

# Washington West Supervisory Union

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# Scientific Habits of Mind

Science is more than a mere collection of facts or ideas; it is a unique way of knowing that implies a particular manner of thinking and acting on the world. Scientific habits of mind describe the essential thinking skills, which serve as tools for both formal and informal learning in science and for life-long participation in society. The four major Habits of Mind are Problem Solving, Reasoning, Communication, and Making Connections.

## **Problem Solving**

Problem solving is a broad term encompassing many kinds of scientific inquiry. In some cases, scientists ask questions, make accurate observations, collect and interpret data, and draw conclusions from their data. For example, an animal behaviorist can find out about how a particular organism reacts to stimuli by setting up a controlled experiment and making deductions from the results. This process, called experimenting, is sometimes considered the dominant way by which scientists find out about the natural world. Whether this is true or not (and this often depends on the particular scientific discipline), experimenting is certainly one of the most important aspects of scientific problem solving. Experimenting is most often recursive in nature; it is not a one-time activity. In a word, scientists often perform an experiment and get inconclusive results or even discover errors in their procedures, which then lead them to try again, to attempt to get more accurate, reliable, or valid data upon which to base conclusions. This process is dissimilar to how students learn how to play safely in their own neighborhood.

Yet other types of scientific inquiry are based on the processes of observation and inference. Naturalists often identify new species of plants and animals not through experimentation, but rather through the power of observation. Theoretical physicists often create and build models, and using their powers of inference to learn about physical systems. Likewise, paleontologist can make inferences about the environment of an ancient organism based on associated plant fossils. In each of these cases, however, scientists are solving problems by applying scientific problem-solving techniques.

## **Reasoning**

Reasoning is closely related to problem solving, and stresses the use of data and logic to draw conclusions, create interpretations, and make decisions. Reasoning is used in all aspects of science. As field geologists observe a rock outcrop, they must decide whether the outcrop is a significant aspect of the field map being produced. To do so, they must reason from both textbook and practical knowledge as well as their experience. Likewise, animal behaviorists use reasoning throughout their experiments. Is the procedure accurate? Does the data look reasonable? Are there any variables left uncontrolled? Without applying reasoning abilities, no scientist (or intelligent being for that matter!) could accomplish much.

### **Communication**

Communication involves the sharing of data, observations, results, and interpretations via graphic representations and the written and spoken word. No one scientist can know or understand everything. Thus, communication becomes a critical habit of mind for sharing information. Scientists communicate orally in person, by using the phone and other technology, and by attending professional meetings at which their work can be shared. They also communicate through journals, magazines, books, and other print materials. Recently, communication has become increasingly technological. Scientists create, share, and use large databases; they communicate using their computers and through interactive television. Regardless of the medium, however, regular and accurate communication is a key component of scientific advancement.

### **Making Connections**

Making connections emphasizes how ideas in science are related to each other and to other experiences in the formal educational setting and most importantly to everyday life experiences. The traditional disciplines of biology, chemistry, physics, and earth science are divisions created by scientists that allow for in-depth focus on a particular aspect of science. Yet these divisions by their very nature limit thinking. Making connections also implies the use of universal scientific process skills, laboratory techniques, and reasoning not only within all scientific disciplines but in other fields as well. Scientifically literate individuals can apply these skills in many situations and often apply scientific processes to solve daily problems. This habit of mind is also particularly important in solving real-world problems that overlap traditional scientific boundaries. For example, architectural engineers attempting to achieve the best acoustical qualities when designing an auditorium must understand the physics of sound. Likewise, someone trying to improve the quality of paint for use by artists must know about how the human eye and brain interact to perceive color. These connections to other disciplines are critical to most successful science in today's world.

## WWSU Science Curriculum Document

This curriculum guide represents the culmination of work completed during the 2007-2008 school year, and has been modified and adapted- with assessments added during the subsequent two school years. The committee would like to thank Karen Reinhardt, science curriculum specialist, for her support with the development of this document.

Additional thanks to the following teachers who served as members of the WWSU Science Curriculum Development Team over the past several years. Their commitment to science education in the WWSU schools is immeasurable.

*Sheila M. Rivers*

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Washington West Science Curriculum Committee			
<b>K-2 Team</b>	<b>3-4 Team</b>	<b>5-6 Team</b>	<b>7-8 Team</b>
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			<b>Other Representatives</b>
			Judy Corey Barbara Tomasi-Gay

## Washington West Supervisory Union K-8 Science Curriculum Topics

Grade	Physical Science	Life Science/ Human Body	Earth Science
<b>K</b>	<ul style="list-style-type: none"> <li>• Sorting/Classifying: Properties of Matter (9)</li> </ul>	<ul style="list-style-type: none"> <li>• Classification: Plants and Animals (30, 34, 38, 49)</li> <li>• Human Body Systems: Senses (41; 1-2: 41)</li> </ul>	<ul style="list-style-type: none"> <li>• Sorting and Classifying: Rocks(46)</li> <li>• Weather/Characteristics of the Solar System (23, 44, 48)</li> </ul>
<b>1-2</b>	<ul style="list-style-type: none"> <li>• Sound (29)</li> <li>• Magnets (25)</li> <li>• Properties of Solids/Liquids (9, 12, 14, 23)</li> <li>• Forces and Motion (PreK-K:19, 1-2:19, 1-2: 21, 3-4: 21, 22)</li> </ul>	<ul style="list-style-type: none"> <li>• Life Cycles (31, 43)</li> <li>• Human Body (40, 42)</li> <li>• Needs Of Living Things (Plants) (34, 49)</li> </ul>	<ul style="list-style-type: none"> <li>• Earth and Sky (44, 45, 48)</li> </ul>
<b>3-4</b>	<ul style="list-style-type: none"> <li>• Electricity and Magnetism (24, 25)</li> <li>• Properties/States of Matter (9, 12, 13, 14, 48)</li> </ul>	<ul style="list-style-type: none"> <li>• Life Cycles/Characteristics of Organisms (30, 31, 38, 39)</li> <li>• Human Body Systems (40, 41, 42)</li> <li>• Interdependence (34, 35, 36)</li> </ul>	<ul style="list-style-type: none"> <li>• Geology (1-2: 46, 3-4:46, 47)</li> <li>• Earth and Sky (44, 45)</li> </ul>
<b>5-6</b>	<ul style="list-style-type: none"> <li>• Force and Motion (19, 20, 21, 22)</li> <li>• Matter/Physical and Chemical Change (9, 13, 14, 15)</li> <li>• Energy: Light and Sound (3-4: 28, 28, 29)</li> </ul>	<ul style="list-style-type: none"> <li>• Cells (30, 32b, 33, 39)</li> <li>• Ecosystems (34, 35, 36, 37, 49 bullet 2)</li> <li>• Human Body (32, 40, 41, 42, 43)</li> </ul>	<ul style="list-style-type: none"> <li>• Geology (46, 47, 48 3-4:49, 5-6: 49)</li> <li>• Solar System (44, 45, 7-8:45)</li> </ul>
<b>7-8</b>	<ul style="list-style-type: none"> <li>• Matter (9, 10, 12, 13, 14, 15, 5-6:23, 7-8:23)</li> <li>• Forces and Motion (19, 21, 22)</li> <li>• Electricity and Magnetism (5-6:24, 7-8:24, 5-6:25, 5-6:26)</li> <li>• Light (28)</li> </ul>	<ul style="list-style-type: none"> <li>• Cells (30, 31, 33, 41)</li> <li>• Ecosystems (34, 37, 48)</li> <li>• Genetics/Evolution (39, 40)</li> <li>• Classification (38)</li> <li>• Microbiology (42)</li> </ul>	<ul style="list-style-type: none"> <li>• Natural Resources (36, 49)</li> <li>• Weather (48)</li> </ul>

**Pre-K/Kindergarten  
Grade Level Expectations  
Scientific Inquiry**

**Scientific Questioning**

**SPK-K:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...**

- Developing a question by completing the prompt, “I wonder...?”
- Demonstrating a “questioning mind” through extended, intentional (purposeful) interactions with materials or people; experimenting with possibilities.

**Predicting and Hypothesizing**

**SPK-K:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Stating ideas about what may happen or be observed in the future (e.g., student thinks ahead).

**Designing Experiments**

**SPK-K:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Explaining the process of an investigation before and during the process (e.g., “on the job” planning, investigating, and explaining can happen simultaneously).
- Using procedures that are safe and humane.

**Conducting Experiments**

**SPK-K:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Using more than one of the senses to make observations.
- Describing obvious features of an object or event.
- Representing data in a variety of ways including words, numbers, symbols, and pictures
- Drawing scientifically:
  - a. Recording shapes, prominent features with supporting details (e.g., eyelashes on eyes), and color.
  - b. Spatially organizing and differentiating significant parts observed.
  - c. Adding essential information to a diagram provided by the teacher.
  - d. Using simple equipment and nonstandard measurement tools to gather data and extend the senses (e.g., balances, scales, counters, magnifiers).
  - e. Following teacher guidance to complete steps while investigating a question.

### **Representing Data and Analysis**

#### **SPK-K:5: Students demonstrate their ability to REPRESENT DATA by...**

- Organizing a piece of data (measurement or observation) or a group representation (e.g., pictograph, bar graph, or chart).

#### **SPK-K:6: Students demonstrate their ability to ANALYZE DATA by...**

- Sorting objects based upon current observations and justifying groupings.

#### **SPK-K:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Explaining observations with the support of material props, photographs, drawings, or diagrams.

### **Applying Results**

#### **SPK-K:8: Students demonstrate their ability to APPLY RESULTS by...**

- Identifying similarities between past experiences and current investigations.

## Kindergarten

### Sorting and Classifying: Matter, Rocks

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>All living and non-living things are composed of matter having characteristic properties that distinguish one substance from another. All matter can undergo change; with such change, mass remains constant.</li> <li>There are forces within the Earth and its surrounding atmosphere that cause changes in its structure and composition over time. Change can be slow or fast.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How are things alike and different?</li> <li>How are rocks similar and different?</li> <li>How do rocks change over time?</li> </ul>	
<p><b>SPK-K:9</b>  <b>Students demonstrate their understanding of the Properties of Matter by...</b></p> <ul style="list-style-type: none"> <li>Observing and sorting substances that are solids and liquids and identifying their differences.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>The physical properties of objects can be sorted by how they are alike or different.</li> <li>Objects can be sorted according to their properties.</li> </ol>
<p><b>SPK-K:46</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>Sorting and recognizing similarities and differences in a variety of rocks (from boulders to grains of sand).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Chunks of rocks come in many sizes and shapes, from boulders to grains of sand and even smaller.</li> </ol>
<p><b>SPK-K:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>Using more than one of the senses to make observations.</li> <li>Describing obvious features of an object or event.</li> <li>Representing data in a variety of ways including words, numbers, symbols, and pictures</li> <li>Drawing scientifically:             <ol style="list-style-type: none"> <li>Recording shapes, prominent features with supporting details (e.g., eyelashes on eyes), and color.</li> <li>Spatially organizing and differentiating significant parts observed.</li> <li>Adding essential information to a diagram provided by the teacher.</li> <li>Using simple equipment and nonstandard measurement tools to gather data and extend the senses (e.g., balances, scales, counters, magnifiers).</li> </ol> </li> <li>Following teacher guidance to complete steps while investigating a question.</li> </ul>	
<p><b>SPK-K:6: Students demonstrate their ability to ANALYZE DATA by...</b></p> <ul style="list-style-type: none"> <li>Sorting objects based upon current observations and justifying groupings.</li> </ul>	

## Kindergarten Classification: Plants and Animals

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>• All living things and their component cells need energy to function and survive through the life cycle of birth, development, reproduction, and death.</li> <li>• Energy (from the sun) is transferred through interdependent systems to support life.</li> <li>• All living things have similarities and differences. Inherited physical traits, behaviors, and interdependencies help to classify these organisms.</li> <li>• Natural resources are materials that we obtain from the living and non-living environment. Human interactions can have positive and negative impacts on these resources.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How are living and non-living things alike and different?</li> <li>• What do plants and animals need to survive?</li> <li>• How can you tell an animal from a plant?</li> <li>• Why is it so important to take care of the earth’s plants and animals?</li> </ul>	
<p><b>SPK-K:30</b>  <b>Students demonstrate their understanding of Structure and Function–Survival Requirements by...</b></p> <ul style="list-style-type: none"> <li>• Observing and recording what happens when food and water are given to living and non-living things.</li> </ul>	<p><b>Science Concept:</b>  a. There are differences between living and non-living things.</p>
<p><b>SPK-K:34</b>  <b>Students demonstrate their understanding of Energy Flow in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Caring for plants and animals by identifying and providing for their needs.</li> </ul>	<p><b>Science Concept:</b>  a. Plants and animals both need water, food and air.</p>
<p><b>SPK-K:38</b>  <b>Students demonstrate their understanding of Classification of Organisms by...</b></p> <ul style="list-style-type: none"> <li>• Sorting and identifying examples of plants and animals.</li> </ul>	<p><b>Science Concept:</b>  a. Some living things (organisms) are identified as plants or animals.</p>
<p><b>SPK-K:49</b>  <b>Students demonstrate their understanding of Processes and Change within Natural Resources by...</b></p> <ul style="list-style-type: none"> <li>• Identifying items that students consume on a daily basis (e.g., food, fiber, paper, wool or wood).</li> </ul>	<p><b>Science Concepts:</b>  a. Natural Resources are materials that we obtain from the living and non-living environment.</p>
<p><b>SPK-K:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...</b></p> <ul style="list-style-type: none"> <li>• Developing a question by completing the prompt, “I wonder...?”</li> <li>• Demonstrating a “questioning mind” through extended, intentional (purposeful) interactions with materials or people; experimenting with possibilities.</li> </ul>	

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**SPK-K:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Stating ideas about what may happen or be observed in the future (e.g., student thinks ahead).

**SPK-K:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Explaining the process of an investigation before and during the process (e.g., “on the job” planning, investigating, and explaining can happen simultaneously).
- Using procedures that are safe and humane.

**SPK-K:8: Students demonstrate their ability to APPLY RESULTS by...**

- Identifying similarities between past experiences and current investigations.

## Kindergarten Human Body Systems: Senses

<p><b>Enduring Understanding:</b> The human body is made up of interconnected systems that maintain equilibrium and respond to the environment to ensure survival.</p>
<p><b>Essential Question:</b></p> <ul style="list-style-type: none"> <li>How do our senses help us survive?</li> </ul>

<p><b>SPK-K:41</b> <b>Students demonstrate their understanding of Human Body Systems by...</b></p> <ul style="list-style-type: none"> <li>Identifying the five senses and using the senses to identify objects in their environment.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. People use their senses to find out about their surroundings and themselves. Different senses give different information.</p>
<p><b>S1-2:41</b> <b>Students demonstrate their understanding of Human Body Systems by...</b></p> <ul style="list-style-type: none"> <li>Identifying the senses needed to meet survival needs for a given scenario.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. People use their senses to find out about their surroundings and meet their needs.</p> <p>b. Body parts help people satisfy their need for food.</p> <ul style="list-style-type: none"> <li>-eyes/nose: find food</li> <li>-legs/hands: get food</li> <li>-mouth: eat food</li> </ul> <p>c. Senses help people satisfy their need to avoid danger.</p> <ul style="list-style-type: none"> <li>-nose: smell fire</li> <li>-ears: hear danger</li> </ul>
<p><b>SPK-K:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>Using more than one of the senses to make observations.</li> <li>Describing obvious features of an object or event.</li> <li>Representing data in a variety of ways including words, numbers, symbols, and pictures</li> <li>Drawing scientifically:             <ol style="list-style-type: none"> <li>a. Recording shapes, prominent features with supporting details (e.g., eyelashes on eyes), and color.</li> <li>b. Spatially organizing and differentiating significant parts observed.</li> <li>c. Adding essential information to a diagram provided by the teacher.</li> <li>d. Using simple equipment and nonstandard measurement tools to gather data and extend the senses (e.g., balances, scales, counters, magnifiers).</li> </ol> </li> <li>Following teacher guidance to complete steps while investigating a question.</li> </ul>	

## Kindergarten Weather/Characteristics of Solar System

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Heat is a form of energy that flows from one object to another.</li> <li>• The sun, planets, and moons in our solar system have specific characteristics and follow patterns. These contribute to our understanding of the universe.</li> <li>• The relationship between the earth and the sun creates changes over time encompassing the water cycle, climate, and weather and seasonal patterns.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How does the sun affect the earth?</li> <li>• How does the sky look/change throughout the day/season/year?</li> <li>• How might weather change from day to day?</li> </ul>	
<p><b>SPK-K:23</b> Students demonstrate their understanding of Heat Energy by...</p> <ul style="list-style-type: none"> <li>• Identifying the sun as a source of heat energy.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The sun warms the land, air and water.</p>
<p><b>SPK-K:44</b> Students demonstrate their understanding of Characteristics of the Solar System by...</p> <ul style="list-style-type: none"> <li>• Observing and recording the day and night sky.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The sun can be seen only at day time. b. The sun and moon are in the sky.</p>
<p><b>SPK-K:48</b> Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</p> <ul style="list-style-type: none"> <li>• Observing and describing weather daily throughout a school year.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Weather changes from day to day.</p>
<p><b>SPK-K:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>• Organizing a piece of data (measurement or observation) or a group representation (e.g., pictograph, bar graph, or chart).</li> </ul>	
<p><b>SPK-K:7: Students demonstrate their ability to EXPLAIN DATA by...</b></p> <ul style="list-style-type: none"> <li>• Explaining observations with the support of material props, photographs, drawings, or diagrams.</li> </ul>	

**Grades 1-2**  
**Grade Level Expectations**  
**Scientific Inquiry**

**Scientific Questioning**

**S1-2:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...**

- Posing observational questions that compare things in terms of number, shape, texture, size, weight, color, motion, etc. (e.g., How fast does a Lady Beetle move compared to a Bess Beetle?)
- Investigating and completing questions to identify a variable that can be changed (e.g., What will happen if...? or I wonder if I change...?).
- Generating new questions that could be explored at the end of an investigation.

**Predicting and Hypothesizing**

**S1-2:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Predicting a logical outcome to a situation, using prior knowledge, experience and/or evidence.
- Explaining reasons for that prediction.

**Designing Experiments**

**S1-2:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Writing a plan related to a question that includes:
  - a. What the experimenter will do.
  - b. What will be observed, measured, and/or compared.
- Recording major steps sequentially.

