropriate technology and mathematics skills to access, gather, store, retrieve and organize data.</li> <li>▪ Students will explain how the student’s scientific investigations relate to established scientific principles.</li> </ul> <p><i>Is the point here that the students’ investigations are to verify established principles?</i></p> <ul style="list-style-type: none"> <li>▪ Students will apply established safety rules and guidelines in conducting scientific investigations inside and outside the classroom.</li> </ul>
GRADE 6	I. HISTORY AND NATURE OF SCIENCE	C. Scientific Enterprise	The student will know that science and technology are <i>highly vigorous</i> human efforts that both influence and are influenced by civilizations worldwide. <i>Language Precision</i>	<ul style="list-style-type: none"> <li>▪ Students will know that people of all backgrounds and with diverse interests, talents, qualities, and motivations engage in fields of science and engineering</li> <li>▪ Students will identify different disciplines of science and engineering.</li> <li>▪ Students will understand that scientists sometimes work in teams and sometimes work alone, but all communicate extensively with others.</li> <li>▪ Students will know that colleges and universities, business and industry, research institute and governmental agencies are major settings in which scientists and engineers work.</li> <li>▪ Students will explain that technology is the application of science in order to find solutions to societies’ wants and needs.</li> <li>▪ Students will identify appropriate problems that can be solved using technological design or scientific inquiry.</li> </ul>
GRADE 6	I. HISTORY AND NATURE OF SCIENCE	D. Historic Perspectives	The student will understand how scientific discovery, <i>culture</i> , <i>societal norms</i> , and technology have influenced one another in different time periods. <i>At grade 5, or is it not the intention to test the standard?</i>	<ul style="list-style-type: none"> <li>▪ Students will cite examples of various individuals throughout history who made discoveries and contributions in science and technology.</li> <li>▪ Students will relate student experiences in scientific investigation to the experiences of scientists throughout history.</li> </ul>
GRADE 6	II. PHYSICAL SCIENCE	A. Structure of Matter	The student will use the idea that matter is made of small particles called atoms to explain that matter can exist in different states and that each state exhibits distinct physical properties.	<ul style="list-style-type: none"> <li>▪ Students will know that matter can exist as solid, liquid, gas or plasma.</li> <li>▪ Students will know that a change in temperature or pressure can change the state of a substance.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 6	II. PHYSICAL SCIENCE	B. Chemical Reactions	<p>The student will use the idea that matter is made of small particles called <b>atoms</b> to explain how matter combines in a variety of ways to form all living and non-living substances.</p> <p><i>What of molecules?</i></p>	<ul style="list-style-type: none"> <li>▪ Students will give examples of elements, compounds and mixtures.</li> <li>▪ Students will classify a substance as a mixture or pure substance.</li> <li>▪ Students will know that there are about 100 different elements with unique properties that combine in many ways.</li> </ul>
GRADE 6	II. PHYSICAL SCIENCE	C. Energy Transformations	<p>The student will understand that energy is a <b>property</b> and cannot be created or destroyed, but only changed from one form into another.</p> <p><i>A property?</i></p>	<ul style="list-style-type: none"> <li>▪ Students will know that energy exists as heat, chemical energy, mechanical energy and electrical energy.</li> <li>▪ Students will recognize that most of what goes on in the universe from exploding stars and biological growth to the operation of machines and the motion of people involves some form of energy being transformed into another.</li> <li>▪ Students will recognize that energy in the form of heat is almost always one of the products of energy transformation.</li> <li>▪ Students will identify different forms of energy in everyday situations.</li> <li>▪ Students will identify transformations of energy from one form to another in everyday situations.</li> </ul>
GRADE 6	II. PHYSICAL SCIENCE	D. Motion	<p>The student will understand the nature of force and motion.</p>	<ul style="list-style-type: none"> <li>▪ Students will use a frame of reference to describe the position, direction, speed and motion of an object.</li> <li>▪ Students will determine the average speed of an object by measuring distance and time.</li> <li>▪ Students will know the difference between average speed, over time, versus speed at a particular time.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 6	II. PHYSICAL SCIENCE	E. Forces of Nature	The student will understand that the structure and motion of objects in the universe are governed by different forces.	<ul style="list-style-type: none"> <li>Students will know that every object exerts gravitational force on every other object.</li> <li>Students will know that gravitational force between two objects depends on how much mass the objects have and on how far apart they are.</li> <li>Students will know that gravitational force is hard to detect unless at least one of the objects has a lot of mass.</li> </ul> <p><i>Grade 6?</i></p> <ul style="list-style-type: none"> <li>Students will know that electric currents and magnets can exert a force on certain objects and each other.</li> <li>Students will recognize that gravitational forces are weak compared to electric and magnetic.</li> </ul>
GRADE 6	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will understand the Earth's composition and structure.	<ul style="list-style-type: none"> <li>Students will know that the Earth is comprised of layers including the lithosphere, hydrosphere, and atmosphere.</li> </ul>
GRADE 6	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand how the atmosphere interacts on Earth.	<ul style="list-style-type: none"> <li>Students will identify the composition and structure of the atmosphere.</li> <li>Students will recognize that air masses circulate in the atmosphere.</li> </ul> <p>Know?</p> <ul style="list-style-type: none"> <li>Students will describe the temperature and pressure variations that exist in the layers of the atmosphere.</li> </ul>
GRADE 6	III. EARTH AND SPACE SCIENCE	C. The Solar System	The student will understand the composition and structure of the solar system and the Earth's place in it.	<ul style="list-style-type: none"> <li>Students will compare the characteristics of Earth with the characteristics and movement patterns of the other planets, their satellites, and other objects in our Solar System.</li> <li>Students will know that the Sun is a medium-sized star and is the closest star to Earth. It is the central and largest body in the Solar System and is located at the edge of a galaxy.</li> <li>Students will explain the length of day, length of year, phases of the Moon, eclipses, tides and shadows through the regular and predictable motions of the Earth and Moon.</li> </ul>
GRADE 6	IV. LIFE SCIENCE	A. Cells	The student will understand that all organisms are composed of cells, which are the fundamental units of life that carry on the many functions needed to sustain life.	<ul style="list-style-type: none"> <li>Students will know that cells are the fundamental units of life.</li> <li>Students will know that most organisms are single cells.</li> <li>Students will know that all organisms are composed of cells.</li> </ul>
GRADE 6	IV. LIFE SCIENCE	B. Organisms	The student will understand living systems, at all levels of organization, demonstrate the complementary nature of structure and function.	<ul style="list-style-type: none"> <li>Students will know a variety of body plans and external structures in plants and animals that serve specific functions for survival.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 6	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	The student will understand that within the diversity of living organisms, patterns of similarities, differences and complex interactions exist between organisms and with the physical environment.	<ul style="list-style-type: none"> <li>▪ Students will identify organisms that interact with each other as producers, consumers, and decomposers in a food chain</li> <li>▪ Students will identify organisms that interact with each other as herbivores, carnivores, and omnivores through food webs.</li> <li>▪ Students will compare/contrast predator/prey, parasite/host, producer/consumer relationships.</li> <li>▪ Students will classify organisms based on the details of external features.</li> <li>▪ Students will know that all individuals of a species that exist together at a given place and time make up a population, and all populations living together and the physical factors with which they interact compose an ecosystem.</li> </ul>