**Conducting Experiments**

**S1-2:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Referring to and following a simple plan for an investigation.
- Describing observations using senses rather than feelings (e.g., The snail has a hard shell with wavy, brown lines, rather than the snail is awesome).
- Recording observations of similarities and differences.
- Drawing scientifically:
  - a. Recording relative proportion (e.g., Eyes are approximately the right size when compared to the head) including focus on finer details, and differentiating all parts observed.
  - b. Labeling significant aspects of a scientific drawing or diagram with words provided,
  - c. Creating a title for a scientific drawing or diagram.
- Recording data (in a table provided by the teacher) generated from the use of simple science equipment , as well as nonstandard and standard measurement tools.

### **Representing Data and Analysis**

#### **S1-2:5: Students demonstrate their ability to REPRESENT DATA by...**

- Organizing a collection of data into a table or a graph template.
- Creating a title for a table or graph.

### **Representing Data and Analysis**

#### **S1-2:6: Students demonstrate their ability to ANALYZE DATA by...**

- Sorting and classifying objects based upon observations, prior knowledge, or experience and justifying groupings.
- Identifying and describing the pattern in diagrams and charts (e.g., model, bar graph, pictograph, diagram or chart).

#### **S1-2:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Developing a reasonable explanation based upon observations (e.g., I found out...)

### **Applying Results**

#### **S1-2:8: Students demonstrate their ability to APPLY RESULTS by...**

- Generating new questions related to discoveries during an investigation.
- Relating current investigation to a similar investigation.

## Grades 1-2 Magnets

**Enduring Understanding:**

- Magnetism is a force that acts over a distance and attracts or repels certain materials.

**Essential Question:**

- How do magnets affect objects?

**SPK-K:25****Students demonstrate their understanding of Magnetism by...**

Investigating, observing and describing how magnets can make some things move without touching (e.g., determining the distance needed for a magnet to attract an object).

**Science Concepts:**

- a. Magnets can move some objects without touching them.

**S1-2:6: Students demonstrate their ability to ANALYZE DATA by...**

- Sorting and classifying objects based upon observations, prior knowledge, or experience and justifying groupings.
- Identifying and describing the pattern in diagrams and charts (e.g., model, bar graph, pictograph, diagram or chart).

## Grades 1-2 Sound

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>• Sound is a form of energy that travels from a source and interacts with matter in predictable ways.</li> </ul>
<p><b>Essential Question:</b></p> <ul style="list-style-type: none"> <li>• How is sound made?</li> </ul>

<p><b>S1-2:29</b>  <b>Students demonstrate their understanding of Sound Energy by...</b></p> <ul style="list-style-type: none"> <li>• Investigating different objects, observing and describing the vibrations of those objects and the sounds that are made.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Sound is caused by vibrating objects.</p>
<p><b>S1-2:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>• Writing a plan related to a question that includes:             <ol style="list-style-type: none"> <li>a. What the experimenter will do.</li> <li>b. What will be observed, measured, and/or compared.</li> </ol> </li> <li>• Recording major steps sequentially.</li> </ul>	
<p><b>S1-2:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>• Referring to and following a simple plan for an investigation.</li> <li>• Describing observations using senses rather than feelings (e.g., The snail has a hard shell with wavy, brown lines, rather than the snail is awesome).</li> <li>• Recording observations of similarities and differences.</li> <li>• Drawing scientifically:             <ol style="list-style-type: none"> <li>a. Recording relative proportion (e.g., Eyes are approximately the right size when compared to the head) including focus on finer details, and differentiating all parts observed.</li> <li>b. Labeling significant aspects of a scientific drawing or diagram with words provided,</li> <li>c. Creating a title for a scientific drawing or diagram.                 <ul style="list-style-type: none"> <li>• Recording data (in a table provided by the teacher) generated from the use of simple science equipment , as well as nonstandard and standard measurement tools.</li> </ul> </li> </ol> </li> </ul>	
<p><b>S1-2:6: Students demonstrate their ability to ANALYZE DATA by...</b></p> <ul style="list-style-type: none"> <li>• Sorting and classifying objects based upon observations, prior knowledge, or experience and justifying groupings.</li> <li>• Identifying and describing the pattern in diagrams and charts (e.g., model, bar graph, pictograph, diagram or chart).</li> </ul>	
<p><b>S1-2:7: Students demonstrate their ability to EXPLAIN DATA by...</b></p> <ul style="list-style-type: none"> <li>• Developing a reasonable explanation based upon observations (e.g., I found out...)</li> </ul>	
<p><b>S1-2:8: Students demonstrate their ability to APPLY RESULTS by...</b></p> <ul style="list-style-type: none"> <li>• Generating new questions related to discoveries during an investigation.</li> <li>• Relating current investigation to a similar investigation.</li> </ul>	

## Grades 1-2 Life Cycles

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>All living things and their component cells need energy to function and survive through the life cycle of birth, development, reproduction, and death.</li> <li>All humans follow a predictable pattern of development from conception to adulthood.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do organisms change throughout their life cycles?</li> <li>How do humans change from babies to adults?</li> </ul>

<p><b>S1-2:31</b>  <b>Students demonstrate their understanding of Reproduction by...</b></p> <ul style="list-style-type: none"> <li>Drawing and labeling the stages of development in the life of a familiar plant or animal.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. All organisms undergo stages of development that include being born, developing into adulthood, reproducing and dying.</p> <p>b. Most organisms come from male and female parents.</p>
<p><b>S1-2:43</b>  <b>Students demonstrate their understanding of the Patterns of Human Development by...</b></p> <ul style="list-style-type: none"> <li>Identifying activities that you can do now that you couldn't do as a baby (e.g., dress yourself, get food from refrigerator, bathe yourself).</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Explaining where babies grow and develop.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. A human baby grows inside its mother until its birth. Even after birth, a human baby is unable to care for itself, and its survival depends on the care it receives from adults.</p>
<p><b>S1-2:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>Drawing scientifically:             <ol style="list-style-type: none"> <li>Recording relative proportion (e.g., Eyes are approximately the right size when compared to the head) including focus on finer details, and differentiating all parts observed.</li> <li>Labeling significant aspects of a scientific drawing or diagram with words provided,</li> <li>Creating a title for a scientific drawing or diagram.</li> </ol> </li> </ul>	

## Grades 1-2 Human Body

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>Inherited traits are passed on (transferred) from parents to offspring.</li> <li>The human body is made up of interconnected systems that maintain equilibrium and respond to the environment to ensure survival.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How and why are humans alike and different?</li> <li>How can things in the environment be harmful to humans?</li> </ul>

<p><b>S1-2:40</b>  <b>Students demonstrate their understanding of Human Heredity by...</b></p> <ul style="list-style-type: none"> <li>Observing and comparing their physical features with those of classmates and other organisms.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. People have different external features, such as size, color of hair, skin, and eyes. However, humans are more like one another than like other animals.</p>
<p><b>S1-2:42</b>  <b>Students demonstrate their understanding of the Patterns of Human Health/Disease by...</b></p> <ul style="list-style-type: none"> <li>Identifying things in the environment that could be harmful if swallowed (e.g., soaps, cleaning solutions, unknown pills).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Some things people take into their bodies from the environment are toxic and can hurt them.</p>
<p><b>S1-2:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>Organizing a collection of data into a table or a graph template.</li> <li>Creating a title for a table or graph.</li> </ul>	

**This does not need to be a “unit”. GE 40 can be taught at beginning of the year as part of Responsive Classroom and/or math data collection. GE 42 can be taught as part of Health Curriculum**

## Grades 1-2 Properties of Solids and Liquids

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>All living things are composed of matter having characteristic properties that distinguish one substance from another. All matter can undergo change; with such change, mass remains constant.</li> <li>Heat is a form of energy that flows from one object to another.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How are things alike and different?</li> <li>How are solids and liquids alike and different?</li> <li>How does heat affect states of matter?</li> </ul>	
<p><b>S1-2:9</b> <b>Students demonstrate their understanding of Properties of Matter by...</b></p> <ul style="list-style-type: none"> <li>Identifying, recording and comparing characteristics of objects made of similar and different properties.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Objects are made of one or more materials such as paper, wood, metal, or cloth.</li> <li>Similarities and differences in physical properties can be identified.</li> </ol>
<p><b>S1-2:12</b> <b>Students demonstrate their understanding of the States of Matter by...</b></p> <ul style="list-style-type: none"> <li>Identifying, describing and comparing the state of matter of solids and liquids.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Solids and liquids are states of matter and have properties that can be described.</li> <li>Solids have the properties of hardness, color, and ability to maintain shape.</li> <li>Liquids have properties of color, tendency to flow, ability to mix with other liquids, taking up the shape of the container.</li> </ol>
<p><b>S1-2:14</b> <b>Students demonstrate their understanding of Physical Change by...</b></p> <ul style="list-style-type: none"> <li>Describing and reporting the change in properties when heat is applied to a solid or when heat leaves a liquid (e.g., water and ice).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Heating and cooling (changes in temperature) can change states of matter. Water can be a liquid or a solid through the processes of melting and freezing.</li> </ol>
<p><b>S 1-2:23</b> <b>Students demonstrate their understanding of Heat Energy by...</b></p> <ul style="list-style-type: none"> <li>Experimenting, observing, and describing how heat moving from one object to another can cause temperature changes.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Heat can move from one object to another.</li> <li>The temperature of substances can change.</li> </ol>

## Grades 1-2 Forces and Motion

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>All matter is in motion. Forces act upon matter to change its motion.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do objects move?</li> <li>How can forces change the motion of an object?</li> </ul>	
<p><b>SPK-K:19</b> <b>Students demonstrate their understanding of Motion by...</b></p> <ul style="list-style-type: none"> <li>Manipulating objects and observing and describing the motion.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The position of an object can be described. (e.g., in front of or behind)</p> <p>b. The motion of an object can be described as a direction. (e.g., straight, zig zag, round and round back and forth, up, down).</p>
<p><b>S1-2:19</b> <b>Students demonstrate their understanding of Motion by...</b></p> <ul style="list-style-type: none"> <li>Investigating and describing how objects move in different ways.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The position and movement of an object can be described such as fast, slow, speeding up and slowing down and movement in different directions.</p>
<p><b>S1-2:21</b> <b>Students demonstrate their understanding of Force by...</b></p> <ul style="list-style-type: none"> <li>Investigating and identifying how pushing or pulling moves or does not move an object.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. A force is a push or a pull. Force can change the motion of an object.</p>
<p><b>S3-4:21</b> <b>Students demonstrate their understanding of Force by...</b></p> <ul style="list-style-type: none"> <li>Investigating and describing how different amounts of force can change the direction and speed of an object in motion.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Changes in speed or direction of motion are caused by forces.</p> <p>b. The greater the force, the greater the change in motion.</p>
<p><b>S1-2:22</b> <b>Students demonstrate their understanding of Gravitational Force by...</b></p> <ul style="list-style-type: none"> <li>Observing and describing that different objects fall to the earth unless something is holding them up.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Objects fall to the ground unless something holds them.</p>
<p><b>S1-2:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>Writing a plan related to a question that includes: <ul style="list-style-type: none"> <li>What the experimenter will do.</li> <li>What will be observed, measured, and/or compared.</li> </ul> </li> <li>Recording major steps sequentially.</li> </ul>	

(unit continued next page)

**S1-2:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Referring to and following a simple plan for an investigation.
- Describing observations using senses rather than feelings (e.g., The snail has a hard shell with wavy, brown lines, rather than the snail is awesome).
- Recording observations of similarities and differences.
- Drawing scientifically:
  - a. Recording relative proportion (e.g., Eyes are approximately the right size when compared to the head) including focus on finer details, and differentiating all parts observed.
  - b. Labeling significant aspects of a scientific drawing or diagram with words provided.
  - c. Creating a title for a scientific drawing or diagram.
- Recording data (in a table provided by the teacher) generated from the use of simple science equipment , as well as nonstandard and standard measurement tools.

**S1-2:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Developing a reasonable explanation based upon observations (e.g., I found out...)

**S1-2:8: Students demonstrate their ability to APPLY RESULTS by...**

- Generating new questions related to discoveries during an investigation.
- Relating current investigation to a similar investigation.

## Grades 1-2 Needs of Living Things

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>• Energy (from the sun) is transferred through interdependent systems to support life.</li> <li>• Natural resources are materials that we obtain from the living and non-living environment. Human interactions can have positive and negative impacts on these resources.</li> </ul>
<p><b>Essential Question:</b></p> <ul style="list-style-type: none"> <li>• How do plants get what they need to survive?</li> <li>• How does light affect plant growth?</li> <li>• How do animals and plants depend on each other?</li> <li>• Why do all animals need plants to survive?</li> <li>• How do we get our food?</li> <li>• How do we use the earth's resources?</li> </ul>

<p><b>S1-2:34</b> <b>Students demonstrate their understanding of Energy Flow in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Experimenting with plant growth under different conditions, including light and no light.</li> </ul>	<p><b>Science Concept:</b> a. Plants need light (energy) to survive.</p>
<p><b>S1-2:49</b> <b>Students demonstrate their understanding of Processes and Change within Natural Resources by...</b></p> <ul style="list-style-type: none"> <li>• Identifying the natural sources of the food that is consumed on a daily basis (e.g., Bread-- wheat— flour; Sap— maple syrup; Pasture—meat and dairy).</li> </ul>	<p><b>Science Concept:</b> a. Most food comes from farms either directly as crops or through the animals that eat the crops.</p>
<p><b>S1-2:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...</b></p> <ul style="list-style-type: none"> <li>• Posing observational questions that compare things in terms of number, shape, texture, size, weight, color, motion, etc. (e.g., How fast does a Lady Beetle move compared to a Bess Beetle?)</li> <li>• Investigating and completing questions to identify a variable that can be changed (e.g., What will happen if...? or I wonder if I change...?).</li> <li>• Generating new questions that could be explored at the end of an investigation.</li> </ul>	
<p><b>S1-2:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>• Predicting a logical outcome to a situation, using prior knowledge, experience and/or evidence.</li> <li>• Explaining reasons for that prediction.</li> </ul>	
<p><b>S1-2:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>• Organizing a collection of data into a table or a graph template.</li> <li>• Creating a title for a table or graph.</li> </ul>	

## Grades 1-2 Earth and Sky

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>The sun, planets, and moons in our solar system have specific characteristics and follow patterns. These contribute to our understanding of the universe.</li> <li>The relationship between the earth and the sun creates changes over time encompassing the water cycle, climate, and weather and seasonal patterns.</li> </ul>	
<p><b>Essential Question:</b></p> <ul style="list-style-type: none"> <li>How does the sky look at different times?</li> <li>In what ways do objects in the sky change or appear to change?</li> <li>How do weather patterns change over time?</li> </ul>	
<p><b>S1-2:44</b> <b>Students demonstrate their understanding of Characteristics of the Solar System by...</b></p> <ul style="list-style-type: none"> <li>Observing and describing qualitatively how the sky looks at different times.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Keeping a journal record of the shape of the moon each night for a month.</li> </ul>	<p><b>Science Concepts:</b></p> <ul style="list-style-type: none"> <li>a. The moon looks slightly different every day, but looks the same again about every four weeks.</li> <li>b. The moon can be seen sometimes at night and sometimes during the day.</li> </ul>
<p><b>S1-2:45</b> <b>Students demonstrate their understanding of Processes and Change over Time within Systems of the Universe by...</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> <input type="checkbox"/> Drawing a picture of stars in the night sky.</li> </ul>	<p><b>Science Concept:</b></p> <ul style="list-style-type: none"> <li>a. There are more stars in the sky than anyone can easily count, but they are not scattered evenly; and they are not all the same in brightness or color.</li> </ul>
<p><b>S1-2:48</b> <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>Observing and recording weather data through the seasons and identifying and drawing conclusions based on the patterns in the data collected.</li> </ul>	<p><b>Science Concepts:</b></p> <ul style="list-style-type: none"> <li>a. The sun provides the light and heat necessary to maintain the temperature of the earth.</li> <li>b. There are cyclical changes that we see throughout the seasons that can be observed and recorded.</li> </ul>
<p><b>S1-2:6: Students demonstrate their ability to ANALYZE DATA by...</b></p> <ul style="list-style-type: none"> <li>Sorting and classifying objects based upon observations, prior knowledge, or experience and justifying groupings.</li> <li>Identifying and describing the pattern in diagrams and charts (e.g., model, bar graph, pictograph, diagram or chart).</li> </ul>	

**Grades 3-4**  
**Grade Level Expectations**  
**Scientific Inquiry**

**Scientific Questioning**

**S3-4:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...**

- Identifying at least one variable that affects a system and using that variable to generate an experimental question that includes a cause and effect relationship.

**Predicting and Hypothesizing**

**S3-4:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Identifying simple patterns of evidence used to develop a prediction and propose an explanation.

**Designing Experiments**

**S3-4:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Writing a plan related to the question that includes:
  - a. A list of materials needed.
  - b. A diagram, with important elements labeled, that supports procedures and illustrates the setup.
  - c. A procedure that lists steps sequentially (beginning, middle, and end) and describes how the experimenter will manipulate or change only one variable at a time. (“Fair Test”).
  - d. Appropriate timing between observations (intervals) and/or number of trials needed.

**Conducting Experiments**

**S3-4:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Referring to and following a detailed plan for an investigation.
- Clearly describing evidence and quantifying observations with appropriate units.
- Recording data at various points during an investigation by reporting what actually happens, even when data conflicts with expectations.
- Recording the sequence in which events take place.
- Recording relevant details of an object and its surroundings when applicable.
- Drawing scientifically:
  - a. Recording varying degrees of color, shading or texture and consistent proportion throughout.
  - b. Labeling significant parts of a scientific drawing or diagram and includes a key if necessary.

### **Representing Data and Analysis**

#### **S3-4:5: Students demonstrate their ability to REPRESENT DATA by...**

- Classifying objects and phenomena into sets and subsets and justifying groupings.
- Displaying and labeling data for separate trials/observations.
- Determining an appropriate representation (graph or table or chart or diagram) to represent their findings most accurately.
- Including in tables a title, labeled rows and columns and any necessary keys.
- Including in graphs a title, labels, scale, and recording data correctly.

### **Representing Data and Analysis**

#### **S3-4:6: Students demonstrate their ability to ANALYZE DATA by...**

- Interpreting patterns or trends in data.
- Relating data to the original question and prediction.

#### **S3-4:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Providing a reasonable explanation that accurately reflects data.
- Identifying differences between proposed predictions and experimental data.

### **Applying Results**

#### **S3-4:8: Students demonstrate their ability to APPLY RESULTS by...**

- Generating a new question to obtain additional information.
- Creating a plan to investigate a scientific concept further or connecting a classroom model to a real-world example.
- Connecting the investigation or model to a real world example.

## Grades 3-4 Electricity and Magnetism

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy.</li> <li>• Magnetism is a force that acts over a distance and attracts or repels certain materials.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• What is required for the flow of electricity?</li> <li>• How do magnetic fields interact with other objects?</li> </ul>

<p><b>S3-4:24</b> <b>Students demonstrate their understanding of Electrical Energy by...</b></p> <ul style="list-style-type: none"> <li>• Building complete circuits, drawing diagrams of these electric circuits and explaining why electricity flows or does not flow through the circuit.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Using experimental data to classify different materials as conductors and insulators.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>A complete loop is needed through which an electric charge can flow.</li> <li>Batteries are a source of electrical energy.</li> <li>Electric circuits can produce light, run motors and create sounds.</li> <li>Certain materials are conductors of electricity. Non conductors of electricity are called insulators.</li> </ol>
<p><b>S3-4:25</b> <b>Students demonstrate their understanding of Magnetism by...</b></p> <ul style="list-style-type: none"> <li>• Describing what happens when like and opposite poles of the magnet are placed near each other.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Magnets have opposite charged poles.</li> <li>When the same poles of a magnet are placed near each other, the magnets are repelled.</li> <li>When opposite poles are placed near each other, the magnets are attracted.</li> </ol>
<p><b>S3-4:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>• Writing a plan related to the question that includes:             <ol style="list-style-type: none"> <li>A list of materials needed.</li> <li>A diagram, with important elements labeled, that supports procedures and illustrates the setup.</li> <li>A procedure that lists steps sequentially (beginning, middle, and end) and describes how the experimenter will manipulate or change only one variable at a time. (“Fair Test”).</li> <li>Appropriate timing between observations (intervals) and/or number of trials needed.</li> </ol> </li> </ul>	
<p><b>S3-4:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>• Referring to and following a detailed plan for an investigation.</li> <li>• Clearly describing evidence and quantifying observations with appropriate units.</li> <li>• Recording data at various points during an investigation by reporting what actually happens, even when data conflicts with expectations.</li> <li>• Recording the sequence in which events take place.</li> <li>• Recording relevant details of an object and its surroundings when applicable.</li> <li>• Drawing scientifically:             <ol style="list-style-type: none"> <li>Recording varying degrees of color, shading or texture and consistent proportion throughout.</li> <li>Labeling significant parts of a scientific drawing or diagram and includes a key if necessary.</li> </ol> </li> </ul>	

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**S3-4:5: Students demonstrate their ability to REPRESENT DATA by...**

- Classifying objects and phenomena into sets and subsets and justifying groupings.
- Displaying and labeling data for separate trials/observations.
- Determining an appropriate representation (graph or table or chart or diagram) to represent their findings most accurately.
- Including in tables a title, labeled rows and columns and any necessary keys.
- Including in graphs a title, labels, scale, and recording data correctly.

## Grades 3-4

### Life Cycles/Characteristics of Organisms

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• All living things and their component cells need energy to function and survive through the life cycle of birth, development, reproduction, and death.</li> <li>• All living things have similarities and differences. Inherited physical traits, behaviors, and interdependencies help to classify these organisms.</li> <li>• In order to survive, living things must adapt to changes in their environment through the process of natural selection.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How do the characteristics of living things enable them to survive?</li> <li>• How do living things change throughout their life cycles?</li> <li>• How do scientists classify things?</li> <li>• How are living things alike and different within a species?</li> </ul>

<p><b>S3-4:30</b>  <b>Students demonstrate their understanding of Structure and Function–Survival Requirements by...</b></p> <ul style="list-style-type: none"> <li>• Identifying how the physical structure/characteristic of an organism allows it to survive and defend itself (e.g., The coloring of a fiddler crab allows it to camouflage itself in the sand and grasses of its environment so that it will be protected from predators. A rose is protected by its thorns.).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Organisms have characteristics that help them find what they need to survive in their environment and provide for their survival:</p> <ul style="list-style-type: none"> <li>-Defense</li> <li>-Obtaining food</li> <li>-Reproduction</li> <li>-Eliminate waste</li> </ul>
<p><b>S3-4:31</b>  <b>Students demonstrate their understanding of Reproduction by...</b></p> <ul style="list-style-type: none"> <li>• Investigating and describing a variety of plant and animal life cycles.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Although all organisms have common stages of development, details of a life cycle are different for different organisms.</p>
<p><b>S3-4:38</b>  <b>Students demonstrate their understanding of Classification of Organisms by...</b></p> <ul style="list-style-type: none"> <li>• Describing and sorting plants and animals into groups based on structural similarities and differences (e.g., All pine, spruce and evergreen trees have similar leaf structures; Spiders have eight legs, and insects have six).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. The great variety of living things can be sorted into groups in many ways using various characteristics to decide which things belong to which group.</p>
<p><b>S3-4:39</b>  <b>Students demonstrate their understanding of Evolution/ Natural Selection by...</b></p> <ul style="list-style-type: none"> <li>• Identifying differences in characteristics of a certain type of organism (e.g., dogs with long hair or short hair; humans with blue or brown eyes).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Organisms of the same kind differ in their individual characteristics (traits) (e.g., Even though all dogs are of the same species, they can have very different traits.).</p>

## Grades 3-4 Human Body Systems

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>• Inherited traits are passed on (transferred) from parents to offspring.</li> <li>• The human body is made up of interconnected systems that maintain equilibrium and respond to the environment to ensure survival.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How and why are humans both similar and different?</li> <li>• How do body systems interact to help us survive?</li> <li>• How does the body defend itself from germs?</li> </ul>

<p><b>S3-4:40</b> <b>Students demonstrate their understanding of Human Heredity by...</b></p> <ul style="list-style-type: none"> <li>• Identifying similarities that are inherited from a biological parent.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Some similarities between children and parents such as eye color, are inherited.</p>
<p><b>S3-4:41</b> <b>Students demonstrate their understanding of Human Body Systems by...</b></p> <ul style="list-style-type: none"> <li>• Showing connections between external and internal body structures and how they help humans survive.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. There are external and internal structures that provide for the survival needs of human organisms.</p> <ul style="list-style-type: none"> <li>• Skin protects the body from harmful substances and other organisms, and from drying out.</li> <li>• The skeletal system provides shape and protection for the body’s organs.</li> <li>• The brain gets/gives signals from/to all parts of the body “telling” the body what to do.</li> <li>• From food, people obtain nutrients and other materials for body repair and growth. The indigestible parts of food are eliminated. Key structures are mouth, esophagus, stomach, intestine and anus.</li> <li>• By breathing, people take in the oxygen that they need to live. Key structure is the lung.</li> </ul>
<p><b>S3-4:42</b> <b>Students demonstrate their understanding of the Patterns of Human Health/Disease by...</b></p> <ul style="list-style-type: none"> <li>• Explaining that tears, saliva, and skin, can protect the body from harmful germs.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. If germs are able to get inside a person’s body, they may keep it from working properly. Tears, saliva, and skin protect our bodies from germs.</p>
<p><b>S3-4:8: Students demonstrate their ability to APPLY RESULTS by...</b></p> <ul style="list-style-type: none"> <li>• Generating a new question to obtain additional information.</li> <li>• Creating a plan to investigate a scientific concept further or connecting a classroom model to a real-world example.</li> <li>• Connecting the investigation or model to a real world example.</li> </ul>	

## Grades 3-4 Geology

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>There are forces within the Earth and its surrounding atmosphere that cause changes in its structure and composition over time. Changes can be slow or fast.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How are rocks similar and different?</li> <li>How do earth materials interact over time?</li> </ul>

<p><b>S1-2:46</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Systems of the Universe by...</b></p> <ul style="list-style-type: none"> <li>Observing, describing and comparing color and texture of different types of rocks and soils.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Conducting tests on how different types of soils retain water.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Earth materials are solid rocks and soils.  b. Soils and rocks have properties of color and texture; in addition, some soils retain different amounts of water.</p>
<p><b>S3-4:46</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>Observing and identifying components of soils and rocks.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Recognizing and identifying the four basic materials of the earth (i.e., rocks, soil water and gases).</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Observing and describing the properties of rocks.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Soil is made partly from rock, partly from plant remains and also contains many living organisms.  b. Earth materials are solid rocks, soils, water and the gases of the atmosphere.  c. Rock is composed of different combinations of minerals. Large rocks can be broken down into small rocks.  d. Rocks have properties of color, texture and hardness. Rocks can be classified by their physical properties.</p>
<p><b>S3-4:47</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>Building models that simulate deposits of sediments (e.g., a stream table.)</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Investigating local landforms and comparing them with models created in the classroom.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Waves, wind, water and ice shape and reshape the earth's land surface by eroding rock and soil in some areas and depositing them in other areas.</p>
<p><b>S3-4:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...</b></p> <ul style="list-style-type: none"> <li>Identifying at least one variable that affects a system and using that variable to generate an experimental question that includes a cause and effect relationship.</li> </ul>	
<p><b>S3-4:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>Identifying simple patterns of evidence used to develop a prediction and propose an explanation.</li> </ul>	

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**S3-4:6: Students demonstrate their ability to ANALYZE DATA by...**

- Interpreting patterns or trends in data.
- Relating data to the original question and prediction.

**S3-4:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Providing a reasonable explanation that accurately reflects data.
- Identifying differences between proposed predictions and experimental data.

## Grades 3-4 Properties/States of Matter

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>All living and non-living things are composed of matter having characteristic properties that distinguish one substance from another. All matter can undergo change; with such change, mass remains constant.</li> <li>The relationship between the earth and the sun creates changes over time encompassing the water cycle, climate, and weather and seasonal patterns.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>What is matter?</li> <li>How are the states of matter alike and different?</li> <li>How do you know that a gas is matter?</li> <li>How does heat affect matter?</li> <li>How do we describe weather in terms of matter?</li> </ul>	
<p><b>S3-4:9</b> <b>Students demonstrate their understanding of the Properties of Matter by...</b></p> <ul style="list-style-type: none"> <li>Investigating and measuring how the total weight of the parts of a substance, no matter how they are combined, remains the same (e.g., water and gravel mixture, or a Lego car system, or the weight of sugar plus the weight of water equals the total weight of the sugar solution).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>All matter has weight that can be measured.</li> <li>The weight of the whole is the same as the sum of the parts.</li> <li>Most objects/substances are made of smaller parts.</li> </ol>
<p><b>S3-4:12</b> <b>Students demonstrate their understanding of the States of Matter by...</b></p> <ul style="list-style-type: none"> <li>Identifying, describing and comparing the properties of selected solids, liquids and gases.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Solids, liquids and gases are states of matter that can be observed, described, and measured.</li> <li>Gases take up as much space as you give them.</li> </ol>
<p><b>S3-4:13</b> <b>Students demonstrate their understanding of the Properties of a Gas by...</b></p> <ul style="list-style-type: none"> <li>Experimenting with gas in a closed container (such as a balloon or a bag) and describing how pressure on the container changes when the volume of the gas changes.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Gas is a state of matter that takes up space.</li> </ol>
<p><b>S3-4:14</b> <b>Students demonstrate their understanding of Physical Change by...</b></p> <ul style="list-style-type: none"> <li>Investigating and explaining what happens to liquids in open containers.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Adding heat can change a substance from a solid, to a liquid, to a gas.</li> </ol>

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<p><b>S3-4:48</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>• Observing, recording and analyzing local weather data and making predictions based on that data.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Describing water as it changes into vapor in the air and reappears as a liquid when it is cooled. <b>AND</b></li> <li>• Explaining how this cycle of water relates to weather and the formation of clouds.</li> </ul>	<p><b>Science Concepts:</b></p> <ul style="list-style-type: none"> <li>a. Weather changes from day to day and over the seasons. Weather can be described by measurable quantities (such as temperature, wind direction and speed, precipitation and air pressure).</li> <li>b. Air is a substance that surrounds us, takes up space and whose movement we feel as wind.</li> <li>c. Liquid water is changed by heat from the sun to gas (vapor) and returns to a liquid or solid state when cooled to the freezing point.</li> <li>d. Clouds and fog are made of small drops of water.</li> </ul>
<p><b>S3-4:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>• Writing a plan related to the question that includes: <ul style="list-style-type: none"> <li>a. A list of materials needed.</li> <li>b. A diagram, with important elements labeled, that supports procedures and illustrates the setup.</li> <li>c. A procedure that lists steps sequentially (beginning, middle, and end) and describes how the experimenter will manipulate or change only one variable at a time. (“Fair Test”).</li> <li>d. Appropriate timing between observations (intervals) and/or number of trials needed.</li> </ul> </li> </ul>	
<p><b>S3-4:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>• Referring to and following a detailed plan for an investigation.</li> <li>• Clearly describing evidence and quantifying observations with appropriate units.</li> <li>• Recording data at various points during an investigation by reporting what actually happens, even when data conflicts with expectations.</li> <li>• Recording the sequence in which events take place.</li> <li>• Recording relevant details of an object and its surroundings when applicable.</li> <li>• Drawing scientifically: <ul style="list-style-type: none"> <li>a. Recording varying degrees of color, shading or texture and consistent proportion throughout.</li> <li>b. Labeling significant parts of a scientific drawing or diagram and includes a key if necessary.</li> </ul> </li> </ul>	
<p><b>S3-4:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>• Classifying objects and phenomena into sets and subsets and justifying groupings.</li> <li>• Displaying and labeling data for separate trials/observations.</li> <li>• Determining an appropriate representation (graph or table or chart or diagram) to represent their findings most accurately.</li> <li>• Including in tables a title, labeled rows and columns and any necessary keys.</li> <li>• Including in graphs a title, labels, scale, and recording data correctly.</li> </ul>	
<p><b>S3-4:6: Students demonstrate their ability to ANALYZE DATA by...</b></p> <ul style="list-style-type: none"> <li>• Interpreting patterns or trends in data.</li> <li>• Relating data to the original question and prediction.</li> </ul>	
<p><b>S3-4:7: Students demonstrate their ability to EXPLAIN DATA by...</b></p> <ul style="list-style-type: none"> <li>• Providing a reasonable explanation that accurately reflects data.</li> <li>• Identifying differences between proposed predictions and experimental data.</li> </ul>	

## Grades 3-4 Interdependence

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Energy (from the sun) is transferred through interdependent systems to support life.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How do living organisms obtain energy to survive?</li> </ul>

<p><b>S3-4:34</b>  <b>Students demonstrate their understanding of Energy Flow in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Identifying the source of energy for the survival of organisms.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Energy derived from food is needed for all organisms (plants and animals) to stay alive and grow.</p>
<p><b>S3-4:35</b>  <b>Students demonstrate their understanding of Food Webs in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Recognizing that, in a simple food chain, all animals' food begins with plants.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Researching and designing a habitat and explaining how it meets the needs of the organisms that live there.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Food for animals can be traced back to plants.  b. Organisms can survive best only in habitats in which their needs are met.</p>
<p><b>S3-4:36</b>  <b>Students demonstrate their understanding of Equilibrium in an ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Explaining how one organism depends upon another organism to survive.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Organisms interact with one another in various ways besides providing food (e.g., Many plants depend on animals for carrying their pollen to other plants for fertilizing their flowers).</p>
<p><b>S3-4:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...</b></p> <ul style="list-style-type: none"> <li>• Identifying at least one variable that affects a system and using that variable to generate an experimental question that includes a cause and effect relationship.</li> </ul>	
<p><b>S3-4:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>• Identifying simple patterns of evidence used to develop a prediction and propose an explanation.</li> </ul>	
<p><b>S3-4:8: Students demonstrate their ability to APPLY RESULTS by...</b></p> <ul style="list-style-type: none"> <li>• Generating a new question to obtain additional information.</li> <li>• Creating a plan to investigate a scientific concept further or connecting a classroom model to a real-world example.</li> <li>• Connecting the investigation or model to a real world example.</li> </ul>	

## Grades 3-4 Earth and Sky

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>The sun, planets, and moons in our solar system have specific characteristics and follow patterns. These contribute to our understanding of the universe.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do the earth, moon, and sun interact? (day and night)</li> <li>In what way do objects move or appear to move in the night sky?</li> </ul>	
<p><b>S3-4:44</b>  <b>Students demonstrate their understanding Characteristics of the Solar System by...</b></p> <ul style="list-style-type: none"> <li>Creating a model of the planets and their correct order from the sun.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Drawing or building and then explaining a model of the earth rotating on its axis in relation to the sun and moon (i.e., day and night).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The earth is one of several planets that orbit the sun, and the moon orbits the earth.</p> <p>b. Like all planets and stars, the earth is approximately spherical in shape. The rotation of the earth on its axis every 24 hours produces the night and day cycle.</p>
<p><b>S3-4:45</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Systems of the Universe by...</b></p> <ul style="list-style-type: none"> <li>Identifying similar star patterns/or groups from night photographs of the same location at different times of the years.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Comparing (similarities) between the sun and stars.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Stars are like the sun, but so far away that they look like points of light. Some are smaller; some are larger than the sun.</p> <p>b. The patterns of the stars stay the same, although they appear to move across the sky.</p>

**Grades 5-6**  
**Grade Level Expectations**  
**Scientific Inquiry**

**Scientific Questioning**

**S5-6:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by ...**

- Distinguishing between observational, experimental, and research questions (e.g., Observational—How does a cricket chirp? Experimental—Does the amount of light affect how a cricket chirps? Research—Do all crickets chirp? Why do crickets chirp? ).
- Identifying multiple variables that affect a system and using the variables to generate experimental questions that include cause and effect relationships.

**Predicting and Hypothesizing**

**S 5-6: 2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Using logical inferences derived from evidence to predict what may happen or be observed in the future.
- Providing an explanation (hypothesis) that is reasonable in terms of available evidence.

**Designing Experiments**

**S5-6:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Writing a plan related to the question and prediction that includes:
  - a. A list of materials needed that specifies quantities (e.g., 250 ml water).
  - b. A procedure that lists significant steps sequentially and describes which variable will be manipulated or changed and which variables will remain the same (“Fair Test”).
  - c. An appropriate format for recording data.
  - d. A strategy for conducting multiple trials (“Fair Test”).

**Conducting Experiments**

**S5-6:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Choosing appropriate measurements for the task and measuring accurately.
- Collecting data and recording accurate and complete data from multiple trials.
- Drawing scientifically:
  - a. Selecting an appropriate perspective (e.g., cross section, top view, side view) and recording precise proportions.

## **Representing Data and Analysis**

### **S5-6:5: Students demonstrate their ability to REPRESENT DATA by...**

- Determining an appropriate representation (line graph in addition to prior examples) to represent their findings accurately.
- Selecting a scale that is appropriate for range of data to be plotted, labels units, and presents data in an objective way.
- Including clearly labeled keys and symbols, when necessary.
- Using correct scientific terminology to label representations.