GRADE 6	IV. LIFE SCIENCE	D. Heredity	The student will understand that heredity information is contained in genes that determine characteristics of organisms that are inherited.	<ul style="list-style-type: none"> <li>▪ Students will know that some traits are inherited and other result from interactions with the environment.</li> <li>▪ Students will know that reproduction is a characteristic of all living things and why it is essential for the continuation of a species.</li> </ul>
GRADE 7	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	<p>The student will understand that science is a way of knowing about the world that is characterized by empirical <b>criteria</b>, logical argument, and skeptical review.</p> <p>Criteria or evidence?</p>	<ul style="list-style-type: none"> <li>▪ Students will explain, using examples, that for most <b>core</b> knowledge in science, there is much experimental and observational confirmation.</li> </ul> <p><i>Which core knowledge?</i></p> <ul style="list-style-type: none"> <li>▪ Students will understand how scientific knowledge is subject to change as new evidence becomes available, or as new theories cause scientists to look at old observations differently.</li> <li>▪ Students will know that science can sometimes be used to inform <b>ethical</b> decisions by identifying the likely consequences of particular actions, but cannot be used to establish that some action is either <b>moral or immoral</b>.</li> </ul> <p><i>At grade 7?</i></p> <ul style="list-style-type: none"> <li>▪ Students will explain how scientists distinguish among fact, hypothesis, theory and law.</li> <li>▪ Students will use accepted physical, conceptual, and mathematical scientific models to explain natural phenomena.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 7	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will understand that scientific inquiry is used by scientists to investigate the natural world in systematic ways	<ul style="list-style-type: none"> <li>▪ Students will know that scientists use different kinds of investigations and methods depending on the questions they are trying to answer.</li> <li>▪ Students will distinguish among observation, prediction, and inference.</li> <li>▪ Students will know that hypotheses are valuable even if they turn out not to be true.</li> <li>▪ Students will know that an understanding of mathematics and the use of technology are essential in determining how a scientific investigation is conducted and <b>the explanations that can be made.?</b></li> </ul> <p><i>Language Precision</i></p> <ul style="list-style-type: none"> <li>▪ Students will explain why an experiment must be repeated many times and yield consistent results before the results are accepted as correct.</li> <li>▪ Students will know that systems have boundaries, components, resources, flow and feedback.</li> </ul>
GRADE 7	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will design and conduct scientific investigations.	<ul style="list-style-type: none"> <li>▪ Students will identify a question that can be answered with a scientific investigation with available knowledge and tools.</li> <li>▪ Students will formulate a testable hypothesis based on prior knowledge.</li> <li>▪ Students will systematically observe, organize, and record relevant qualitative and quantitative data in a clear and accurate way.</li> <li>▪ Students will use appropriate tools and SI units for measuring length, time, mass, volume, and temperature with suitable precision and accuracy.</li> <li>▪ Students will recognize that a variable is a condition that may influence the outcome of an investigation and know the importance of manipulating one variable at a time.</li> <li>▪ Students will write a specific step by step procedure for a scientific investigation.</li> <li>▪ Students will construct reasonable models, predictions and explanations based on collected data or evidence presented in tables or graphs and make inferences based on patterns or trends in the data.</li> <li>▪ Students will present and explain data and findings using multiple representations including tables, graphs, mathematical and physical models, and demonstrations.</li> <li>▪ Students will use appropriate technology and mathematics skills to access, gather, store, retrieve and organize data.</li> <li>▪ Students will explain how the student's scientific investigations relate to established scientific principles.</li> <li>▪ Students will apply established safety rules and guidelines in conducting scientific investigations inside and outside the classroom.</li> </ul>
GRADE 7	I. HISTORY AND NATURE OF SCIENCE	C. Scientific Enterprise	The student will know that science and technology are highly vigorous human efforts that both influence and are influenced by civilizations worldwide.	<ul style="list-style-type: none"> <li>▪ Students will know that the development of technology drives scientific investigation and explanations and that scientific knowledge drives the development of technology.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 7	<b>I. HISTORY AND NATURE OF SCIENCE</b>	D. Historic Perspectives	The student will understand how scientific discovery, culture, societal norms, and technology have influenced one another in different time periods.	<ul style="list-style-type: none"> <li>▪ Students will cite examples of various individuals throughout history who made discoveries and contributions in science and technology.</li> <li>▪ Students will cite examples of how the prevailing culture of a time influenced scientific and technologic advances.</li> <li>▪ Students will relate student experiences in scientific investigation to the experiences of scientists throughout history.</li> </ul>
GRADE 7	<b>II. PHYSICAL SCIENCE</b>	A. Structure of Matter	Use the idea that matter is made of small particles called atoms to explain that matter can exist in different states and that each state exhibits distinct physical properties.	<ul style="list-style-type: none"> <li>▪ Students will distinguish between mass (the amount of matter in a sample of a substance) and volume (the amount of space that a sample of a substance occupies).</li> </ul> <p><b>How is the amount of matter measured?</b></p>
GRADE 7	<b>II. PHYSICAL SCIENCE</b>	B. Chemical Reactions	The student will use the idea that matter is made of small particles called atoms to explain how matter combines in a variety of ways to form all living and non-living substances.	<ul style="list-style-type: none"> <li>▪ Students will distinguish among elements, compounds and mixtures.</li> <li>▪ Students will use the properties of substances to classify them into groups with common properties (e.g. metals, nonmetals).</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 7	II. PHYSICAL SCIENCE	C. Energy Transformations	The student will understand that energy is a property and cannot be created or destroyed, but only changed from one form into another.	<ul style="list-style-type: none"> <li>▪ Students will understand that adding or taking away heat from a system may result in temperature change.</li> <li>▪ Students will recognize that heat moves in predictable ways, moving from warmer objects to cooler ones until both reach the same temperature.</li> <li>▪ Students will give examples of the movement of heat by convection, conduction and radiation.</li> <li>▪ Students will know that energy can be transferred through waves.</li> <li>▪ Students will know that vibrations move at different speeds in different materials, have different wavelengths, and set up wave-like disturbances that spread away from the source.</li> <li>▪ Students will know that waves have many different forms, some visible, some not.</li> <li>▪ Students will demonstrate that light from the sun is made up of a mixture of many different colors of light.</li> <li>▪ Students will demonstrate that objects that give off or reflect light that is made up of a mixture of colors of light.</li> <li>▪ Students will know that human eyes respond to a narrow range of wavelengths of electromagnetic radiation (visible light), and that differences of wavelength within that range are perceived as differences in color.</li> </ul>
GRADE 7	II. PHYSICAL SCIENCE	D. Motion	The student will understand the nature of force and motion.	<ul style="list-style-type: none"> <li>▪ Students will represent the motion of an object on a graph.</li> <li>▪ Students will interpret distance vs. time graphs.</li> <li>▪ Students will distinguish between velocity and speed.</li> <li>▪ Students will know that acceleration is a change in speed or direction.</li> </ul>
GRADE 7	II. PHYSICAL SCIENCE	E. Forces of Nature	The student will understand that the structure and motion of objects in the universe are governed by different forces.	

<b>Grade Level</b>	<b>Strand</b>	<b>Sub-Strand</b>	<b>Standard</b>	<b>Benchmarks</b>
GRADE 7	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will understand Earth's composition and structure.	<ul style="list-style-type: none"> <li>▪ Students will explain how land forms are created through forces such as folding, faulting, volcanic eruptions, deposition of sediment, and weathering and erosion.</li> <li>▪ Students will explain how features on the Earth's surface are constantly changing through a combination of slow and rapid processes such as weathering, erosion, sediment deposition, landslides, volcanic eruptions, and earthquakes.</li> <li>▪ Students will understand the concept of plate tectonics including the organization of the Earth into plates and the processes that move them.</li> <li>▪ Students will describe the various processes and their interactions that are involved in the rock cycle.</li> <li>▪ Students will interpret successive layers of sedimentary rocks and their fossils to document the age and history of the Earth.</li> <li>▪ Students will know how constructive and destructive Earth processes can affect the evidence of Earth's history.</li> <li>▪ Students will be able to use various characteristics to classify and identify rocks and the minerals that comprise them.</li> </ul>
GRADE 7	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand how the Earth's atmosphere interacts in the Earth's system.	<ul style="list-style-type: none"> <li>▪ Students will explain how the processes of evaporation, condensation, and precipitation, affect weather patterns.</li> <li>▪ Students will know that the sun is the principal energy source of winds, ocean currents, and the water cycle.</li> <li>▪ Students will know that changes in the composition of the atmosphere, ocean temperature, and geologic events can impact the Earth's climate.</li> <li>▪ Students will explain how the tilt of the Earth's axis and the Earth's revolution around the Sun affect seasons and weather patterns.</li> </ul>
GRADE 7	III. EARTH AND SPACE SCIENCE	C. The Solar System	The student will understand the composition and structure of the solar system and the Earth's place in it.	<ul style="list-style-type: none"> <li>▪ Students will be able to explain the length of day, length of year, phases of the Moon, eclipses, tides and shadows through the regular and predictable motions of the Earth and Moon.</li> </ul>
GRADE 7	IV. LIFE SCIENCE	A. Cells	The student will understand that all organisms are composed of cells, which are the fundamental units of life that carry on the many functions needed to sustain life.	<ul style="list-style-type: none"> <li>▪ Students will distinguish between single and multi-cellular organisms.</li> <li>▪ Students will distinguish between plant and animal cells.</li> <li>▪ Students will know that cells repeatedly divide for growth and repair.</li> </ul>
GRADE 7	IV. LIFE SCIENCE	B. Organisms	The student will understand living systems, at all levels of organization, demonstrate the complementary nature of structure and function.	<ul style="list-style-type: none"> <li>▪ Students will explain the organization of whole organisms in a living system including populations, niche, and communities.</li> <li>▪ Students will explain how organisms are organized into specialized cells, tissues, organs and organ systems that perform specialized functions.</li> <li>▪ Students will know that organisms can react to internal and environmental stimuli through behavior.</li> </ul>

<b>Grade Level</b>	<b>Strand</b>	<b>Sub-Strand</b>	<b>Standard</b>	<b>Benchmarks</b>
GRADE 7	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	The student will understand that within the diversity of living organisms, patterns of similarities, differences and complex interactions exist between organisms and with the physical environment.	<ul style="list-style-type: none"> <li>▪ Students will use and create dichotomous keys to classify organisms based on the details of external and /or internal features.</li> <li>▪ Students will give examples of ways humans can alter the equilibrium of ecosystems, causing potentially irreversible effects including human population growth, technology, and consumption; human destruction of habitats (through direct harvesting, pollution and atmospheric changes).</li> <li>▪ Students will give examples of the effects of how populations and environmental degradation can lead to risk to human health and the survival of the species.</li> </ul>
GRADE 7	IV. LIFE SCIENCE	D. Heredity	The student will understand that heredity information is contained in genes that determine characteristics of organisms that are inherited through asexual and sexual reproduction.	<ul style="list-style-type: none"> <li>▪ Students will know that inherited traits result from information contained in genes located on chromosomes of each cell.</li> <li>▪ Students will know that each gene carries a single unit of information.</li> <li>▪ Students will know that a single gene can influence more than one trait.</li> <li>▪ Students will know that inherited traits can be determined by one or many genes.</li> <li>▪ Students will identify the criteria established to define and distinguish species.</li> <li>▪ Students will explain how flowering plants reproduce sexually.</li> </ul>
GRADE 7	IV. LIFE SCIENCE	E. Biological Populations Change Over Time	The student will understand how evolution provides a scientific explanation for the fossil record of ancient life forms, as well as the striking similarities observed among the diverse species of living organisms.	<ul style="list-style-type: none"> <li>▪ Students will know the concept of extinction and that extinction is common.</li> <li>▪ Students will know that fossils record the extinction of many life forms.</li> <li>▪ Students will know that fossils document the appearance of many life forms.</li> <li>▪ Students will give examples how fossils record the diversification of many life forms.</li> </ul>
GRADE 7	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will understand how the flow of energy and the recycling of matter contributes to a stable ecosystem.	<ul style="list-style-type: none"> <li>▪ Students will know all energy within an ecosystem originates from the sun.</li> <li>▪ Students will know that plants use the energy in light to make sugars out of carbon dioxide and water. They use or store this food/sugar/. Organisms eat plants for the food/sugar and energy, and produce carbon dioxide and water.</li> </ul>
GRADE 7	IV. LIFE SCIENCE	G. Human Organism	The student will understand human body systems and their relationship to good health.	<ul style="list-style-type: none"> <li>▪ Students will give examples of the effects of how environmental factors can lead to diseases and other risks to human health.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will understand that science is a way of knowing about the world that is characterized by empirical criteria, logical argument, and skeptical review.	<ul style="list-style-type: none"> <li>▪ Students will explain how scientific knowledge is subject to change as new evidence becomes available, or as new theories cause scientists to look at old observations differently.</li> <li>▪ Students will know that science can sometimes be used to inform ethical decisions by identifying the likely consequences of particular actions, but cannot be used to establish that some action is either moral or immoral.</li> <li>▪ Students will explain how scientific claims are subject to peer review, where scientists evaluate explanations proposed by other scientists by examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, replicating investigations, and suggesting alternative explanations for the same observations.</li> <li>▪ Students will explain the development, usefulness, and limitations of scientific models in the explanation and prediction of natural phenomena.</li> </ul>