## **Representing Data and Analysis**

### **S 5-6: 6: Students demonstrate their ability to ANALYZE DATA by...**

- Identifying relationships of variables based upon evidence.
- Questioning data that might not seem accurate or does not fit into the pattern of other findings.

### **S5-6:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Explaining data using correct scientific terminology.
- Using experimental results to support or refute original hypothesis.
- Considering all data when developing an explanation/conclusion.
- Using additional resources (e.g., books, journals, databases, interview, etc.) to strengthen an explanation.
- Identifying problems/flaws with the experimental design.
- Preparing a conclusion statement/summary.

## **Applying Results**

### **S5-6:8: Students demonstrate their ability to APPLY RESULTS by...**

Explaining how experimental findings can be generalized to other situations.

## Grades 5-6 Force and Motion

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>All matter is in motion. Forces act upon matter to change its motion.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do forces affect an object's motion?</li> <li>How do an object's mass and its physical characteristics affect its motion?</li> </ul>

<p><b>S5-6:19</b> <b>Students demonstrate their understanding of Motion by...</b></p> <ul style="list-style-type: none"> <li>Measuring and calculating speed (the distance an object moves over a measured amount of time).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Speed indicates the rate at which an object is traveling.</li> <li>Speed is a relationship between the distance an object travels and time elapsed.</li> </ol>
<p><b>S5-6:20</b> <b>Students demonstrate their understanding of Motion by...</b></p> <ul style="list-style-type: none"> <li>Investigating and identifying evidence of an object's inertia and explaining their observation in terms of the object's tendency to resist a change in motion.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Inertia is the tendency of an object that depends on the object's mass. The inertia (mass) of an object resists change in the object's motion (Stationary objects remain stationary; moving objects continue moving: Newton's First Law).</li> </ol>
<p><b>S5-6:21</b> <b>Students demonstrate their understanding of Force by...</b></p> <ul style="list-style-type: none"> <li>Investigating variables that change an object's speed, direction, or both, and identifying and describing the forces that cause the change in motion.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>A force applied to a moving object will change the object's speed, direction or both.</li> <li>Friction is a force that often opposes motion.</li> <li>Gravity and magnetism are examples of long-range forces that do not require direct contact of the interacting objects.</li> </ol>
<p><b>S5-6:22</b> <b>Students demonstrate their understanding of Gravitational force by...</b></p> <ul style="list-style-type: none"> <li>Predicting the effect of gravitational forces between pairs of objects (i.e., earth and object's on the surface, earth and moon, earth and sun).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Gravity is the force that holds objects to the earth's surface, keeps planets in orbit around the sun and governs the rest of the motion in the solar system.</li> <li>The force of gravity pulls toward the center of mass of an object.</li> </ol>

<p><b>Designing Experiments</b></p> <p><b>S5-6:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>Writing a plan related to the question and prediction that includes:             <ol style="list-style-type: none"> <li>A list of materials needed that specifies quantities (e.g., 250 ml water).</li> <li>A procedure that lists significant steps sequentially and describes which variable will be manipulated or changed and which variables will remain the same ("Fair Test").</li> <li>An appropriate format for recording data.</li> <li>A strategy for conducting multiple trials ("Fair Test").</li> </ol> </li> </ul>
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**S5-6:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Choosing appropriate measurements for the task and measuring accurately.
- Collecting data and recording accurate and complete data from multiple trials.
- Drawing scientifically:
  - a. Selecting an appropriate perspective (e.g., cross section, top view, side view) and recording precise proportions.

**S5-6:5: Students demonstrate their ability to REPRESENT DATA by...**

- Determining an appropriate representation (line graph in addition to prior examples) to represent their findings accurately.
- Selecting a scale that is appropriate for range of data to be plotted, labels units, and presents data in an objective way.
- Including clearly labeled keys and symbols, when necessary.
- Using correct scientific terminology to label representations.

**S 5-6:6: Students demonstrate their ability to ANALYZE DATA by...**

- Identifying relationships of variables based upon evidence.
- Questioning data that might not seem accurate or does not fit into the pattern of other findings.

## Grades 5-6 Ecosystems

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Energy (from the sun) is transferred through interdependent systems to support life.</li> <li>• Natural resources are materials that we obtain from the living and non-living environment. Human interactions can have positive and negative impacts on these resources.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How do living organisms obtain energy to survive?</li> <li>• How do species depend on one another and the environment for survival?</li> </ul>

<p><b>S5-6:34</b> <b>Students demonstrate their understanding of Energy Flow in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Developing a model that shows how the flow of energy from the sun is transferred to organisms as food in order to sustain life.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Energy within an ecosystem originates from the sun. Plants use energy from the sun, carbon dioxide, and water, to make energy rich food and oxygen. Plants are producers.</p> <p>b. Animals eat food that plants make combined with oxygen to produce energy, carbon dioxide, and water. Animals are consumers.</p>
<p><b>S5-6:35</b> <b>Students demonstrate their understanding of Food Webs in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Developing a model for a food web of a local aquatic and local terrestrial environment.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Food webs model the interdependent relationships that organisms engage in as they acquire their food and energy needs. Aquatic food webs (fresh water and marine) are supported by microscopic ocean plants. Land food webs are supported by land plants.</p>
<p><b>S5-6:36</b> <b>Students demonstrate their understanding of Equilibrium in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Experimenting with a closed system, describing how an environmental change effects the system (e.g., bottle biology).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. The number of organisms an ecosystem can support depends on the kinds of organisms present and the availability of biotic and abiotic resources (i.e., quantity of light and water, range of temperatures, and soil composition).</p>
<p><b>S5-6:37</b> <b>Students demonstrate their understanding of Recycling in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Identifying the recycling role of decomposers in a variety of situations.</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Decomposers, primarily bacteria and fungi, are consumers that use waste material and dead organisms for food.</p>
<p><b>S5-6:49</b> <b>Students demonstrate their understanding of Processes and Change within Natural Resources by...</b></p> <ul style="list-style-type: none"> <li>• Identifying examples of good and poor management of natural resources.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining how overpopulation of living things can degrade an environment due to increased use of resources.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Responsible management of the earth's resources (air, soil, water, trees) is beneficial for the environment and for human use.</p>

**S5-6:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Explaining data using correct scientific terminology.
- Using experimental results to support or refute original hypothesis.
- Considering all data when developing an explanation/conclusion.
- Using additional resources (e.g., books, journals, databases, interview, etc.) to strengthen an explanation.
- Identifying problems/flaws with the experimental design.
- Preparing a conclusion statement/summary.

**S5-6:8: Students demonstrate their ability to APPLY RESULTS by...**

- Explaining how experimental findings can be generalized to other situations.

## Grades 5-6 Cells: Needs and Functions

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>All living things and their component cells need energy to function and survive through the life cycle of birth, development, reproduction, and death.</li> <li>In order to survive, living things must adapt to changes in their environment through the process of natural selection.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do the characteristics of a cell enable the organism to survive?</li> </ul>

<p><b>S5-6:30</b> <b>Students demonstrate their understanding of Structure and Function-Survival Requirements by...</b></p> <ul style="list-style-type: none"> <li>Explaining that the cell, as the basic unit of life, has the same survival needs as the organism.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Identifying and drawing individual cells seen through a microscope and recognizing that most cells are microscopic.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Diagramming the exchange of materials through a cell membrane.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. All organisms are made of one or more cells. Cells are the basic unit of structure and function in an organism. All cells carry out the same basic functions to survive:</p> <ul style="list-style-type: none"> <li>Obtain food (energy) and materials for growth and repair</li> <li>Eliminate (recycle) waste</li> <li>Reproduce</li> <li>Provide for defense</li> </ul> <p>b. All cells are enclosed in a membrane that allows materials to pass into and out of the cell.</p> <p>c. Most cells are microscopic.</p>
<p><b>S5-6:32</b> <b>Students demonstrate their understanding of how Differentiation by...</b></p> <ul style="list-style-type: none"> <li>Explaining the relationship between cell, tissue, organ and system.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Observing plant or animal tissue and explaining how “specialized” cells help to support the specialized function of tissue (e.g., muscle cells form muscle tissue, skin cells form skin tissue, nerve cells form brain tissue).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. In addition to basic functions, cells can carry out “specialized” functions that support the survival of groups of cells and the organism.</p> <p>b. Groups of similar cells connect and work together to form tissue, groups of tissue form organs, and groups of organs form systems.</p>
<p><b>S5-6:33</b> <b>Students demonstrate their understanding of how Energy Flow Within Cells Supports an Organism’s Survival by...</b></p> <ul style="list-style-type: none"> <li>Demonstrating through drawings, stories or models that cells take in food and oxygen to produce energy and send out waste materials.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. In order to obtain energy for all the functions of survival, individual cells take in food and oxygen to produce energy and send out waste materials.</p>
<p><b>S5-6:39</b> <b>Students demonstrate their understanding of Evolution/ Natural Selection by...</b></p> <ul style="list-style-type: none"> <li>Explaining, through engaging in simulations, how a variation in a characteristic (trait) enables an organism to survive in a changing environment.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. When the environment changes some plants and animals with advantageous traits are able to survive; others, with less-advantageous traits, either move to new locations or die.</p>

## Grades 5-6 Geology/Water Cycle

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>• There are forces within the Earth and its surrounding atmosphere that cause changes in its structure and composition over time. Changes can be slow or fast.</li> <li>• The relationship between the earth and the sun creates changes over time encompassing the water cycle, climate, and weather and seasonal patterns.</li> <li>• Natural resources are materials that we obtain from the living and non-living environment. Human interactions can have positive and negative impacts on these resources.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How do geological changes affect our earth?</li> <li>• To what extent do the water cycle, climate, weather, and seasonal changes affect changes over time on earth?</li> <li>• What role do people play in how we use our natural resources?</li> </ul>	
<p><b>S5-6:46</b> <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>• Explaining the process of how rocks are formed (the Rock Cycle).</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Creating a model of the earth's structure explaining the nature of the layers.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Rocks come from magma or lava, as well as from sediments that build up in layers. As all rocks from earth's surface weather, form sediments and become buried and heated (through pressure or direct heat), they may crystallize into new rock. Eventually those new rocks may be brought to the surface by forces that drive plate motions (The Rock Cycle).</p> <p>b. The earth is layered with a rigid shell, a hot mantle and a dense metallic core.</p>
<p><b>S5-6:47</b> <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>• Identifying examples of geologic changes on the earth's surface, where possible in the local environment (include slow and fast changes).</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Plotting locations of volcanoes and earthquakes and explaining the relationship between location and plate movement.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining the processes that occur when rocks are changed from one form to another.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Determining the relative age of fossils within sedimentary rocks from their location in the strata (i.e. which fossils within a sequence are older).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Some changes on the earth can be very slow, such as weathering and mountain-building, and some can be very fast—such as volcanoes and earthquakes.</p> <p>b. Earth's rigid shell is composed of large plates that move at rates of centimeters a year Major geologic events, such as earthquakes, volcanic eruptions and mountain building, result from these plate motions.</p> <p>c. Thousands of layers of sedimentary rock confirm the long history of the changing surface of the earth and the changing life forms whose remains are found in successive layers (land forms—coastlines, mountains, rivers, canyons, deltas).</p>
<p><b>S5-6:48</b> <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>• Diagramming, labeling and explaining the process of the water cycle (e.g., evaporation, precipitation, run-off).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The cycling of water in and out of the atmosphere plays an important role in determining climatic patterns. Water evaporates from the surface of the earth, rises and cools, and falls again to the surface as rain. The water falling on land collects in rivers and lakes, soil and porous layers of rock and much of it flows back into the ocean.</p>

<p><b>S3-4:49</b>  <b>Students demonstrate their understanding of Processes and Change within Natural Resources by...</b></p> <ul style="list-style-type: none"> <li>• Observing and describing properties of living and nonliving resources.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining how the properties of living and non-living resources make them suitable for use by humans.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The varied earth materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel, for growing the plants we use as food, or supporting animal life. Earth materials provide many of the resources that humans use.</p> <p>b. Earth materials have chemical and physical properties that make them useful as building materials, or for growing plants or for fuel.</p>
<p><b>S5-6:49</b>  <b>Students demonstrate their understanding of Processes and Change within Natural Resources by...</b></p> <ul style="list-style-type: none"> <li>• Identifying examples of good and poor management of natural resources.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining how overpopulation of living things can degrade an environment due to increased use of resources.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Responsible management of the earth’s resources (air, soil, water, trees) is beneficial for the environment and for human use.</p>
<p><b>S5-6:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by ...</b></p> <ul style="list-style-type: none"> <li>• Distinguishing between observational, experimental, and research questions (e.g., Observational—How does a cricket chirp? Experimental—Does the amount of light affect how a cricket chirps? Research—Do all crickets chirp? Why do crickets chirp? ).</li> <li>• Identifying multiple variables that affect a system and using the variables to generate experimental questions that include cause and effect relationships.</li> </ul>	
<p><b>S 5-6: 2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>• Using logical inferences derived from evidence to predict what may happen or be observed in the future.</li> <li>• Providing an explanation (hypothesis) that is reasonable in terms of available evidence.</li> </ul>	

## Grades 5-6

### Matter/Physical and Chemical Change

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>All living and non-living things are composed of matter having characteristic properties that distinguish one substance from another. All matter can undergo change; with such change, mass remains constant.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>To what extent do heating and cooling affect states of matter?</li> <li>To what extent does a chemical change affect matter?</li> </ul>	
<p><b>S5-6:9</b>  <b>Students demonstrate their understanding of the Properties of Matter by...</b></p> <ul style="list-style-type: none"> <li>Investigating and explaining how the relative volume or mass of an object affects the density of the object.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>All substances have a unique density that depends on the volume (amount of space) that the substance is packed into.</li> <li>The relative densities of substances can be observed and described.</li> </ol>
<p><b>S5-6:13</b>  <b>Students demonstrate their understanding of the Properties of a Gas by</b></p> <ul style="list-style-type: none"> <li>Measuring the mass of a gas (e.g., air in a basketball).</li> </ul>	<p><b>Science Concept:</b></p> <ol style="list-style-type: none"> <li>Gas is a state of matter that has mass.</li> </ol>
<p><b>S5-6:14</b>  <b>Students demonstrate their understanding of Physical Change by...</b></p> <ul style="list-style-type: none"> <li>Predicting the effect of heating and cooling on the physical state and the mass of a substance.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Energy is required to transform the physical state of a substance from solid to liquid to gas, while conserving mass. Physical changes are reversible.</li> </ol>
<p><b>S5-6:15</b>  <b>Students demonstrate their understanding of Chemical Change by...</b></p> <ul style="list-style-type: none"> <li>Observing evidence of simple chemical change to identify that new substances are formed when a chemical reaction has occurred (e.g., rusted nail, vinegar combined with baking soda).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Simple chemical reactions will produce new substances that might be indicated by a different state of matter, a color change, or a temperature change of the substances.</li> </ol>
<p><b>S5-6:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by ...</b></p> <ul style="list-style-type: none"> <li>Distinguishing between observational, experimental, and research questions (e.g., Observational—How does a cricket chirp? Experimental—Does the amount of light affect how a cricket chirps? Research—Do all crickets chirp? Why do crickets chirp? ).</li> <li>Identifying multiple variables that affect a system and using the variables to generate experimental questions that include cause and effect relationships.</li> </ul>	
<p><b>S 5-6: 2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>Using logical inferences derived from evidence to predict what may happen or be observed in the future.</li> <li>Providing an explanation (hypothesis) that is reasonable in terms of available evidence.</li> </ul>	

## Grades 5-6 Light and Sound Energy

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>Light and sound are forms of energy that travel from a source and interact with matter in predictable ways.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How is light produced?</li> <li>How does light travel?</li> <li>How does light interact with objects?</li> <li>How is sound produced and how does it travel?</li> </ul>	
<p><b>S3-4:28</b> <b>Students demonstrate their understanding of Light Energy by...</b></p> <ul style="list-style-type: none"> <li>Investigating with flashlights and other light sources and describing how light rays reflect off of objects.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Explaining what occurs when light rays are blocked (e.g., shadows).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Light maintains direction of motion until it interacts with another object.</li> <li>Light can be reflected or absorbed.</li> </ol>
<p><b>S5-6:28</b> <b>Students demonstrate their understanding of Light Energy by...</b></p> <ul style="list-style-type: none"> <li>Designing demonstrations that represent the characteristics of light energy transfer.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Light travels from an energy source (such as the sun) in straight lines.</li> <li>When light hits an object, it is absorbed, reflected, transmitted or some combination.</li> <li>Objects can be seen only when light waves are emitted from or reflected off the object and enter into the eye.</li> </ol>
<p><b>S5-6:29</b> <b>Students demonstrate their understanding of Sound Energy by...</b></p> <ul style="list-style-type: none"> <li>Generating a sound and identifying the path of vibration from the source to the ear.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Sound is produced by vibrations in materials that set up wavelike disturbances that spread away from the source.</li> </ol>
<p><b>S5-6:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>Writing a plan related to the question and prediction that includes:             <ol style="list-style-type: none"> <li>A list of materials needed that specifies quantities (e.g., 250 ml water).</li> <li>A procedure that lists significant steps sequentially and describes which variable will be manipulated or changed and which variables will remain the same (“Fair Test”).</li> <li>An appropriate format for recording data.</li> <li>A strategy for conducting multiple trials (“Fair Test”).</li> </ol> </li> </ul>	
<p><b>S5-6:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>Choosing appropriate measurements for the task and measuring accurately.</li> <li>Collecting data and recording accurate and complete data from multiple trials.</li> <li>Drawing scientifically:             <ol style="list-style-type: none"> <li>Selecting an appropriate perspective (e.g., cross section, top view, side view) and recording precise proportions.</li> </ol> </li> </ul>	

**S5-6:5: Students demonstrate their ability to REPRESENT DATA by...**

- Determining an appropriate representation (line graph in addition to prior examples) to represent their findings accurately.
- Selecting a scale that is appropriate for range of data to be plotted, labels units, and presents data in an objective way.
- Including clearly labeled keys and symbols, when necessary.
- Using correct scientific terminology to label representations.

**S 5-6:6: Students demonstrate their ability to ANALYZE DATA by...**

- Identifying relationships of variables based upon evidence.
- Questioning data that might not seem accurate or does not fit into the pattern of other findings.

## Grades 5-6 Solar System

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>The sun, planets, and moons in our solar system have specific characteristics and follow patterns. These contribute to our understanding of the universe.</li> <li>All matter is in motion. Forces act upon matter to change its motion.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do the earth, moon, and sun interact to create observable cycles?</li> </ul>

<p><b>S5-6:44</b>  <b>Students demonstrate their understanding of Characteristics of the Solar System by...</b></p> <ul style="list-style-type: none"> <li>Creating a diagram or model of the orbit of the earth around the sun and the moon around the earth.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The earth orbits the sun in a near circular path that takes a year to complete.</p> <p>b. The moon’s orbit around the earth once in about 28 days changes the portion of the moon visible to us, as a result of the sun’s reflected light. (phases of the moon).</p>
<p><b>S5-6:45</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Systems of the Universe by...</b></p> <ul style="list-style-type: none"> <li>Explaining (after viewing a picture or illustration with sun/moon showing true relative size) why the sun and moon appear to be the same size when seen from the earth.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Relating this phenomenon to a lunar and solar eclipses.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. From earth the moon and the sun appear to be the same size, because the moon is so much closer to the earth than the sun.</p> <p>b. Telescopes magnify the appearance of some very distant objects in the sky, including the moon and the planets. The number of stars that can be seen through telescopes is dramatically greater than can be seen by the unaided eye.</p>
<p><b>S7-8:45</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Systems of the Universe by...</b></p> <ul style="list-style-type: none"> <li>Identifying and labeling the location of the sun in our solar system and its relationship to the galaxy.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The sun is many thousands of times closer to the earth than any other star. The sun is located near the edge of a disc-shaped galaxy of stars.</p>
<p><b>S5-6:22</b>  <b>Students demonstrate their understanding of Gravitational force by...</b></p> <ul style="list-style-type: none"> <li>Predicting the effect of gravitational forces between pairs of objects (i.e., earth and object’s on the surface, earth and moon, earth and sun).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Gravity is the force that holds objects to the earth’s surface, keeps planets in orbit around the sun and governs the rest of the motion in the solar system.</p> <p>b. The force of gravity pulls toward the center of mass of an object.</p>

## Grades 5-6 Human Body

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>Inherited traits are passed on (transferred) from parents to offspring.</li> <li>The human body is made up of interconnected systems that maintain equilibrium and respond to the environment to ensure survival.</li> <li>All humans follow a predictable pattern of development from conception to adulthood.</li> <li>All living things and their component cells need energy to function and survive through the life cycle of birth, development, reproduction, and death.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do human body systems interact to help us survive?</li> <li>How can the environment affect the human body?</li> </ul>

<p><b>S5-6:40</b> <b>Students demonstrate their understanding of Human Heredity by...</b></p> <ul style="list-style-type: none"> <li>Identifying that an offspring's traits are determined by combining the sex cells (female egg and male sperm) of the parents.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Organisms can reproduce sexually when a female egg cell is fertilized by a male sperm cell to produce an offspring that has the traits of both parents.</p>
<p><b>S5-6:41</b> <b>Students demonstrate their understanding of Human Body Systems by...</b></p> <ul style="list-style-type: none"> <li>Investigating circumstances that affect more than one body system and explaining the interconnected relationship between the body systems (e.g., the effects of exercise on several interdependent body systems, such as respiratory, circulatory, digestive, nervous, skeletal systems).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The digestive, respiratory and circulatory systems are connected.</p> <ul style="list-style-type: none"> <li>The digestive system processes the food that cells need.</li> <li>The excretory system disposes of cellular waste and the intestinal tract removes solid waste.</li> <li>The respiratory system exchanges oxygen and carbon dioxide.</li> <li>The circulatory system moves all these substances to and from the cells.</li> </ul> <p>b. A change in one system can have an effect on other systems. (e.g., exercise changing heart rate and breathing rate).</p>
<p><b>S5-6:42</b> <b>Students demonstrate their understanding of the Patterns of Human Health/Disease by...</b></p> <ul style="list-style-type: none"> <li>Connecting the specialized function of white blood cells to their location in the circulatory system.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. White blood cells engulf invading microbes or produce antibodies that attack them.</p>
<p><b>S5-6:43</b> <b>Students demonstrate their understanding of the Patterns of Human Development by...</b></p> <ul style="list-style-type: none"> <li>Drawing/diagramming/modeling the life span of humans in a timeline highlighting major points in the cycle (e.g., one cell grows into a many-celled embryo, composed of different types of cells--grows into a fetus--baby is born--grows into a toddler--grows into a child--grows into a teenager--grows</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Following fertilization, cell division produces a small cluster of cells that then differentiate by appearance and function to form the basic tissues and organs of an embryo, which eventually grows into an adult organism.</p>

<p>into an adult).</p> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining what occurs in the processes of fertilization and early embryo development (e.g., sperm + egg combine to produce a new individual).</li> </ul>	
<p><b>S5-6:32</b></p> <p><b>Students demonstrate their understanding of how Differentiation by...</b></p> <ul style="list-style-type: none"> <li>• Explaining the relationship between cell, tissue, organ and system.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Observing plant or animal tissue and explaining how “specialized” cells help to support the specialized function of tissue (e.g., muscle cells form muscle tissue, skin cells form skin tissue, nerve cells form brain tissue).</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. In addition to basic functions, cells can carry out “specialized” functions that support the survival of groups of cells and the organism.</p> <p>b. Groups of similar cells connect and work together to form tissue, groups of tissue form organs, and groups of organs form systems.</p>
<p><b>S5-6:7: Students demonstrate their ability to EXPLAIN DATA by...</b></p> <ul style="list-style-type: none"> <li>• Explaining data using correct scientific terminology.</li> <li>• Using experimental results to support or refute original hypothesis.</li> <li>• Considering all data when developing an explanation/conclusion.</li> <li>• Using additional resources (e.g., books, journals, databases, interview, etc.) to strengthen an explanation.</li> <li>• Identifying problems/flaws with the experimental design.</li> <li>• Preparing a conclusion statement/summary.</li> </ul>	
<p><b>S5-6:8: Students demonstrate their ability to APPLY RESULTS by...</b></p> <ul style="list-style-type: none"> <li>• Explaining how experimental findings can be generalized to other situations.</li> </ul>	

**Grades 7-8**  
**Grade Level Expectations**  
**Scientific Inquiry**

**Scientific Questioning**

**S7-8:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...**

- Developing questions that reflect prior knowledge.
- Refining and focusing broad ill-defined questions.

**Predicting and Hypothesizing**

**S7-8:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Predicting results (evidence) that support the hypothesis.
- Proposing a hypothesis based upon a scientific concept or principle, observation, or experience that identifies the relationship between variables.

**Designing Experiments**

**S7-8:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Writing a plan related to the question, hypothesis, and prediction that includes:
  - a. A diagram labeled using scientific terminology that supports procedures and illustrates the setup.
  - b. A procedure that lists significant steps that identify manipulated (independent) and responding (dependent) variables.
  - c. A control for comparing data when appropriate.
  - d. Identification of tools and procedures for collecting data and reducing error.

**Conducting Experiments**

**S7-8:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Accurately quantifying observations using appropriate measurement tools.
- Using technology to collect, quantify, organize, and store observations (e.g., use of probe).
- Drawing scientifically:
  - a. Recording multiple perspectives to scale (e.g., magnification, cross section, top view, side view, etc.).

**Representing Data and Analysis**

**S7-8:5: Students demonstrate their ability to REPRESENT DATA by...**

- Representing independent variable on the “X” axis and dependent variable on the “Y” axis.
- Determining a scale for a diagram that is appropriate to the task.
- Using technology to enhance a representation.
- Using color, texture, symbols and other graphic strategies to clarify trends/patterns within a representation.

## **Representing Data and Analysis**

### **S7-8:6: Students demonstrate their ability to ANALYZE DATA by...**

- Identifying, considering and addressing experimental errors (e.g., errors in experimental design, errors in data collection procedures).
- Identifying limitations and/or sources of error within the experimental design.

### **S7-8:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Using scientific concepts, models, and terminology to report results, discuss relationships, and propose new explanations.
- Generating alternative explanations.
- Documenting and explaining changes in experimental design.
- Sharing conclusion/summary with appropriate audience beyond the research group.
- Using mathematical analysis as an integral component of the conclusion.

## **Applying Results**

### **S7-8:8: Students demonstrate their ability to APPLY RESULTS by...**

- Identifying additional data that would strengthen an investigation.
- Explaining limitations for generalizing findings.
- Explaining relevance of findings (e.g., So what?) to local environment (community, school, classroom)
- Devising recommendations for further investigation and making decisions based on evidence.

## Grades 7-8

# Properties of Matter/Physical and Chemical Change

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>All living and non-living things are composed of matter having characteristic properties that distinguish one substance from another. All matter can undergo change; with such change, mass remains constant.</li> <li></li> <li>Heat is a form of energy that flows from one object to another.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How can physical properties be used to distinguish one type of matter from another?</li> <li>How are atoms, molecules, compounds, and elements the building blocks of all living and non-living matter?</li> <li>How is molecular motion represented in each state of matter?</li> <li>What properties of a gas prove that it exists?</li> <li>To what extent does heating and cooling affect states of matter?</li> <li>How is matter changed and conserved in a chemical change?</li> <li>How is heat energy transferred from one object to another?</li> </ul>

<p><b>S7-8:9</b>  <b>Students demonstrate their understanding of the Properties of Matter by...</b></p> <ul style="list-style-type: none"> <li>Calculating the density of regularly and irregularly shaped objects.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Explaining why all three states of matter can be observed in a room that has a uniform temperature.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>The density of a substance can be measured and quantified as the mass (amount of a substance) that is contained per unit volume of that substance.</li> <li>Changing the temperature of materials will change the density of the material.</li> </ol>
<p><b>S7-8:10</b>  <b>Students demonstrate their understanding of the Properties of Matter by...</b></p> <ul style="list-style-type: none"> <li>Illustrating through words or representations, the differences between atoms and molecules.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Recognizing that all living and non-living things are formed from combinations of about 100 elements.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>All matter is made up of atoms that are too small to see.</li> <li>Atoms bond together to form molecules.</li> <li>An element is a substance in which the atoms are all the same.</li> <li>All living and non-living things are formed from combinations of about 100 elements.</li> </ol>
<p><b>S7-8:12</b>  <b>Students demonstrate their understanding of the States of Matter by...</b></p> <ul style="list-style-type: none"> <li>Modeling (plays, models, diagrams) molecular motion of the three states of matter and explaining how that motion defines each state.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Atoms and molecules are in perpetual motion.</li> <li>The atoms in solids only vibrate closely together.</li> <li>The atoms in liquids loosely slide past one another.</li> <li>The atoms in gases move freely apart from one another, and collide with one another.</li> </ol>

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<p><b>S7-8:13</b>  <b>Students demonstrate their understanding of the Properties of a Gas by...</b></p> <ul style="list-style-type: none"> <li>Using real world examples (tires, balloons, soda) predict and explain the effect that a change in one variable (pressure, temperature or volume) will have on the others.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>There exists a predictable relationship among the volume, temperature, and amount of a gas and the pressure the gas exerts.</li> <li>For any specified amount of a gas, the pressure that the gas exerts will increase as the temperature increases or the volume of the gas decreases. The pressure that the gas exerts will decrease as the temperature decreases or the volume of the gas increases.</li> <li>Gases exert pressure in all directions.</li> </ol>
<p><b>S7-8:14</b>  <b>Students demonstrate their understanding of Physical Change by...</b></p> <ul style="list-style-type: none"> <li>Constructing their own models representing the states of matter at the molecular level and explaining the effect of increased and decreased heat energy on the motion and arrangement of molecules.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Observing the physical processes of evaporation and condensation, and accounting for the disappearance and appearance of liquid water in terms of molecular motion and conservation of mass.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Increased temperature of substances causes increased motion of the atoms and molecules in the substance.</li> <li>As the temperature and motion of molecules in a substance increase, the space between molecules in the substance increases possibly causing a change in state.</li> </ol>
<p><b>S7-8:15</b>  <b>Students demonstrate their understanding of Chemical Change by...</b></p> <ul style="list-style-type: none"> <li>Observing evidence of chemical change, and offering qualitative explanations for the observed changes in substances in terms of interaction and rearrangement of the atoms, and the production of new substances with different characteristics but the same mass as the original substance.</li> </ul>	<p><b>Science Concepts</b></p> <ol style="list-style-type: none"> <li>Chemical change is a transformation of matter that results from the interaction of the molecules in a substance and a new substance results (e.g., electrophoresis of water). Chemical change is not reversible.</li> <li>During chemical change, the atoms in the substances are rearranged and because the mass of the product of a chemical reaction is the same as the mass of the reactants in that reaction, we know the total number of atoms in the substances stays the same.</li> </ol>
<p><b>S5-6:23</b>  <b>Students demonstrate their understanding of Heat Energy by...</b></p> <ul style="list-style-type: none"> <li>Identifying real world applications where heat energy is transferred and by showing the direction that the heat energy flows.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>Heat energy only flows from high temperature to lower temperature. in order to reach equilibrium (same temperature).</li> <li>Heat can move from one object to another by conduction.</li> </ol>

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<p><b>S7-8:23</b>  <b>Students demonstrate their understanding of Heat Energy by...</b></p> <ul style="list-style-type: none"> <li>• Creating a diagram, model, or analogy for a material in a warmer and cooler state showing or describing the motion of the molecules.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Creating a diagram, model, or analogy to explain the difference between conduction, convection, and radiation, and using their visual to explain how heat energy travels in different directions and through different materials by each method of energy transfer.</li> </ul>	<p><b>Science Concepts:</b></p> <ul style="list-style-type: none"> <li>a. Heat energy is the motion of molecules</li> <li>b. Increased motion of the molecules in a system increases the heat energy of the system.</li> <li>c. Heat energy is transferred by: <ul style="list-style-type: none"> <li>Conduction—Collision of molecules in solids.</li> <li>Convection—Organized flow of heat currents through a fluid.</li> <li>Radiation—Transfer by waves that can travel through a vacuum.</li> </ul> </li> </ul>
<p><b>S7-8:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>• Writing a plan related to the question, hypothesis, and prediction that includes: <ul style="list-style-type: none"> <li>a. A diagram labeled using scientific terminology that supports procedures and illustrates the setup.</li> <li>b. A procedure that lists significant steps that identify manipulated (independent) and responding (dependent) variables.</li> <li>c. A control for comparing data when appropriate.</li> <li>d. Identification of tools and procedures for collecting data and reducing error.</li> </ul> </li> </ul>	
<p><b>S7-8:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>• Accurately quantifying observations using appropriate measurement tools.</li> <li>• Using technology to collect, quantify, organize, and store observations (e.g., use of probe).</li> <li>• Drawing scientifically: <ul style="list-style-type: none"> <li>a. Recording multiple perspectives to scale (e.g., magnification, cross section, top view, side view, etc.).</li> </ul> </li> </ul>	
<p><b>S7-8:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>• Representing independent variable on the “X” axis and dependent variable on the “Y” axis.</li> <li>• Determining a scale for a diagram that is appropriate to the task.</li> <li>• Using technology to enhance a representation.</li> <li>• Using color, texture, symbols and other graphic strategies to clarify trends/patterns within a representation.</li> </ul>	

## Grades 7-8 Electromagnetism

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy.</li> <li>• Magnetism is a force that acts over a distance and attracts or repels certain materials. Electromagnetic energy is produced when either magnets or electrical charges move.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How does electrical energy flow?</li> <li>• How is electrical energy transformed into other forms of energy?</li> <li>• How do magnetic fields interact with objects?</li> <li>• How are magnetism and electricity related?</li> </ul>

<p><b>S5-6:24</b> <b>Students demonstrate their understanding of Electrical Energy by...</b></p> <ul style="list-style-type: none"> <li>• Investigating charged objects (static electricity) and describing their observations in terms of behavior of charges and equilibrium.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Unbalanced charges produce a potential for a flow of electricity. (Static)</p> <p>b. Unbalanced charges will move toward equilibrium because like charges repel and opposite charges attract.</p>
<p><b>S7-8:24</b> <b>Students demonstrate their understanding of Electrical Energy by...</b></p> <ul style="list-style-type: none"> <li>• Building an electric circuit and explaining the transfer of electrical energy into heat, light, and sound, leaving the system but not destroyed.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Describing the effect of a change in voltage in the circuit system.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Electric circuits provide a means of transferring electrical energy when heat, light, and sound are produced. The electrical energy is spread out yet still conserved.</p> <p>b. Electric charges can have “Potential” energy (voltage). The higher the potential energy of the charges, the higher the voltage.</p>
<p><b>S5-6:25</b> <b>Students demonstrate their understanding of Magnetism by...</b></p> <ul style="list-style-type: none"> <li>• Identifying real world objects that demonstrate and utilize a magnetic force field acting over a distance.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Distinguishing between objects affected by magnetic force and objects affected by other non-contact forces.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Magnetism is a force field that acts over a distance.</p>
<p><b>S5-6:26</b> <b>Students demonstrate their understanding of Electromagnetic Forces by...</b></p> <ul style="list-style-type: none"> <li>• Investigating devices that demonstrate the magnetic effects of electricity and the electric effects of moving magnets.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Identifying the relationship between the device and the magnetic or electric effect it produces.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Moving electrical charges [electricity] produce magnetic force [magnetism] (i.e., electromagnet, motor).</p> <p>b. Moving magnets produce electricity (e.g., generator).</p>

**S7-8:7: Students demonstrate their ability to EXPLAIN DATA by...**

- Using scientific concepts, models, and terminology to report results, discuss relationships, and propose new explanations.
- Generating alternative explanations.
- Documenting and explaining changes in experimental design.
- Sharing conclusion/summary with appropriate audience beyond the research group.
- Using mathematical analysis as an integral component of the conclusion.