GRADE 8	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will understand that scientific inquiry is used by scientists to investigate the natural world in systematic ways	<ul style="list-style-type: none"> <li>▪ Students will give examples of how different domains of science use differing bodies of scientific knowledge and employ different methods to investigate questions.</li> <li>▪ Students will know that scientific investigations involve the common elements of systematic observations, carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations.</li> <li>▪ Students will know that an understanding of mathematics and the use of technology are essential in determining how a scientific investigation is conducted and the explanations that can be made.</li> <li>▪ Students will know that scientists may conduct investigations in a simple system and make generalizations to more complex systems.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will design and conduct scientific investigations.	<ul style="list-style-type: none"> <li>▪ Students will identify a question that can be answered with a scientific investigation with available knowledge and tools.</li> <li>▪ Students will formulate a testable hypothesis based on prior knowledge.</li> <li>▪ Students will systematically observe, organize, and record relevant qualitative and quantitative data in a clear and accurate way.</li> <li>▪ Students will use appropriate tools and SI units for measuring length, time, mass, volume, and temperature with suitable precision and accuracy.</li> <li>▪ Students will specify variables to be changed, controlled, and measured.</li> <li>▪ Students will use sufficient trials and adequate sample size to ensure reliable data.</li> <li>▪ Students will write a specific step-by-step procedure for a scientific investigation.</li> <li>▪ Students will construct reasonable models, predictions and explanations based on collected data or evidence presented in tables or graphs and make inferences based on patterns or trends in the data.</li> <li>▪ Students will present and explain data and findings using multiple representations including tables, graphs, mathematical and physical models, and demonstrations.</li> <li>▪ Students will explain how variability affects measurements and calculations.</li> <li>▪ Students will be able to use appropriate technology and mathematics skills to access, gather, store, retrieve and organize data.</li> <li>▪ Students will establish cause effect relationships based on gathered and established evidence.</li> <li>▪ Students will explain how the student’s scientific investigations relate to established scientific principles.</li> <li>▪ Students will be able to apply established safety rules and guidelines in conducting scientific investigations inside and outside the classroom.</li> </ul>
GRADE 8	I. HISTORY AND NATURE OF SCIENCE	C. Scientific Enterprise	The student will know that science and technology are highly vigorous human efforts that both influence and are influenced by civilizations worldwide.	<ul style="list-style-type: none"> <li>▪ Students will evaluate the documentation and verifiability of information from a variety of sources.</li> <li>▪ Students will know that technological solutions have intended benefits and unintended consequences.</li> <li>▪ Students will use scientific inquiry and the technological design process to solve problems.</li> <li>▪ Students will know that technological changes and scientific advances are often accompanied by social, political, and economic changes.</li> <li>▪ Students will recognize that science and technology are influenced by social needs, attitudes, values, and limitations, and cultural backgrounds and beliefs.</li> <li>▪ Students will know that scientists and engineers have ethical codes regarding living things and impact on the environment.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	I. HISTORY AND NATURE OF SCIENCE	D. Historic Perspectives	The student will understand how scientific discovery, culture, societal norms, and technology have influenced one another in different time periods.	<ul style="list-style-type: none"> <li>▪ Students will cite examples of various individuals throughout history who made discoveries and contributions in science and technology.</li> <li>▪ Students will cite examples of how the prevailing culture of a time influenced scientific and technologic advances.</li> <li>▪ Students will relate student experiences in scientific investigation to the experiences of scientists throughout history.</li> <li>▪ Students will cite examples of how science contributed to revolutions or changes in agriculture, manufacturing, sanitation, medicine, warfare, transportation, information processing, or communication.</li> </ul>
GRADE 8	II. PHYSICAL SCIENCE	A. Structure of Matter	The student will use the idea that matter is made of small particles called atoms to explain that matter can exist in different states and that each state exhibits distinct physical properties.	<ul style="list-style-type: none"> <li>▪ Students will use evidence to explain that matter is made of small particles called <b>atoms</b>, which are too small to see.</li> </ul> <p><i>Molecules</i></p> <ul style="list-style-type: none"> <li>▪ Students will describe the states of matter in terms of the space between atoms and/or molecules.</li> </ul> <p><i>It is more than the space between the atoms/molecules.</i></p> <ul style="list-style-type: none"> <li>▪ Students will give evidence that the space between atoms and/or molecules is smallest in a solid, and greatest in a gas.</li> <li>▪ Students will know that equal volumes of different substances usually have different masses.</li> <li>▪ Students will know that an atom is the smallest unit of an element that maintains the characteristics of the element.</li> </ul> <p><i>Are the atoms of chlorine green? Language Precision</i></p> <ul style="list-style-type: none"> <li>▪ Students will differentiate between an atom and a molecule.</li> <li>▪ Students will understand that atoms combine to form molecules that are the smallest part unit of a compound.</li> <li>▪ Students will know that all pure substances have characteristic properties of solubility, density, melting point and boiling point and that characteristic properties are independent of the amount of the sample of substance.</li> <li>▪ Students will use characteristic properties to identify pure substances elements and compounds.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	II. PHYSICAL SCIENCE	B. Chemical Reactions	The student will use the idea that matter is made of small particles called atoms to explain how matter combines in a variety of ways to form all living and non-living substances.	<ul style="list-style-type: none"> <li>▪ Students will distinguish among elements, compounds and mixtures.</li> <li>▪ Students will use characteristic properties to separate mixtures.</li> <li>▪ Students will differentiate between physical changes and chemical changes.</li> <li>▪ Students will recognize that no matter how substances within a closed system interact, the total mass of the system remains the same.</li> <li>▪ Students will show how the idea of atoms and molecules explains conservation of mass.</li> </ul> <p><i>What will be acceptable evidence that the students have met this benchmark?</i></p>
GRADE 8	II. PHYSICAL SCIENCE	C. Energy Transformations	The student will understand that energy is a property and cannot be created or destroyed, but only changed from one form into another. Is energy a property?	<ul style="list-style-type: none"> <li>▪ Students will understand that energy is a property ? of many substances.</li> <li>▪ Students will know that heat energy is the disorderly motion of atoms and molecules.</li> <li>▪ Students will know that chemical energy is in the arrangement of atoms and molecules.</li> <li>▪ Students will know that mechanical energy is in moving bodies or in elastically distorted shapes.</li> <li>▪ Students will know that electrical energy is in the attraction or repulsion between charges.</li> <li>▪ Students will know that potential energy is stored energy and is associated with gravitational or electrical force, mechanical position, or chemical composition.</li> <li>▪ Students will differentiate between kinetic and potential energy and identify situations where kinetic energy is converted into potential energy and vice versa.</li> <li>▪ Students will use the idea that matter is made of small particles to explain the movement of heat in conduction and convection.</li> <li>▪ Students will know that electromagnetic waves have ranges of wavelengths such as radio waves, microwaves, infrared wave, visible light, ultraviolet light, and x-rays.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	II. PHYSICAL SCIENCE	D. Motion	Understand the nature of force and motion.	<ul style="list-style-type: none"> <li>▪ Students will explain the relationship between force, mass and acceleration.</li> <li>▪ Students will know that an object that is not being subjected to a force will continue to move at a constant speed and in a straight line (Inertia).</li> <li>▪ Students will know that if more than one force acts on an object in a straight line, the forces will reinforce or cancel one another, depending on their direction and magnitude.</li> <li>▪ Students will know that unbalanced forces will cause changes in the speed or direction of an object's motion.</li> <li>▪ Students will use the concepts of inertia, force, velocity and mass to describe the motion of an object.</li> <li>▪ Students will describe the effect of friction and gravity on motion.</li> <li>▪ Students will know that whenever one thing exerts a force on another an equal amount of force is exerted back.</li> </ul>
GRADE 8	II. PHYSICAL SCIENCE	E. Forces of Nature	The student will understand that the structure and motion of objects in the universe are governed by different forces	
GRADE 8	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will understand Earth's composition and structure.	<ul style="list-style-type: none"> <li>▪ Students will explain how earthquakes, volcanoes, sea-floor spreading, and mountain building are a result of the movement of crustal plates.</li> </ul>
GRADE 8	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand how the atmosphere interacts with the Earth system.	<ul style="list-style-type: none"> <li>▪ Students will understand how radiation, conduction and convection of energy in and out of the atmosphere affects weather and climate.</li> <li>▪ Students will know that the wind, ocean currents, and layers of the atmosphere are produced by gravitational forces and unequal heating of the Earth.</li> <li>▪ Students will demonstrate how the rotation of the Earth affects the winds and ocean currents.</li> <li>▪ Students will predict or forecast the weather based on collected data.</li> </ul>
GRADE 8	III. EARTH AND SPACE SCIENCE	C. The Solar System	The student will understand the composition and structure of the solar system and the Earth's place in it.	<ul style="list-style-type: none"> <li>▪ Students will know that the Sun is the principle energy source for the solar system and that this energy is transferred in the form of radiation.</li> <li>▪ Students will know that energy that travels through space in the form of waves as electromagnetic radiation and that some types electromagnetic radiation can be seen as color and others are made of wave lengths that are too long or too short to be seen.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	III. EARTH AND SPACE SCIENCE	D. The Universe	The student will understand the composition and structure of the universe.	<ul style="list-style-type: none"> <li>▪ Students will know that the universe consists of many billions of galaxies, each containing many billions of stars and that there are vast distances measured in light years that separate these galaxies and stars from one another and from the Earth.</li> <li>▪ Students will know common types and life cycles of stars in the universe.</li> <li>▪ Students will explain how Doppler evidence suggests that the universe is expanding, moving away from the Earth and provides support for the Big Bang theory of the origin of the universe.</li> </ul> <p><i>At grade 8</i></p>
GRADE 8	IV. LIFE SCIENCE	A. Cells	The student will understand that all organisms are composed of cells, which are the fundamental units of life that carry on the many functions needed to sustain life.	<ul style="list-style-type: none"> <li>▪ Students will know that cells convert energy from food for the production of materials necessary for life including cell growth and cell division.</li> <li>▪ Students will explain that multi-cellular organisms have specialized cells that perform specialized functions.</li> </ul>
GRADE 8	IV. LIFE SCIENCE	B. Organisms	The student will understand living systems, at all levels of organization, demonstrate the complementary nature of structure and function.	<ul style="list-style-type: none"> <li>▪ Students will compare and contrast specialized functions of digestion, circulation, respiration, reproduction, excretion, control and coordination and movement in multi-cellular organisms including humans</li> <li>▪ Students will know that an organism's ability to regulate its internal environment enables it to grow, reproduce and obtain resources in a constantly changing environment.</li> <li>▪ Students will know that organisms' behavioral response may be determined by heredity and past experience.</li> </ul>
GRADE 8	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	<p>The student will understand that within the diversity of living organisms, patterns of similarities, differences and complex interactions exist between organisms and with the physical environment.</p> <p><i>I have difficulty understanding this statement.</i></p>	<ul style="list-style-type: none"> <li>▪ Students will give examples of relationships that are mutually beneficial and competitive.</li> <li>▪ Students will be able to taxonomically group organisms to the appropriate kingdom.</li> <li>▪ Students will know that living and nonliving factors affect the number and types of organisms that an ecosystem can support.</li> <li>▪ Students will explain the factors that affect the number and types of organisms an ecosystem can support including available resources; abiotic factors, and disease.</li> <li>▪ Students will be able to explain how the interrelationships and interdependencies among organisms generate stable ecosystems.</li> <li>▪ Students will be able to explain how the amount of life an environment can support is limited by the availability of matter, energy, and the ability of the ecosystem to recycle materials.</li> </ul> <p><i>How is amount of life measured?</i></p>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 8	IV. LIFE SCIENCE	D. Heredity	The student will understand that heredity information is contained in genes that determine characteristics of organisms that are inherited through asexual and sexual reproduction.	<ul style="list-style-type: none"> <li>Students will compare and contrast the advantages and disadvantages of sexual and asexual reproduction.</li> </ul>
GRADE 8	IV. LIFE SCIENCE	E. Biological Populations Change Over Time	The student will understand how evolution provides a scientific explanation for the fossil record of ancient life forms, as well as the striking similarities observed among the diverse species of living organisms.	<ul style="list-style-type: none"> <li>Students will be able to explain how a species' biological adaptation in structure, function and behavior enhances their reproductive success and survival in a particular environment. ??</li> <li>Students will know there is scientific evidence of common ancestry among some organisms.</li> <li>Students will give examples of when the environment changes, characteristics of some species do not allow survival.</li> <li>Students will give examples of physical characteristics of an organism that <b>changes</b> the organisms' chance of survival. ??</li> <li>Students will explain how diversity of species develops through gradual processes over generations.</li> </ul> <p>Language Precision</p>
GRADE 8	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will understand how the flow of energy and the recycling of matter contributes to a stable ecosystem.	<ul style="list-style-type: none"> <li>Students will explain how energy is transferred through food chains and food webs in an ecosystem.</li> <li>Students will explain how the amount of useable energy available to organisms decreases as it passes through a food chain and/or food web.</li> <li>Students will know that the total amount of matter in a closed system remains the same as it is transferred between organisms and the physical environment even though the matters location or form changes.</li> </ul>