## Grades 7-8 Light

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Light and sound are forms of energy that travel from a source and interact with matter in predictable ways.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How does light travel and interact with matter?</li> </ul>

<p><b>S7-8:28</b> <b>Students demonstrate their understanding of Light Energy by...</b></p> <ul style="list-style-type: none"> <li>• Designing demonstrations that represent the characteristics of light energy transfer.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining that visible light is made up of the colored light waves.</li> </ul>	<p><b>Science Concepts:</b></p> <ul style="list-style-type: none"> <li>a. Light is a form of radiant energy.</li> <li>b. Transmitted light can be refracted (change in direction of the light) when it passes from one media into another.</li> <li>c. Visible light is part of the electromagnetic spectrum. Visible (white) light is made up of the colored light waves of the visible spectrum.</li> </ul>
<p><b>S7-8:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...</b></p> <ul style="list-style-type: none"> <li>• Writing a plan related to the question, hypothesis, and prediction that includes:             <ul style="list-style-type: none"> <li>a. A diagram labeled using scientific terminology that supports procedures and illustrates the setup.</li> <li>b. A procedure that lists significant steps that identify manipulated (independent) and responding (dependent) variables.</li> <li>c. A control for comparing data when appropriate.</li> <li>d. Identification of tools and procedures for collecting data and reducing error.</li> </ul> </li> </ul>	
<p><b>S7-8:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...</b></p> <ul style="list-style-type: none"> <li>• Accurately quantifying observations using appropriate measurement tools.</li> <li>• Using technology to collect, quantify, organize, and store observations (e.g., use of probe).</li> <li>• Drawing scientifically:             <ul style="list-style-type: none"> <li>a. Recording multiple perspectives to scale (e.g., magnification, cross section, top view, side view, etc.).</li> </ul> </li> </ul>	

## Grades 7-8 Forces and Motion

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>All matter is in motion. Forces act upon matter to change its motion.</li> </ul>	
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>How do we measure and predict an object's motion?</li> <li>Why do we use speed, velocity, momentum, and acceleration to describe an object in motion?</li> <li>How can forces change the motion of an object?</li> <li>How are gravity, mass, and distance related?</li> </ul>	
<p><b>S7-8:19</b> <b>Students demonstrate their understanding of Motion by...</b></p> <ul style="list-style-type: none"> <li>Designing investigations that illustrate the effect of a change in mass or velocity on an object's momentum.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>Describing that the acceleration of an object is proportional to the force on the object and inversely proportional to the mass of the object.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Velocity indicates the speed and the direction of a moving object.</p> <p>b. Momentum is the characteristic of an object in motion that depends on the object's mass and velocity. Momentum provides the ability for a moving object to stay in motion without an additional force.</p> <p>c. Acceleration is a relationship between the force applied to a moving object and the mass of the object (Newton's Second Law).</p>
<p><b>S7-8:21</b> <b>Students demonstrate their understanding of Force by...</b></p> <ul style="list-style-type: none"> <li>Diagramming or describing, after observing a scenario with a moving object, the forces acting on the object before and after it is put in motion (Students include in their diagram or description, the effect of these forces on the motion of the object.)</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. If there is no change in the speed or direction of a moving object or stationary object, the forces acting on the object are balanced</p> <p>b. If there is a change in the speed or direction of an object, an outside force needs to be applied and the forces acting on the object are unbalanced (Newton's First Law).</p>
<p><b>S7-8:22</b> <b>Students demonstrate their understanding of Gravitational Force by...</b></p> <ul style="list-style-type: none"> <li>Describing the effects of gravitational force on objects in the Solar System, and identifying evidence that the force of gravity is relative to the mass of objects and their distance apart.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The force of gravity depends on the amount of mass objects have and how far apart they may be.</p> <p>b. The force of gravity is hard to detect unless at least one of the objects has considerable mass.</p>
<p><b>S7-8:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...</b></p> <ul style="list-style-type: none"> <li>Developing questions that reflect prior knowledge.</li> <li>Refining and focusing broad ill-defined questions.</li> </ul>	
<p><b>S7-8:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>Predicting results (evidence) that support the hypothesis.</li> <li>Proposing a hypothesis based upon a scientific concept or principle, observation, or experience that identifies the relationship between variables.</li> </ul>	

**S7-8:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Writing a plan related to the question, hypothesis, and prediction that includes:
  - a. A diagram labeled using scientific terminology that supports procedures and illustrates the setup.
  - b. A procedure that lists significant steps that identify manipulated (independent) and responding (dependent) variables.
  - c. A control for comparing data when appropriate.
  - d. Identification of tools and procedures for collecting data and reducing error.

**S7-8:4: Students demonstrate their ability to CONDUCT EXPERIMENTS by...**

- Accurately quantifying observations using appropriate measurement tools.
- Using technology to collect, quantify, organize, and store observations (e.g., use of probe).
- Drawing scientifically:
  - a. Recording multiple perspectives to scale (e.g., magnification, cross section, top view, side view, etc.).

## Grades 7-8 Cells: Needs and Functions

**Enduring Understandings:**

- All living things and their component cells need energy to function and survive through the life cycle of birth, development, reproduction, and death.
- The human body is made up of interconnected systems that maintain equilibrium and respond to the environment to ensure survival.

**Essential Questions:**

- How do the characteristics of a cell enable the organism to survive?
- How do living things reproduce and change throughout their life cycles?
- How do organisms and the cells within them acquire and process energy for survival?
- How do body systems interact to help us survive?

<p><b>S7-8:30</b> <b>Students demonstrate their understanding of Structure and Function–Survival Requirements by...</b></p> <ul style="list-style-type: none"> <li>• Conducting experiments that investigate how different concentrations of materials (inside vs. outside a cell) will cause water to flow into or out of cells.</li> <li>• Examining cells under a microscope and identifying cell wall, and chloroplasts and by comparing the function of a common cell structure such as membrane in all cells with the function of a unique structure such as chloroplasts in plant cells.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Examining cells under a microscope, identifying the nucleus and explaining the relationship between genes (located in the nucleus) and traits.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>a. Cells contain structures that carry out survival functions.</li> <li>b. The nucleus of a cell contains the genes. Every cell contains a complete set of genes for that organism.</li> <li>c. Genes provide the instructions that direct the functions of the cell.</li> <li>d. Plant cells have a cell wall in addition to a cell membrane. The cell wall has openings that allow materials to pass through to the cell and the cell wall provides structural support for the cell.</li> <li>e. Most plant cells contain chloroplasts where green pigment traps the energy from sunlight and transforms it from light energy into chemical energy.</li> <li>f. Some materials can pass into and out of cells as concentrations move toward equilibrium (diffusion).</li> </ol>
<p><b>S7-8:31</b> <b>Students demonstrate their understanding of Reproduction by ...</b></p> <ul style="list-style-type: none"> <li>• Explaining that cells come only from other living cells and that genes duplicate in the process of cell division producing an identical copy of the original cell.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Describing the relationship between human growth and cell division.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>a. Cells only come from other cells.</li> <li>b. Cells repeatedly divide to make more cells for growth and repair.</li> <li>c. During cell reproduction, genes duplicate so that each new cell will have an identical set of genes.</li> <li>d. When cells divide, they are reproducing asexually.</li> <li>e. In asexual reproduction, the new cell (organism) is identical to the parent.</li> <li>f. Some complete organisms can reproduce asexually (e.g., budding).</li> <li>g. In asexual reproduction, the new cell (organism) is identical to the parent.</li> <li>h. Half of an individual’s traits come from one parent, half from the other.</li> </ol>

<p><b>S7-8:33</b>  <b>Students demonstrate their understanding of how Energy Flow Within Cells Supports an Organism’s Survival by...</b></p> <ul style="list-style-type: none"> <li>• Recognizing that energy from the sun is transferred and utilized in plant and animal cells through chemical changes and then transferred into other forms such as heat (e.g., using word equation).</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>a. Plant cells take in carbon dioxide and water and use the energy from sunlight to chemically change them to food (sugar) and oxygen.</li> <li>b. All cells chemically change sugar (food) and oxygen into energy required to survive.</li> <li>c. Energy is used by all cells to carry out functions for survival, and some energy is transferred to the environment as heat.</li> </ol>
<p><b>S7-8:41</b>  <b>Students demonstrate their understanding of Human Body Systems by...</b></p> <ul style="list-style-type: none"> <li>• Identifying ways that the human body responds to changes to maintain equilibrium.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining the function of the lungs in respiration.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Developing models that illustrate the human reproductive system.</li> </ul>	<p><b>Science Concepts:</b></p> <ol style="list-style-type: none"> <li>a. The lungs take in the oxygen that the body cells need for the chemical change that releases energy from food and the lungs eliminate carbon dioxide that produced during the chemical change.</li> <li>b. The reproductive system enables the whole organism (human) to reproduce.</li> <li>c. In order to maintain equilibrium, internal body systems react to environmental changes through the nervous system. (e.g., sweating, increased respiration during exercise, response to environmental stimuli, etc.).</li> </ol>
<p><b>S7-8:2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...</b></p> <ul style="list-style-type: none"> <li>• Predicting results (evidence) that support the hypothesis.</li> <li>• Proposing a hypothesis based upon a scientific concept or principle, observation, or experience that identifies the relationship between variables.</li> </ul>	

## Grades 7-8 Ecosystems

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• Energy (from the sun) is transferred through interdependent systems to support life.</li> <li>• The relationship between the earth and the sun creates changes over time encompassing the water cycle, climate, and weather and seasonal patterns.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How do living organisms obtain energy to survive?</li> <li>• How does the relationship between the earth and sun create seasonal and climatic patterns?</li> </ul>

<p><b>S7-8:34</b>  <b>Students demonstrate their understanding of Energy Flow in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Describing how light is transformed into chemical energy by producers and how this chemical energy is used by all organisms to sustain life (e.g., using a word equation).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Plants transform energy from the sun into stored chemical energy by changing carbon dioxide and water into sugar (food). Plants use or store the sugar they produce to satisfy their energy needs.</p> <p>b. All organisms release the energy stored in sugar (food) through a chemical change that requires oxygen and produces carbon dioxide and water in addition to energy. Some consumers eat plants directly (herbivores). Some consumers eat other animals (carnivores) and use the energy from the plant's sugar food that was stored in the animal's cells. Some consumers eat both plant and animal material (omnivore).</p>
<p><b>S7-8:37</b>  <b>Students demonstrate their understanding of Recycling in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Explaining how products of decomposition are utilized by the ecosystem to sustain life while conserving mass (e.g., worm farm, compost).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. When decomposers break down the matter contained in plants and animals, the molecules of matter can be recycled through the ecosystem and used by plants to produce food or as building material for all organisms.</p> <p>b. As matter is transferred from one organism to another in an ecosystem, the total amount (mass) remains the same. [See S :15— Physical Science Chemical Change.]</p>
<p><b>S7-8:48</b>  <b>Students demonstrate their understanding of Processes and Change over Time within Earth Systems by...</b></p> <ul style="list-style-type: none"> <li>• Diagramming, labeling and explaining the process of the water cycle (precipitation, evaporation, condensation, runoff, ground water, transpiration).</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Identifying the major gases of earth's atmosphere.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Explaining how differential heating can affect the earth's weather patterns.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Creating a model showing the tilt of the earth on</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. The cycling of water in and out of the atmosphere plays an important role in determining climatic patterns. Water evaporates from the surface of the earth, rises and cools, condenses into rain or snow, and falls again to the surface. Global patterns of atmospheric movement influence local weather. Oceans have a major effect on climate, because water in the oceans holds a large amount of heat.</p> <p>b. The entire planet is surrounded by a relatively thin blanket of air composed of nitrogen, oxygen, and small amounts of other gases, including water vapor.</p> <p>c. Heat from the sun is the primary source of energy for changes on the earth's surface. The differences</p>

<p>its axis and explaining how the sun's energy hitting the earth surface creates the seasons.</p>	<p>in heating of the earth's surface produce the planet's weather patterns.  d. Seasons result from variations in the amount of sun's energy hitting the earth's surface. This happens because of the tilt of the earth's axis and the orbit of the earth around the sun.</p>
<p><b>S5-6:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>• Determining an appropriate representation (line graph in addition to prior examples) to represent their findings accurately.</li> <li>• Selecting a scale that is appropriate for range of data to be plotted, labels units, and presents data in an objective way.</li> <li>• Including clearly labeled keys and symbols, when necessary.</li> <li>• Using correct scientific terminology to label representations.</li> </ul>	
<p><b>S5-6:7: Students demonstrate their ability to EXPLAIN DATA by...</b></p> <ul style="list-style-type: none"> <li>• Explaining data using correct scientific terminology.</li> <li>• Using experimental results to support or refute original hypothesis.</li> <li>• Considering all data when developing an explanation/conclusion.</li> <li>• Using additional resources (e.g., books, journals, databases, interview, etc.) to strengthen an explanation.</li> <li>• Identifying problems/flaws with the experimental design.</li> <li>• Preparing a conclusion statement/summary.</li> </ul>	
<p><b>S5-6:8: Students demonstrate their ability to APPLY RESULTS by...</b></p> <ul style="list-style-type: none"> <li>• Explaining how experimental findings can be generalized to other situations.</li> </ul>	

## Grades 7-8 Natural Resources

<p><b>Enduring Understanding:</b></p> <ul style="list-style-type: none"> <li>• Energy (from the sun) is transferred through interdependent systems to support life.</li> <li>• Natural resources are materials that we obtain from the living and non-living environment. Human interactions can have positive and negative impacts on these resources.</li> </ul>
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<p><b>Essential Question:</b></p> <ul style="list-style-type: none"> <li>• How are the Earth’s resources useful to us and to what extent does human activity affect these resources?</li> <li>• Why is it important to manage our natural resources?</li> </ul>
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<p><b>S 7-8:36</b>  <b>Students demonstrate their understanding of Equilibrium in an Ecosystem by...</b></p> <ul style="list-style-type: none"> <li>• Identifying an abiotic or biotic change in a local ecosystem and predicting the short and long-term effects of this change (e.g., local river study).</li> </ul>	<p><b>Science Concept:</b></p> <p>a. Given adequate biotic and abiotic resources, an ecosystem will maintain equilibrium and continue indefinitely.</p> <p>b. Factors that affect biotic or abiotic resources such as disease, predation, climate, and pollution can change the dynamics of an ecosystem and the interdependent relationships among populations of organisms. until a new equilibrium is reached (e.g., Members of a species that occur together at a given time are referred to as a population).</p>
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<p><b>S7-8:49</b>  <b>Students demonstrate their understanding of Processes and Change within Natural Resources by...</b></p> <ul style="list-style-type: none"> <li>• Investigating natural resources in the community and monitoring/managing them for responsible use.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Identifying a human activity—in a local environment— and determining the impact of that activity on a specific (local) natural resource.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Researching the impact of different human activities on the earth’s land, waterways and atmosphere and describing possible effects on the living organisms in those environments.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Human activities have impacts on natural resources, such as increasing wildlife habitats, reducing/managing the amount of forest cover, increasing the amount and variety of chemicals released into the atmosphere and intensive farming. Some of these changes have decreased the capacity of the environment to support life forms. Others have enhanced the environment to support greater availability of resources.</p> <p>b. Fresh water, limited in supply, is essential for life and also for most industrial processes. Rivers, lakes, and groundwater can be depleted or polluted, becoming unavailable or unsuitable for life.</p>
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<p><b>S5-6:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by ...</b></p> <ul style="list-style-type: none"> <li>• Distinguishing between observational, experimental, and research questions (e.g., Observational—How does a cricket chirp? Experimental—Does the amount of light affect how a cricket chirps? Research—Do all crickets chirp? Why do crickets chirp? ).</li> <li>• Identifying multiple variables that affect a system and using the variables to generate experimental questions that include cause and effect relationships.</li> </ul>
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**S 5-6: 2: Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...**

- Using logical inferences derived from evidence to predict what may happen or be observed in the future.
- Providing an explanation (hypothesis) that is reasonable in terms of available evidence.

**S5-6:3: Students demonstrate their understanding of EXPERIMENTAL DESIGN by...**

- Writing a plan related to the question and prediction that includes:
  - a. A list of materials needed that specifies quantities (e.g., 250 ml water).
  - b. A procedure that lists significant steps sequentially and describes which variable will be manipulated or changed and which variables will remain the same (“Fair Test”).
  - c. An appropriate format for recording data.
  - d. A strategy for conducting multiple trials (“Fair Test”).

## Grades 7-8 Microbiology

**Enduring Understandings:**

- The human body is made up of interconnected systems that maintain equilibrium and respond to the environment to ensure survival.

**Essential Questions:**

- How does the body respond to contact with harmful substances/pathogens?

**S7-8:42****Students demonstrate their understanding of the Patterns of Human Health/Disease by...**

- Identifying a variety of microbes (e.g., virus, bacteria, fungi) and toxic materials that can interfere with body systems and cause harm.

**Science Concepts:**

- a. Viruses, bacteria, fungi, and parasites may infect the human body and interfere with normal body functions.
- b. The environment may contain dangerous levels of substances that are harmful to human beings.

**S7-8:1: Students demonstrate their understanding of SCIENTIFIC QUESTIONING by...**

- Developing questions that reflect prior knowledge.
- Refining and focusing broad ill-defined questions.

## Grades 7-8 Genetics/Evolution

<p><b>Enduring Understandings:</b></p> <ul style="list-style-type: none"> <li>• In order to survive, living things must adapt to changes in their environment through the process of natural selection.</li> <li>• Inherited traits are passed on (transferred) from parents to offspring.</li> </ul>
<p><b>Essential Questions:</b></p> <ul style="list-style-type: none"> <li>• How does variation within a species increase the likelihood of its survival?</li> <li>• How and why are humans both similar and different?</li> </ul>

<p><b>S7-8:39</b> <b>Students demonstrate their understanding of Evolution/ Natural Selection by...</b></p> <ul style="list-style-type: none"> <li>• Explaining that advantageous traits of organisms are passed on through reproduction.</li> </ul> <p><b>AND</b></p> <ul style="list-style-type: none"> <li>• Identifying that traits occur randomly.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Differences in physical characteristics (traits) occur randomly (by chance) in a population or species.</p> <p>b. As environments change, organisms that possess advantageous traits (those that enable them to survive) pass those traits to offspring through reproduction.</p>
<p><b>S7-8:40</b> <b>Students demonstrate their understanding of Human Heredity by...</b></p> <ul style="list-style-type: none"> <li>• Identifying that traits are produced from the instructions of one or more genes that are inherited from the parents.</li> </ul>	<p><b>Science Concepts:</b></p> <p>a. Every organism requires a set of instructions (genes) for specifying its traits. Heredity is the passage of these instructions from one generation to another.</p> <p>b. An inherited trait of an individual can be determined by one or by many genes, and a single gene can influence more than one trait</p>
<p><b>S7-8:5: Students demonstrate their ability to REPRESENT DATA by...</b></p> <ul style="list-style-type: none"> <li>• Representing independent variable on the “X” axis and dependent variable on the “Y” axis.</li> <li>• Determining a scale for a diagram that is appropriate to the task.</li> <li>• Using technology to enhance a representation.</li> <li>• Using color, texture, symbols and other graphic strategies to clarify trends/patterns within a representation.</li> </ul>	
<p><b>S7-8:7: Students demonstrate their ability to EXPLAIN DATA by...</b></p> <ul style="list-style-type: none"> <li>• Using scientific concepts, models, and terminology to report results, discuss relationships, and propose new explanations.</li> <li>• Generating alternative explanations.</li> <li>• Documenting and explaining changes in experimental design.</li> <li>• Sharing conclusion/summary with appropriate audience beyond the research group.</li> <li>• Using mathematical analysis as an integral component of the conclusion.</li> </ul>	

## Grades 7-8 Classification

**Enduring Understandings:**

- All living things have similarities and differences. Inherited physical traits, behaviors, and interdependencies help to classify these organisms.