GRADE 8	IV. LIFE SCIENCE	G. Human Organism	The student will understand human body systems and their relationship to good health.	<ul style="list-style-type: none"> <li>Students will explain how many factors related to human health can be controlled and some cannot be controlled.</li> <li>Students will know that protection from disease is a specialized function in multi-cellular organisms.</li> <li>Students will know that disease in organisms can be caused by intrinsic failures of the system or infection by other organisms.</li> <li>Students will use systematic approach to think critically about risks/benefits of a variety of <b>hazards</b>.</li> </ul> <p><i>Hazards have benefits?</i></p>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	I. HISTORY AND NATURE OF SCIENCE	A. Scientific World View	The student will understand the nature of scientific ways of thinking and that scientific knowledge changes and accumulates over time, some scientific ideas are incomplete, and opportunity exists in these areas for new advances.	<ul style="list-style-type: none"> <li>▪ Students will be able to distinguish among hypothesis, theory, and law as scientific terms and how they are used to answer a specific question.</li> <li>▪ Students will be able to explain how scientific innovations and new evidence can challenge accepted theories and models, including cell theory, atomic theory, theory of evolution, plate tectonic theory, germ theory of disease, Big Bang theory.</li> </ul> <p><i>Or give historical examples?</i></p> <ul style="list-style-type: none"> <li>▪ Students will know that scientific explanations must meet criteria to be considered valid, including must be consistent with experimental and observational evidence about nature, be logical, respect the rules of evidence, be open to criticism and report methods and procedures.</li> <li>▪ Students will recognize how traditions govern the conduct of science, including ethics, peer review, conflict and consensus.</li> </ul>
GRADE 9–12	I. HISTORY AND NATURE OF SCIENCE	B. Scientific Inquiry	The student will design and conduct a scientific investigation and evaluate the results of that investigation. Understand and use the processes of scientific investigation to design, conduct, describe, and evaluate these investigations.	<ul style="list-style-type: none"> <li>▪ Students will be able to design and complete a scientific experiment using the scientific method [only one?] including questioning, testing, hypothesizing, analyzing data, making conclusions based on evidence, and comparing conclusions to the original hypothesis and prior knowledge.</li> <li>▪ Students will be able to distinguish between qualitative and quantitative data.</li> <li>▪ Students will be able to apply mathematics to analyze and support conclusions and models.</li> <li>▪ Students will be able to identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.</li> <li>▪ Students will be able to apply established safety rules and guidelines in conducting scientific investigations inside and outside the classroom.</li> </ul>
GRADE 9– 12	I. HISTORY AND NATURE OF SCIENCE	C. Scientific Enterprise	The student will explain the relationship between science and technology and how both are used in our world.	<ul style="list-style-type: none"> <li>▪ Students will be able to analyze an example of a way you use the scientific method in your daily life.</li> <li>▪ Students will compare and contrast the goals and career opportunities of engineering/technology and science.</li> <li>▪ Students will provide an example of a need/problem explained by science and solved by engineering/ technology.</li> <li>▪ Students will describe the different scientific and engineering disciplines involved in a common household item.</li> </ul> <p><i>What does this mean?</i></p> <ul style="list-style-type: none"> <li>▪ Students will provide an example of how technology facilitated a rapid advancement in science.</li> </ul> <p><i>What about the converse?</i></p>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9 – 12	<b>I. HISTORY AND NATURE OF SCIENCE</b>	D. Historic Perspectives	The student will recognize the historical and cultural context of scientific endeavors and how they influence each other.	<ul style="list-style-type: none"> <li>▪ Students will be able to trace the development of a scientific advancement, invention, or theory through time and its impact on society.</li> <li>▪ Students will be able to explain the impact of society on major scientific developments.</li> <li>▪ Students will provide an example of a scientific advancement contributed by another civilization.</li> <li>▪ Students will compare and contrast the differences between scientific theory and other bodies of knowledge, including <b>cultural beliefs</b>, and the importance of each in a science discussion.</li> </ul> <p>Sophisticated principle.</p>
GRADE 9–12	<b>II. PHYSICAL SCIENCE</b>	A. Structure of Matter	The student will understand the <b>nature</b> of matter including their forms, properties and interactions. <i>Know the properties of matter? Also, what does “their” refer to? Nothing before it is plural.</i>	<ul style="list-style-type: none"> <li>▪ Students will identify the major components of the nuclear atom (protons, neutrons, electrons) and their arrangement, relative mass, and charge (Atomic Theory).</li> <li>▪ Students will be able to explain the relationship of an element’s position on the periodic table to its atomic number and mass.</li> <li>▪ Students will compare and contrast the properties of an element and its isotopes and how radioactive isotopes can be used to estimate the age of materials.</li> <li>▪ Students will be able to identify and distinguish between substances using physical and chemical properties (e.g., color, solubility, density, chemical reactivity, pH, melting and boiling point).</li> <li>▪ Students will use the periodic table to identify regions, families (groups) and periods, and to predict the properties of elements (e.g., atomic size, number of bonding electrons, reactivity).</li> <li>▪ Students will be able to explain how atoms form compounds through both ionic and covalent bonding and predict the properties of compounds based on types of bonds present (ionic, covalent, intermolecular forces between molecules).</li> <li>▪ Students will be able to differentiate between homogeneous and heterogeneous mixtures and pure substances.</li> <li>▪ Students will compare and contrast the phases of matter (solids, liquids, gases) in terms of structure, energy, and particle motion.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	II. PHYSICAL SCIENCE	B. Chemical Reactions	The student will understand that the conservation of atoms in chemical reactions <b>leads to the ability</b> [Language Precision] to calculate quantities of products and reactions in chemical changes of matter.	<ul style="list-style-type: none"> <li>Students will be able to distinguish between chemical and physical changes.</li> <li>Students will describe and predict chemical reactions using words or symbolic equations.</li> </ul> <p><i>Difficult principle.</i></p> <ul style="list-style-type: none"> <li>Students will observe, measure, and calculate quantities to demonstrate conservation of matter and energy in chemical changes.</li> <li>Students will be able to explain the range of reaction rates and the states and conditions that influence them, including catalysts, temperature, and surface area.</li> <li>Students will be able to relate chemical reactions to real world processes.</li> <li>Students will be able to differentiate between complete and reversible reactions.</li> </ul>
GRADE 9–12	II. PHYSICAL SCIENCE	C. Energy Transformations	The student will identify, analyze, and measure relationships with energy forms, transformations, and transfers.	<ul style="list-style-type: none"> <li>Students will distinguish between the different types of energy including kinetic energy, potential energy and electromagnetic waves.</li> <li>Students will be able to describe the electromagnetic spectrum in terms of wavelength, frequency, speed, and give a <b>use</b> of each.</li> <li>Students will be able to use the <b>1<sup>st</sup> Law of Thermodynamics</b> !!!to explain changes in energy in both physical and chemical changes.</li> <li>Students will be able to describe the relationship among energy, work and power both conceptually and quantitatively.</li> <li>Students will compare and contrast the amount of energy released through chemical reactions and nuclear reactions (fission and fusion).</li> <li>Students will critique methods of energy production, such as fossil fuels, wind power, renewable sources and nuclear, in terms of impacts on society.</li> <li>Students will be able to describe the <b>2<sup>nd</sup> Law of Thermodynamics</b> as the tendency of everything to become less organized and less orderly over time.</li> </ul> <p><i>Difficult principles.</i></p>