**Essential Questions:**

- How and why do scientists classify living organisms?

**S7-8:38****Students demonstrate their understanding of Classification of Organisms by...**

- Comparing and sorting organisms with similar characteristics into groups based on internal and external structures recognized by scientists.

**AND**

- Recognizing that individuals that can reproduce with one another and produce fertile offspring are classified as a species.

**Science Concepts:**

a. Scientists organize the vast diversity of organisms by describing similarities and differences among living things. Details of internal and external structures of organisms are more important for scientific classification than behavior and general appearance.

b. Individuals that can reproduce with one another and produce fertile offspring are classified as a species.

**S7-8:6: Students demonstrate their ability to ANALYZE DATA by...**

- Identifying, considering and addressing experimental errors (e.g., errors in experimental design, errors in data collection procedures).
- Identifying limitations and/or sources of error within the experimental design.

**S7-8:8: Students demonstrate their ability to APPLY RESULTS by...**

- Identifying additional data that would strengthen an investigation.
- Explaining limitations for generalizing findings.
- Explaining relevance of findings (e.g., So what?) to local environment (community, school, classroom)
- Devising recommendations for further investigation and making decisions based on evidence.

## Science Curriculum Grades 9 - 12

The Harwood Union High School science program provides students with the opportunity to attain all of the science content standards as well as a number the Vital Results and non-science content standards included in the Vermont Framework. The standards numbered below are embedded throughout the science program and their attainment is indicated by the lettered evidence following each standard.

### **7.1 Students use scientific methods to describe, investigate, and explain phenomena and raise questions. This is evident when students:**

- aaa.** Frame questions that can be investigated using scientific methods and knowledge, including manipulating variables, and predicting outcomes for untested hypotheses using scientific principles.
- bbb.** Critically evaluate the validity and significance of sources and interpretations, including scientific knowledge, observation, and experimentation.
- cc.** Create hypotheses to problems, design their own experiments to test their hypotheses, collect data through observation and instrumentation, and analyze data to draw conclusions; use conclusions to clarify understanding and generate new questions to be explored.
- ddd.** Formulate and revise explanations and models based on evidence, logical argument, and scientific principles.
- ee.** Explain a variety of observations and phenomena using concepts that have been learned.
- f.** Use either deductive or inductive reasoning to explain observations and phenomena, or to predict answers to questions.
- ggg.** Propose, recognize, analyze, synthesize, and evaluate alternative explanations.
- hh.** Identify problems and opportunities, propose designs and choose among the alternatives, implement a solution and evaluate its consequences.
- i.** Work individually and in teams to collect and share information and ideas.

### **7.2 Students design and conduct a variety of their own investigations and projects. This is evident when students:**

- aa.** Design and conduct a controlled experiment.
- bb.** Design and conduct field work.
- cc.** Completely design a physical structure or technological system.
- dd.** Complete a data study based on civic, economic, or social issues.
- ee.** Design a resource or system management plan.
- fff.** Complete a mathematical model of physical phenomena, employing methods of structural analysis.
- g.** Complete research.
- h.** Study decision options in business or public planning that involve issues of optimizations, trade off, cost benefit projections, and risks.
- i.** Complete a historical study, tracing the development of a mathematical or scientific concept and the people connected with it.

### **7.3 Students understand the nature of mathematical, scientific, and technological theory. This is evident when students:**

- aaa.** Use principles and observations to formulate theory and to explain or predict phenomena.
- bb.** Determine the validity of a theory by examining the principles on which it was founded, the constraints that apply to its application, and the body of physical evidence that supports it.
- cc.** Show understanding that new theories develop when phenomena are observed that are not fully explained by old theories.

**7.4 Students understand the history of science, mathematics, and technology. This is evident when students:**

- aa.** Examine important contributions made to the advancement of science, technology, and mathematics, and respond to their impact on past, present, and future understanding.

**7.5 Students analyze the roles and responsibilities of scientists, mathematicians, and technologists in social, economic, cultural, and political systems. This is evident when students:**

- aaa.** Analyze the impact of scientific, mathematical, and technological investigations into and findings about human society, including the ethical issues involved (e.g., the dangers and benefits of genetic engineering).

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Astronomy**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aaa. Identify, record, model and explain evidence of change over time;
- bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;
- ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems;
- ddd. Identify, model, and explain the position of our solar system in the universe relative to distance and time (star and star systems, fusion, instrumentation, and simulations; the universe as a hierarchy of interrelated systems); and
- ff. Explain the emergence of modern views of the universe (past, present, and future scientific theories).

### **Evidence of Learning**

The student will:

- Frame questions that can be investigated using scientific methods and knowledge, including manipulating variables, and predicting outcomes for untested hypotheses using scientific principles.
- Critically evaluate the validity and significance of sources and interpretations, including scientific knowledge, observation, and experimentation.
- Formulate and revise explanations and models based on evidence, logical argument, and scientific principles.
- Propose, recognize, analyze, synthesize, and evaluate alternative explanations.
- Identify problems and opportunities, propose designs and choose among the alternatives, implement a solution and evaluate its consequences.
- Design and conduct a controlled experiment.
- Illustrate mathematical models of a physical phenomenon.
- Complete a historical study, tracing the development of a mathematical or scientific concept and the people connected with it.
- Explain theories based upon observations, concepts, principles, and historical perspective.
- Determine the validity of a theory by examining the principles on which it was founded, the constraints that apply to its application, and the body of physical evidence that supports it.
- Show understanding that new theories develop when phenomena are observed that are not fully explained by old theories.
- Use principles and observations to formulate theory and to explain or predict phenomena.
- Examine important contributions made to the advancement of science, technology and mathematics, and respond to their impact on past, present, and future understanding.
- Analyze the impact of scientific, mathematical, and technological investigations into and findings about human society, including the ethical issues involved.
- Understand and use number systems: natural, whole, integer, rational, real and complex.
- Represent numbers in decimal or fraction form and in scientific notation, and graph numbers on the number line in the coordinate plane.
- Understand and use unitary operations.
- Use dimensionless numbers and numbers with specific units of measure, including length, time, and rate units.

- Compare numbers using order relations, differences, ratios, proportions, percents, and proportional change.
- Understand the interrelationship of the four binary arithmetic operations, and use the properties of these operations in forming and working with algebraic expressions.
- Recognize and represent basic number patterns.
- Measure as exactly as possible or round off, as appropriate, and justify the choice.
- Understand the properties of figures relating to shape, size, location, direction, and orientation.
- Work with basic types of solid and plane figures, and with geometric patterns involving such figures.
- Use relationships between figures that involve congruence, similarity, projections, and transformations.
- Use quotient measures and product measures.
- Know, use and derive formulas for area and volume of many kinds of figures.
- Carry out conversions, scale changes, and dimensional analysis; competently use basic measurement instruments; understand issues of precision, accuracy and error analysis.
- Understand the structure of standard measurement systems (SI and customary), including basic geometric and non-geometric measures.
- Analyze geometric figures and prove things about them using deductive methods.
- Present graphs and figures.
- Formulate and solve meaningful problems in many kinds of situations using grade-related mathematical concepts and reasoning strategies.
- Formulate and carry out detailed solutions to complex problems, using appropriate problem solving techniques.
- Demonstrate understanding that analysis of systems is important to define and control inputs and outputs.
- Demonstrate understanding that systems are effectively designed when specifications and constraints are understood; systems are optimized when efficiencies are maximized; and a system is never 100% efficient (entropy).
- Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements.
- Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds;
- Demonstrate an understanding of the conservation of matter.
- Understanding how radioactive elements decay.
- Use Newton's law to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion.
- Provide examples of transformations of energy from one form to another.
- Provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).
- Discuss electromagnetic waves.
- Identify, record, model and explain evidence of change over time.
- Identify evidence of model and explain the patterns and forces that shape the earth.
- Identify, model, explain, and analyze the interrelated parts and connections between earth systems.
- Identify, model and explain the position of our solar system in the universe relative to distance and time (star and star systems, fusion, instrumentation, and simulations; the universe as a hierarchy of interrelated systems).
- Explain the emergence of modern views of the universe (past, present, and future scientific theories).

## Essential Science Principles

The student will demonstrate understanding of:

- Formation of the universe.
- Characteristics of stars including composition, temperature, motion, magnitudes, and classification.
- Astronomical distances.
- Stellar evolution.
- Star groups.
- Structure of the sun.
- Fusion, transformation of mass, chemical reactions.
- Solar activity, including sunspots, solar flares, auroras, magnetic cycle.
- Formation of the solar system, including historical models.
- Planetary systems.
- Earth's moon, including surface, interior, development.
- Lunar movements - eclipses, rotation and revolution.
- Lunar cycle - phases of the moon, calendars.
- Other satellites.

## Vital Results

1.1, 1.2, 1.3, 1.4, 1.8, 1.11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.8, 2.9, 2.10, 2.14, 3.1, 3.2, 3.7, 3.10, 3.11, 4.5

## Related Standards

7.6aaa, 7.6bbb, 7.6ff, 7.6hh, 7.6I, 7.7aaa, 7.7bbb, 7.7ccc, 7.7ddd, 7.7eee, 7.7ff, 7.7h, 7.7I, 7.7j, 7.8, 7.10aa, 7.10bbb, 7.11aaa, 7.11bbb, 7.12aaa, 7.12bbb,

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Meteorology**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, students:

- aaa. Identify, record, model and explain evidence of change over time;
- bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;
- ccc. Identify, model, explain and analyze the interrelated parts and connections between earth systems.

### **Evidence of Learning**

The student will demonstrate knowledge of:

- Earth's uniqueness.
- Effects of revolution and rotation - seasons, time zones.
- Exploration of the earth - satellites, deep digging operations, compasses, maps, etc.
- Gravity (covered also in Astronomy).
- Plate tectonics, continental drift, including historical perspectives and impact of technology on theory.
- Deformation of the crust: isostatic adjustment, stress, faulting, folding.
- Formation of mountains.
- Earthquakes: cause, location, prediction, measurement.
- Volcanoes: major zones, types, prediction, extraterrestrial (covered also in Astronomy).
- Characteristics of the atmosphere - composition, atmospheric pressure, layers, pollution.
- Solar energy and the atmosphere - radiation, absorption, conduction, convection.
- Winds - global and local.
- Atmospheric moisture, heat energy and water, humidity, dew point.
- Cloud formation and classification.
- Precipitation - forms, causes, measurement.
- Air masses - types, particularly North American.
- Fronts - types.
- Major storms - hurricanes, tornadoes, thunderstorms, lightning.
- Weather instruments - barometers, anemometers, upper atmospheric data.
- Forecasting.
- Climate - factors that affect it including latitude, altitude, topography.
- Worldwide systems: El Nino, La Nina, North Atlantic oscillation.
- Climate zones.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.8, .11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.10, 2.14, 3.1, 3.2, 3.3, 3.7, 3.10, 3.11, 4.5

### **Related Standards**

7.6aaa, 7.6bbb, 7.6ff, 7.6gg, 7.7f, 7.7aaa, 7.7eee, 7.7ff, 7.7h, 7.7I, 7.7j, 7.10aa, 7.10bbb, 7.11bbb, 7.12ee, 7.12aaa, 7.12bbb, 7.12eee

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Oceanography**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aaa. Identify, record, model, and explain evidence of change over time;
- bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;
- ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems.

### **Evidence of Learning**

The student will demonstrate knowledge of:

- Features of ocean basins.
- Sources and types of sediment.
- Properties of ocean water - salinity, temperature, density, color.
- Marine life (basic outline).
- Resources from oceans - minerals, food, fresh water.
- Ocean pollution.
- Ocean currents - surface and deep.
- Ocean waves - energy, shoreline erosion.
- Tides - source, behavior, variations, currents.

### **Vital Results**

1.1, 1.2 , 1.3, 1.4, 1.8, 1.11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8 , 2.9, 2.10, 2.11, 2.12, 2.14, 3.1, 3.3, 3.7, 3.10, 3.11, 4.5

### **Related Standards**

7.5aaa, 7.6aaa, 7.6bbb, 7.6ff, 7.6gg, 7.7f, 7.7aaa, 7.7eee, 7.7ff, 7.7h, 7.7I, 7.7j, 7.10aa, 7.10bbb, 7.11aaa, 7.11bbb, 7.12ee, 7.12aaa, 7.12bbb, 7.12eee, 7.16

# **COURSE: EARTH-SPACE SCIENCE - GRADE 9**

## **Unit: Geology**

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them

over time, and the theories that currently explain their evolution. This is evident when students:

aaa. Identify, record, model, and explain evidence of change over time;

bbb. Identify evidence of, model, and explain the patterns and forces that shape the earth;

ccc. Identify, model, explain, and analyze the interrelated parts and connections between earth systems.

### **Evidence of Learning**

The student will demonstrate knowledge of:

- Geologic principles of determining relative age - superposition, unconformities, crosscutting relationships.
- Determining relative age - rates of erosion, deposition.
- Dating via glacial varves.
- Radioactive decay.
- Fossil record - formation, interpretation.
- Geologic time scale - divisions of geologic time.
- Movements of continents (covered also in Dynamic Earth) - formation of Pangaea, break-up of Pangaea.
- Geologic history of North American continent.
- Grand Canyon, an in-depth study of its formation.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.8, 1.11, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.14, 3.1, 3.2, 3.3, 3.7, 3.10, 3.11, 4.5

### **Related Standards**

7.5aaa, 7.6aaa, 7.6bbb, 7.6ff, 7.6gg, 7.7f, 7.7aaa, 7.7eee, 7.7ff, 7.7h, 7.7i, 7.7j, 7.10aa, 7.10bbb, 7.11aaa, 7.11bbb, 7.12ee, 7.12aaa, 7.12bbb, 7.12eee

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: The Living Condition**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **Evidence of Learning**

The student will:

- Describe the characteristics of life, including cellular organization, metabolism, homeostasis, reproduction, and growth.
- Identify the basic requirements for all living organisms.
- Recognize the uniqueness of viruses with regard to living condition.
- Explain the concept of spontaneous generation.

### **Vital Results**

1.2,1.3,1.13,1.22,2.1

### **Related Standards**

7.11aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Ecology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarities and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students

aaa. Identify, record, model, and explain evidence of change over time (e.g., origin and evolution of the earth's biological, ecological, geological systems);

eee. Analyze and explain natural resource management and demonstrate an understanding of the ecological interactions and interdependence between humans and their resource demands on environmental systems (e.g., production, consumption).

### **Evidence of Learning**

The student will:

- Understand the concept of an ecosystem as a unit of the biosphere in which materials cycle and through which energy flows.
- Demonstrate an ability to recognize the major biotic and abiotic components of an ecosystem and the relationships between them.
- Describe the trophic relationships existing among members of a biotic community and the effects of changes in these relationships.
- Recognize the factors involved in the dynamics of populations of living organisms.
- Describe the characteristics of major ecosystem types and the changes involved in biological succession.
- Identify the major biogeochemical cycles and the factors affecting those cycles, as well as the impact that changes in those cycles may have upon living organisms.
- Develop an understanding of the impact human activities may have upon ecosystems.

### **Vital Results**

1.2,1.3,1.4, 1.5, 1.6, 1.8, 1.10,1.13,1.17, 1.18, 1.20, 2.1, 2.2, 2.6, 2.7, 3.5, 3.7, 3.1, 3.13, 4.5

### **Related Standards**

7.5aaa, 7.6bbb, 7.6hh, 7.11aaa, 7.16aaa, 7.19aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Chemistry of Life**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **Evidence of Learning**

The student will:

- Differentiate among atoms, ions and molecules.
- Explain simple atomic structure including arrangement in electrons.
- Recognize major groups of elements and general trends in the periodic table.
- Compare and contrast compounds and mixtures.
- Distinguish between physical and chemical reactions.
- Define the types of chemical bonds and the reason for their formation.
- Calculate the relative age of an organic remain using the half-life principle.
- Explain the pH scale and the roles played by acids, bases, and buffers.
- Distinguish between organic and inorganic compounds.
- Explain the solvent properties of water and its importance to the cell.
- Differentiate between monomers and polymers and the formation of each.
- Compare and contrast the four principle types of macromolecules found in cells .
- Explain the structure and functioning of enzymes.
- Comprehend the roles played by organic compounds in a healthy human diet.
- Analyze tests for the identification of macromolecules.
- Recognize the subunits that make up macromolecules.
- Relate the structure of the four principle types of macromolecules to their function.

### **Vital Results**

1.10, 1.17, 2.2, 3.4, 3.10, 3.11

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Cell Biology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body.

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- State the parts of the cell theory.
- Identify the contributions of various scientists to the development of the cell theory.
- Compare and contrast various types of cells.
- Identify the major differences between prokaryotes and eukaryotes.
- Explain the importance of surface area-to-volume ratio of cells.
- Describe the benefits and disadvantages of using different types of microscopes.
- Identify that there are specialized parts of the cell and relates the structure of organelles to function.
- Differentiate between diffusion and osmosis.
- Describe isotonic, hypotonic, and hypertonic solutions.
- Predict the direction of water movement through a permeable membrane given the solute concentration on each side.
- Compare and contrast active and passive transport.
- Compare and contrast endocytosis and exocytosis.
- Distinguish between exergonic and endergonic chemical reactions.
- Describe the structure of ATP and how it is used to power chemical reactions.
- Summarize the overall processes of both aerobic and anaerobic respiration.
- Compare the relative efficiencies of aerobic and anaerobic processes.
- Summarize the overall process of photosynthesis.
- Explain the relationship between environmental factors and the rate of photosynthesis.
- Explain the complementary nature of photosynthesis and respiration.
- Describe the general concept of chemosynthesis and its possible role in the origin of life.
- Cite the reasons for the reproduction of cells.
- Contrast sexual and asexual reproduction.
- Describe the forms of asexual reproduction.
- Explain the events occurring during each phase of the cell cycle and how it is regulated.
- Identify and illustrate the events of mitosis and describes the structures involved.
- Recognize chromosome structure and its relationship to mitosis.

- Describe the relationship between cancer and mitosis.
- Compare and contrast mitosis and meiosis.
- Describe changes in chromosome number and structure occurring in meiosis and mitosis.
- Explain the types of errors that may occur in cellular reproduction and their potential effects.
- Identify the early stages of development of a multicellular organism including the zygote, blastula, and gastrula.
- Distinguish between fraternal and identical twins and how they are formed.
- Explain cloning and how it relates to cellular reproduction.

### **Vital Results**

1.2,1.4,1.5,1.8, 1.10, 1.17, 1.18, 1.19, 1.22, 2.1, 2.2, 3.3, 3.6, 3.10, 3.11

### **Related Standards**

7.6aaa, 7.6hh, 7.7eee, 7.11aaa, 7.11eee, 7.12eee

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Genetics**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body.