GRADE 9–12	II. PHYSICAL SCIENCE	D. Motion	The student will predict the motion of most objects.	<ul style="list-style-type: none"> <li>Students will be able to apply Newton's 3 laws of motion <b>to real world situations.</b></li> </ul> <p><i>What are unreal world situations to which Newton's laws apply?</i></p> <ul style="list-style-type: none"> <li>Students will be able to apply the law of conservation of momentum to a real world situation.</li> <li>Students will be able to describe the relationship between thermal energy and motion of particles.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	II. PHYSICAL SCIENCE	E. Forces of Nature	Understand the forces of nature and their <b>application</b> in the real world. <i>If they are natural forces in what sense are they applied in the real world?</i>	<ul style="list-style-type: none"> <li>▪ Students will be able to identify the four forces of nature (gravity, electromagnetic, weak and strong nuclear forces).</li> <li>▪ Students will be able to recognize that the nuclear forces hold the nucleus of an atom together are usually stronger than the electric forces that would make it fly apart.</li> <li>▪ Students will recognize that gravity is a universal force that each mass exerts on any other mass; Comprehend that the strength of gravity is relational to the mass and the distance.</li> <li>▪ Students will describe the electrical force that exists between any two charged objects and distinguish between attraction and repulsion between charged objects.</li> <li>▪ Students will describe how a wire and a magnet can be used to generate electric current.</li> </ul>
GRADE 9–12	III. EARTH AND SPACE SCIENCE	A. Earth Structure and Processes	The student will understand how the interaction of the atmosphere, biosphere, lithosphere, hydrosphere and space has resulted in ongoing change of the Earth system over geologic time.	<ul style="list-style-type: none"> <li>▪ Students will identify the internal and external sources of energy for the Earth.</li> <li>▪ Students will demonstrate understanding of the laws of thermodynamics as they apply to the cycling of materials and transfer of energy in the Earth system.</li> <li>▪ Students will give examples of how biological processes have played significant roles in determining the character of the atmosphere, biosphere and lithosphere over time.</li> <li>▪ Students will be able to use the theory of plate tectonics to explain relationships among earthquakes, volcanoes, mountains, mid-oceanic ridges and deep-sea trenches.</li> <li>▪ Students will be able to describe how glaciers, gravity, wind, temperature changes, waves, and rivers cause weathering and erosion.</li> <li>▪ Students will describe the rock cycle and compare and contrast the processes responsible for the formation of igneous, sedimentary, and metamorphic rocks.</li> <li>▪ Students will use evidence such as, fossils, rock layers, ice caves, radiometric dating, and globally gathered data, to explain how Earth has changed or remained constant over short and long periods of time.</li> <li>▪ Students will recognize the dependency of human activity on limited resources</li> <li>▪ Students will be able to apply an integrated understanding of chemistry, physics, and biology to the analysis of global change issues, such as ozone depletion, greenhouse warming and overpopulation.</li> <li>▪ Students will be able to use globally gathered data to describe how Earth systems interact to create our climate and ecosystems.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	III. EARTH AND SPACE SCIENCE	B. The Water Cycle, Weather and Climate	The student will understand the relationships between the global atmospheric processes driven by energy from the sun, the Earth’s tilt, rotation, revolution, the influence of land and water, and the impact of human <b>affairs</b> .	<ul style="list-style-type: none"> <li>▪ Students will be able to explain how the transfer of energy and motions of the Earth all contribute to global atmospheric processes.</li> <li>▪ Students will be able to trace cyclical movement of an element through the lithosphere, hydrosphere, atmosphere, and biosphere.</li> <li>▪ Students will demonstrate the effect of the Earth’s tilt, rotation, and revolution on the seasons, day length, and tides.</li> <li>▪ Students will identify, investigate and predict the factors that influence the quality of water and how it can be reused, recycled and conserved.</li> <li>▪ Students will be able to identify, analyze and evaluate the factors that may influence weather and climate, and describe both their short and long term effects on the environment.</li> <li>▪ Students will discuss the impact of human activity and natural resource use on the Earth’s climate.</li> <li>▪ Students will be able to connect the biotic and abiotic factors that affect the evolution of the Earth’s environment and structure.</li> <li>▪ <b>Students will explain how specific chemical reactions or reaction series have major implication for climate conditions and ecosystem change.</b></li> </ul> <p><i>For instance?</i></p>
GRADE 9–12	III. EARTH AND SPACE SCIENCE	C. The Solar System	The student will connect the formation and characteristics of our solar system and its components to the conditions necessary for life.	<ul style="list-style-type: none"> <li>▪ Students will be able to explain how the sun, earth, and solar system formed.</li> </ul> <p><i>Is there a single accepted theory?</i></p> <ul style="list-style-type: none"> <li>▪ Students will be able to compare and contrast the <b>nature</b> ?of the planets taking into account their composition, mass and distance from the sun.</li> <li>▪ Students will be able to describe the remotely sensed evidence from current technology that has been used to understand the early history of the solar system.</li> <li>▪ Students will be able to compare and contrast the environmental parameters that make life possible on Earth with conditions found on the other planets of our solar system.</li> </ul>
GRADE 9–12	III. EARTH AND SPACE SCIENCE	D. The Universe	The student will understand that astronomical data reveals the structure, scale, and changes in the stars, galaxies, and universe over time.	<ul style="list-style-type: none"> <li>▪ Students will recognize that stars, <b>galaxy, and universe</b> change over time.</li> <li>▪ Students will recognize that the visible mass of the universe consists of billions of galaxies, each of which is a gravitationally bound cluster of billions of stars.</li> <li>▪ Students will understand that stars produce energy from nuclear reactions, primarily the fusion of hydrogen to form helium.</li> <li>▪ Students will be able to identify that the processes in stars that lead to the formation of other elements.</li> <li>▪ Students will describe the evidence from current technologies that has been used to understand the early history of the universe.</li> </ul> <p><i>Difficult principle applied to galaxy and universe.</i></p>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	IV. LIFE SCIENCE	A. Cells	The student will comprehend that all living things are composed of cells and the life processes in a cell are based on molecular interactions.	<ul style="list-style-type: none"> <li>▪ Students will be able to relate cellular structures and organelles to their functions.</li> <li>▪ Students will be able to differentiate between prokaryotic and eukaryotic cells in terms of their structure and complexity.</li> <li>▪ Students will compare and contrast the structures found in typical plant and animal cells.</li> <li>▪ Students will be able to explain the role of the cell membrane as a highly selective barrier (diffusion, osmosis, active transport).</li> <li>▪ Students will describe the role of enzymes as catalysts in metabolism and cellular synthesis of new molecules.</li> <li>▪ Students will be able to differentiate between the processes of photosynthesis and respiration in terms of energy flow, reactants, and products.</li> <li>▪ Students will describe how cell functions are regulated through intercellular and extra cellular signaling (hormones, neurotransmitters, proteins).</li> <li>▪ Students will describe and compare the processes of mitosis and meiosis and their role in the cell cycle.</li> </ul>
GRADE 9–12	IV. LIFE SCIENCE	B. Organisms	The student will classify, compare, and contrast the diversity of organisms on earth and their modes of accommodating the requirements for life.	<ul style="list-style-type: none"> <li>▪ Students will relate the structure, complexity and organization of organisms (all organ systems) to their methods of obtaining, transforming, releasing, and eliminating the matter and energy used to sustain the organism.</li> <li>▪ Students will be able to explain the development of multicellular organisms from a single cell through the regulation and expression of different genes.</li> <li>▪ Students will recognize that organisms have innate and/or learned behavioral responses to internal and external stimuli, including the tropic responses in plants.</li> <li>▪ Students will be able to identify significant adaptations that have allowed life to evolve from single celled aquatic organisms to multicellular terrestrial organisms over a period of more than 3.5 billion years.</li> <li>▪ Students will be able to use scientific evidence, including the fossil record, homologous structures, embryological development, or biochemical similarities, to classify organisms showing probable evolutionary relationships and reflecting common ancestry.</li> </ul>
GRADE 9–12	IV. LIFE SCIENCE	C. Diversity and Interdependence or Life	The student will describe how the environment and interactions between organisms can affect the number of species and the diversity of species in an ecosystem.	<ul style="list-style-type: none"> <li>▪ Students will be able to describe the factors related to matter and energy in an ecosystem that influence fluctuations in population size and determine the carrying capacity of a population.</li> <li>▪ Students will be able to explain how adaptations of species and co-evolution with other species are related to success in an ecosystem.</li> <li>▪ Students will identify the types of symbiotic relationships (mutualism, commensalism, parasitism) that occur in a stable ecosystem.</li> <li>▪ Students will predict and analyze how a change in an ecosystem, resulting from natural causes, changes in climate, human activity, or introduction of invasive species, can affect the number of organisms in a population and the biodiversity of species in the ecosystem.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	IV. LIFE SCIENCE	D. Heredity	The student will explain how inherited characteristics are encoded by genes.	<ul style="list-style-type: none"> <li>▪ Students will be able to explain that the instructions for the characteristics of all organisms are carried in nucleic acids (DNA and RNA).</li> <li>▪ Students will be able to define the relationship between DNA, genes, and chromosomes.</li> <li>▪ Students will describe the structure and function of DNA and distinguish between replication, transcription, and translation.</li> <li>▪ Students will know that different species of multicellular organisms have a characteristic diploid number chromosomes, and that in typical humans there are 22 autosomal pairs and two sex chromosomes (XX for female and XY for male).</li> <li>▪ Students will describe how genetic information is transmitted from parents to offspring through the process of meiosis and fertilization as they relate to chromosome recombination and sexual reproduction.</li> <li>▪ Students will be able to use Mendel’s laws of segregation and independent assortment and a Punnett Square to determine the genotype and phenotype of a monohybrid crosses.</li> <li>▪ Students will differentiate between dominant, recessive, co- dominant, incompletely dominant, polygenic, and sex-linked traits.</li> <li>▪ Students will be able to explain how somatic and germ-line mutations in the DNA sequence of a gene may be silent or result in phenotypic change in an organism and/or its offspring.</li> <li>▪ Students will determine empirically? the factors that affect the rate of mutations, including, but not limited to, ionizing radiation and chemicals.</li> <li>▪ Students will recognize that biochemical analytical techniques allow for sophisticated analysis with applications such as forensic science, genetic engineering of plants, and medical applications and their societal impacts.</li> </ul>

Grade Level	Strand	Sub-Strand	Standard	Benchmarks
GRADE 9–12	IV. LIFE SCIENCE	E. Biological Populations Change Over Time	The student will explain how evolution provides a scientific explanation for the fossil record of ancient life forms, as well as for the striking molecular similarities observed among the diverse species of living organisms.	<ul style="list-style-type: none"> <li>▪ Students will understand that species change over time and the term biological evolution is used to describe this process.</li> <li>▪ Students will describe how natural selection, the mechanism of biological evolution, causes the differential survival of groups of organisms as a consequence of:               <ol style="list-style-type: none"> <li>a. the potential for a species to increase its numbers;</li> <li>b. the genetic variability of offspring due to mutation and recombination of genes;</li> <li>c. a finite supply of the resources required for life;</li> <li>d. the ensuing selection based on environmental factors of those offspring better able to survive and produce reproductively successful offspring.</li> </ol> </li> <li>▪ Students will be able to predict the success or failure of a population of organisms over time based on genetic variability of offspring, the ability to reproduce, and the exposure to changing environmental factors.</li> <li>▪ Students will be able to describe how genetic variation between populations is due to different selective pressures acting on each population, which can lead to speciation/a new species.</li> <li>▪ Students will recognize [or know that scientists believe] that a great amount of time, approximately 3.5 billion years, is necessary to explain the variation of species that has produced the great diversity of life currently present on earth and found in the fossil record.</li> </ul>
GRADE 9–12	IV. LIFE SCIENCE	F. Flow of Matter and Energy	The student will describe and explain the cycling of matter and flow of energy through an ecosystem's living and non-living components.	<ul style="list-style-type: none"> <li>▪ Students will be able to explain the relationship between abiotic and biotic components of an ecosystem in terms of cycling of water, carbon, oxygen, and nitrogen.</li> <li>▪ Students will know that all matter tends to become more disorganized and that living systems require a continuous input of energy in order to maintain their chemical and physical organizations and prevent death.</li> <li>▪ Students will identify that the primary source of energy for life and fossil fuels is derived from the sun, and explain how sunlight energy is transformed into chemical energy by photosynthesis in organisms.</li> <li>▪ Students will identify and distinguish producers, consumers, and decomposers, and explain the transfer of energy through the trophic levels.</li> <li>▪ Students will describe how respiration releases chemical energy by the breakdown of molecules and store the energy.</li> <li>▪ Students will understand that energy flows through different levels of organization of living systems (cells to communities) and between living systems and the physical environment as chemical elements are recombined in different ways. Each recombination results in storage and dissipation of energy.</li> </ul>

<b>Grade Level</b>	<b>Strand</b>	<b>Sub-Strand</b>	<b>Standard</b>	<b>Benchmarks</b>
GRADE 9–12	IV. LIFE SCIENCE	G. Human Organism	The student will relate the structure and function of human organ systems to the ability to maintain a stable internal environment (homeostasis) despite changes in the outside environment.	<ul style="list-style-type: none"> <li>▪ Students will explain how major organ systems in humans have functional subunits with specific anatomy that perform the function of that organ system.</li> <li>▪ Students will understand and describe the basic anatomy and physiology of the nervous system and sense organs.</li> <li>▪ Students will be able to describe how the function of individual systems within humans is integrated to maintain a homeostatic balance in the body.</li> <li>▪ Students will be able to illustrate how feedback loops in the nervous and endocrine system regulate conditions in the body.</li> <li>▪ Students will realize that behavioral biology has implications for humans since it provides links to psychology, sociology and anthropology.</li> </ul>