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe Mendel's contributions to genetics through investigating his experimental design.
- Explain Mendel's laws and how they developed from his work.
- Explain how probability is used to predict the results of genetic crosses.
- Use Punnett squares to predict the results of monohybrid and dihybrid crosses.
- Examine inheritance patterns not described by Mendel's model such as incomplete dominance, multiple alleles, sex-linked traits, co-dominance, and sex-influenced traits.
- Interpret pedigrees.
- Cite methods used to study inheritance in populations.
- Distinguish between autosomes and sex chromosomes.
- Explain sex determination in humans.
- Describe relatively common genetic disorders seen in humans, their patterns of inheritance, and methods by which they may be detected.
- Describe the composition and structure of the DNA molecule.
- Recount the various scientists who played key roles in elucidating the material of genes and the structure of DNA.
- Compare the structure, composition, and roles played by DNA and RNA.
- Detail the structures and substances involved and the events occurring during replication, transcription, and translation.
- Determine the amino acid sequence of a polypeptide given the nucleotide sequence in a strand of DNA.
- Describe the mechanisms by which gene expression is controlled.
- Detail the processes involved in forming recombinant DNA.
- Explain the use of restriction enzymes, genetic probes, and electrophoresis in isolating genes.
- Analyze a genetic fingerprint.
- Describe the potential risks and benefits of genetic engineering.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.18, 1.19, 2.1, 2.3, 3.5.

### **Related Standards**

7.5aaa, 7.6hh, 7.8aaa, 7.9ddd

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Classification**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **Evidence of Learning**

The student will:

- Describe early attempts at classifying organisms.
- Explain the role of Linnaeus in developing the modern system of classification and the factors that led him to design it the way he did.
- Know the levels of the classification hierarchy.
- Explain the scientific system for naming a species.
- Define the term species.
- Compare and contrast the characteristics of the kingdoms of life.
- Describe how modern classification takes evolutionary relationships and other factors into account.
- Use and construct a dichotomous key.

### **Vital Results**

1.10, 3.10, 3.11

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Evolution**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- aaa. Identify, record, model, and explain evidence of change over time (e.g., origin and evolution of the earth's biological, ecological and geological systems).

### **Evidence of Learning**

The student will:

- Identify possible origins of life on Earth.
- Organize important events in the history of the Earth according to the major geological eras.
- Describe possible means by which early life forms obtained energy and altered the Earth's atmosphere.
- Explain the probability of life existing extra-terrestrially.
- Summarize early attempts to explain the diversity of life on Earth.
- Detail the experiences and influences that led Darwin to develop the concept of evolution by natural selection.
- Describe the process and patterns of natural selection.
- Detail the evidence in support of evolution.
- Compare and contrast Gradualism and Punctuated Equilibrium.
- Explain the relationship between population gene frequencies and the mechanisms by which new species develop.
- Relate the concept of adaptive radiation to the phylogenies of specific groups of organisms.
- Describe the development of the first primates.
- Summarize physical and behavioral characteristics of the primates and the selective pressures, which led to their development.
- Describe the development of bipedalism and the pre-adaptations that enhanced survival of later primates.
- Understand current thought regarding the origins of the hominid line and the relationship of humans to other living primates.
- Describe various hominid species and theories relating to their role in the evolution of our *Homo sapiens*.

### **Vital Results**

1.2, 1.4, 1.6, 1.13, 1.15, 4.5

### **Related Standards**

7.11aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Microbiology and Fungi**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Recount discovery of viruses and early work done with them.
- Explain why viruses are generally not considered as living organisms.
- Describe the structure and composition of viral particles.
- Compare and contrast the various types of viruses and their modes of infection.
- Identify diseases caused by viruses.
- Cite the components of the human immune response to viral infection.
- Know treatment used for viral infections.
- Describe the structure of the HIV virus, its mode of infection, the symptoms it may result in, and the way in which it may avoid destruction by the human immune system.
- Understand how epidemiologists track disease transmission.
- Explain the ways in which viruses may be used in biotechnology.
- Recount the discovery of bacteria and the scientists involved in those efforts.
- Contrast between prokaryotic and eukaryotic cells.
- Cite the characteristics of Kingdom Monera and its member groups.
- Describe the role bacteria and their relatives may have played in the early history of life on Earth.
- Differentiate between archebacteria and eubacteria.
- Identify bacteria by shape and arrangement.
- Describe the cellular structure of bacteria.
- Identify the different ways in which bacteria meet their energy needs.
- Describe the conditions favorable for bacterial growth.
- Explain bacterial reproduction and the methods by which they may exchange genetic material.

- Recount the discovery of antibiotics and problems associated with the development of antibiotic resistance in bacteria.
- Cite the methods of destroying bacteria or minimizing their reproduction.
- Describe the way in which bacteria may be employed in biotechnology.
- Identify the unifying features of members of Kingdom Protista.
- Describe the development of eukaryotic features and the hypothetical phylogeny of this group.
- Describe the environments where protists thrive.
- Compare and contrast asexual and sexual reproduction in protists.
- Differentiate between protozoa and algae.
- Describe the general characteristics of the four major groups of protozoa.
- Identify a variety of protists.
- Compare and contrast algal groups.
- Discuss uses of and diseases caused by protists.
- Explain the ecological roles played by protists.
- Relate the role that protists played in the evolution of more complex forms of life.
- Identify the characteristics of members of the Kingdom Fungi.
- Describe how fungi reproduce and obtain nutrients.
- Explain the ecological roles played by fungi.
- Identify members of the major fungal groups.
- Discuss diseases caused by fungal organisms.

#### **Vital Results**

1.2, 1.6, 1.8, 1.10, 1.18, 1.19, 2.1, 2.7, 2.11, 3.3, 3.5, 3.7, 3.10, 3.11, 3.12, 3.14, 4.5

#### **Related Standards**

7.18aaa, 7.18dd

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Zoology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms);
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe the general characteristics of members of the Kingdom Animalia.
- Explain the evolution of early animal groups.
- Differentiate between Protostomes and Deuterostomes.
- Define and give examples of animals with asymmetrical, radial, bilateral, and spherical body arrangements.
- Compare and contrast the body structure and function of sponges, cnidarians, flatworms, mollusks, annelids, arthropods, echinoderms, and chordates.
- Relate structural adaptations to the phylogeny of animal groups.
- Describe the ecological roles played by members of each group.
- Describe the characteristics of vertebrates.
- Compare and contrast general anatomy and physiology of fishes, amphibians, reptiles, birds and mammals.

### **Vital Results**

1.2,1.4, 1.6, 1.13, 1.15, 1.18, 1.19, 2.1, 3.10, 4.5

### **Related Standards**

7.1aaa, 7.13aaa,

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Botany**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g., plants, animals, microorganisms);
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **Evidence of Learning**

The student will:

- Describe the adaptations developed by early land plants that were lacking in algae.
- Compare and contrast vascular and nonvascular plants.
- Explain the reasons for the success of seed plants.
- Compare and contrast gymnosperms and angiosperms.
- Discuss the evolutionary significance of angiosperms.
- Describe seed structure.
- Compare and contrast monocots and dicots.
- Identify the parts of the flower and the role each part plays in development of seeds and fruits.
- Describe the structure and function of the parts of roots, stems, and leaves.
- Compare herbaceous and woody plants.
- Infer the age and environmental conditions from the cross section of a tree.
- Describe the ecological roles and uses of plants.

### **Vital Results**

1.2,1.4, 1.6, 1.13, 1.15, 1.18, 1.19, 2.1, 3.10, 4.5

### **Related Standards**

7.11aaa, 7.12eee, 7.16aaa

# **COURSE: BIOLOGY - GRADE 10**

## **Unit: Human Biology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation);
- ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g., flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply them to local, regional, and global systems;
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Compare and contrast the human body plan with other vertebrates.
- Identify the characteristics and functions of basic tissue types.
- Describe the function of each organ system.
- Identify the major components of the skin, musculo-skeletal, circulatory, respiratory, digestive, excretory, nervous, endocrine and reproductive systems.
- Explain the overall functioning of each of the body systems.
- Recognize the causes and effects of common diseases and disorders of individual body systems.

### **Vital Results**

1.2,1.3,1.6, 1.10, 1.13, 1.15, 1.18, 1.19, 2.1, 2.2, 2.3, 3.4, 3.5, 3.7, 3.10, 3.11, 3.14, 3.15, 4.5

### **Related Standard**

7.11aaa

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: Introduction**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity).

### **Evidence of Learning**

The student will:

- Recognize that scientists build upon the earlier work of other scientists.
- Recount the developments leading to the evolution of modern medicine.
- Describe how observations of the structure of the human body led to the discovery of the function of organ systems.
- Cite how normal functioning of the human body relies upon maintenance of homeostasis.
- Explain that physicians and other health professionals practice a code of ethics when treating patients.
- Describe the concept of holistic medicine.
- Explain how solving one medical problem may present others.

### **Vital Results**

1.1,1.2,1.3,1.4, 2.7, 2.9, 3.4

### **Related Standard**

7.11aaa

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: Epithelial Tissues**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Identify major epithelial cell types.
- Describe the functions of cell types.
- Name the three layers of skin and describe the functions of each.
- Explain the origin of epithelial tissues, hair, and nails.
- Explain the function and biochemical nature of skin pigmentation.
- Describe common skin disorders, their causes and treatments.

### **Vital Results**

1.2, 1.3, 2.2, 3.4, 3.5, 3.7, 3.9

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Musculo-Skeletal System**

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Describe the structure of bones.
- Recount the cellular elements of the skeletal system.
- Detail the development of the human skeleton.
- Identify the bones, which comprise the human skeletal system.
- Identify the connective tissue elements of the skeletal system.
- Describe the types of joints and their function.
- Identify disorders of the skeletal system and their treatment.
- Explain the role of diet and exercise in maintaining the health of the skeletal system.
- Compare and contrast the three types of muscle.
- Identify the major muscles of the body and their origins and insertions.
- Explain the chemical nature of muscle contraction.
- Discuss the importance of exercise in increasing endurance and maintaining muscle strength.
- Identify disorders of muscle tissue and their treatment.

### **Vital Results**

1.3, 1.17, 2.1, 2.5, 3.5

### **Related Standard**

7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Nervous System**

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Describe the structure and function of a neuron.
- Explain the biochemical events involved in conduction of a nerve impulse.
- Recognize the importance of myelin sheaths.
- Identify the components of the central nervous system.
- Name the major regions of the brain and explain their functions.
- Describe the peripheral nervous system.
- Distinguish between the different types of neurons.
- Explain a motor reflex.
- Compare and contrast voluntary and involuntary reactions.
- Distinguish between the sympathetic and parasympathetic nervous system.
- Describe the structure and functioning of sensory organs.
- Cite common disorders of the nervous system and their causes.
- Recognize the effects of certain substances on the nervous system.
- Explain the neurological basis of pain.
- Explain how narcotics can cause addiction.

### **Vital Results**

1.2, 1.3, 2.1, 2.2, 3.4, 3.5, 3.7

### **Related Standard**

7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Digestive System and Nutrition**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will

- Name the structures of the digestive system.
- Describe how the body uses carbohydrates, lipids, and proteins.
- Explain what essential amino acids are.
- Identify the roles of individual vitamins and trace elements.
- Trace the path of food through the digestive tract.
- Describe the major digestive processes that occur at different points in digestion.
- Explain the role of the liver and pancreas in digestion.
- Detail how and where nutrients are absorbed.
- Identify the role of individual digestive enzymes.
- Explain the symptoms, causes, and treatments of common digestive disorders.

### **Vital Results**

1.2, 1.3, 1.4, 1.18, 1.19, 1.20, 2.2, 3.4, 3.5, 3.7, 3.10

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Respiratory and Circulatory Systems**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- ddd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Name the structures of the respiratory system.
- Explain how oxygen and carbon dioxide are transported in the blood.
- Explain the mechanism by which breathing is regulated.
- Relate changes in gas pressure to respiratory function.
- Associate lung capacity with respiratory health.
- Describe common respiratory disorders, their causes and treatment.
- Identify the functions of the circulatory system.
- Compare and contrast the structure and function of arteries, capillaries, and veins.
- State the function of the lymphatic system.
- Identify the elements of blood and their functions.
- Describe pulmonary and systemic circulation.
- Trace the path of blood flow through the heart.
- Explain disorders of the circulatory system, their causes and treatment.

### **Vital Results**

1.2, 1.3, 1.4, 1.8, 1.18, 1.19, 1.20, 3.4, 3.5, 3.7, 3.9

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Excretory System**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Use scientific methods to describe, investigate, and explain phenomena and raise questions.
- Demonstrate understanding that analysis of systems is important to define and control inputs and outputs.
- Demonstrate understanding that systems are effectively designed when specifications and constraints are understood; systems are optimized when efficiencies are maximized; and a system is never 100 percent efficient (entropy).
- Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).
- Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity).
- Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Essential Science Principles**

- Names the structures of the excretory system
- Identifies the forms of wastes produced by humans and how they are eliminated
- Details the parts of the kidney and explains how urine is formed
- Describes the dynamics of kidney function as it relates to water balance
- Traces the flow of urine from its production to elimination
- Describes the major digestive processes that occur at different points in digestion
- Identifies the role of hormones on kidney function
- Explains the symptoms, causes, and treatments of common excretory disorders
- Describes the events occurring during kidney dialysis

### **Vital Results**

1.2, 1.3, 1.4, 1.18, 1.19, 1.20, 2.2, 3.4, 3.5, 3.7, 3.10

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Endocrine System**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Identify the major endocrine glands of the body, the hormones produced by each, and the action of the individual hormones.
- Compare the action of hormones with electrochemical signals of the nervous system.
- Explain the role of the hypothalamus in the regulation of hormones.
- Compare peptide and steroid hormones.
- Identify endocrine disorders, their symptoms and treatment.

### **Vital Results**

1.2, 1.3, 2.2, 2.3, 3.4, 3.5, 3.6, 3.7, 3.9

### **Related Standards**

7.11aaa, 7.11bbb, 7.18dd

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: Reproduction and Development**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe the structure of gametes and tell how each type is adapted for its function.
- Describe the structure and function of testes and ovaries.
- Trace the path of sperm from the testes to the outside of the body.
- Trace the path of an ovum from the ovary to the uterus.
- Differentiate between oogenesis and spermatogenesis.
- Relate the occurrence of the ovarian cycle to the hypothalamus.
- Compare the hormonal changes occurring during ovulation and pregnancy.
- Discuss the cellular changes subsequent to fertilization.
- Describe the primary events occurring during fetal development.
- Explain the relationship between environmental factors and fetal development.
- Describe reproductive disorders and their symptoms.
- Explain the effects of sexually transmitted diseases.

### **Vital Results**

1.2, 1.3, 1.4, 1.18, 1.19, 1.20, 3.4, 3.5, 3.7, 3.8, 3.9

### **Related Standards**

7.11aaa, 7.11bbb

# **COURSE: HUMAN PHYSIOLOGY - GRADES 11/12**

## **Unit: The Immune System**

### **VT Standard 7.13**

Students understand the characteristics of organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g., chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body - heredity, body systems, and individual development - and understand the impact of the environment on the human body. This is evident when students:

- aaa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g., gene mutations, gene combinations);
- bbb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce (e.g., immunity);
- ccc. Analyze and describe how the health of human beings is affected by diseases passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe the body's lines of defense against infection from a foreign particle.
- Recognize the four main types of immune system cells.
- Compare and contrast the roles of T and B cells in the immune response.
- Explain how immunity may be conferred.
- Describe autoimmune diseases and how they function.
- Explain the role of biotechnology in fighting viral and autoimmune disease.

### **Vital Results**

1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.18, 1.19, 1.20, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9

### **Related Standards**

7.11aaa, 7.11bbb, 7.18aaa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: The Science of Chemistry**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Recognize properties and states of matter.
- Recognize chemical change and express in word equations.
- Define endothermic and exothermic.
- Operate a Bunsen burner and centigram balance.
- Define mass, weight, and volume.
- Define density, use density formula, interpret graph of mass vs. volume.
- Create outline for classification of matter.
- Describe classes of compounds and mixtures.
- Learn basic SI units and conversions.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.7ddd, 7.7ff

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Matter and Energy**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Distinguish between potential and kinetic energy.
- Define and differentiate between heat and temperature.
- Define, understand, and use specific heat capacity.
- Describe relationship between energy and mass.
- Learn care and use of thermometers.
- Explain the purpose of controls in experiments.
- Distinguish between hypotheses, theories, and laws.
- Recognize conservation of mass in chemical changes.
- Define and differentiate between accuracy and precision.
- Define and use significant figures.
- Understand and use scientific notations.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.7ddd, 7.7ff

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Atomic Structure and Electronic Configuration**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties;
- fff. Understand that alternating magnetic fields generate electric fields, and vice versa; discuss electromagnetic waves.

### **Evidence of Learning**

The student will:

- Describe how scientists probed the atom.
- Know three laws that support the atom's existence.
- Compare the Dalton, Rutherford, and Bohr models of the atom
- Calculate the mass of an atom in amu and grams.
- Learn the structure of the atom, including protons, neutrons, electrons, and isotopes.
- Define mass number and atomic number.
- Learn properties of light and its relationship to atomic theory.
- Demonstrate proficiency in flame testing and determining the identity of an unknown element.
- Learn pattern of electrons filling orbitals and energy levels.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6ggg, 7.6hh, 7.7ddd, 7.7ff

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: The Periodic Table**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties;
- fff. Understand that alternating magnetic fields generate electric fields, and vice versa; discuss electromagnetic waves.

### **Evidence of Learning**

The student will:

- Describe the history of the periodic table.
- Recognize the organization of the modern periodic table.
- Learn the trends in properties of the elements related to the periodic table and relate to atomic structure.
- Distinguish between natural and synthetic elements.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6hh, 7.8bb

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Ionic Compounds**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Recognize, name, and write formulas for cations, anions, polyatomic ions and binary compounds.
- Describe the nature of ionic bonding and crystal structure.
- Describe the properties of binary ionic compounds.
- Describe the energy changes associated with forming salts.
- Assign oxidation numbers to elements in compounds and ions.
- Describe electron configurations of elemental ions.
- Define hydrate and determine percent water in a given hydrate.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.8bb, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Covalent Bonds and Molecular Forces**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Describe how covalent bonds form.
- Compare polar and nonpolar covalent bonds.
- Use electronegativity differences to determine bond type.
- Draw Lewis dot structures.
- Predict molecular shape based on Lewis structure and VSEPR theory.
- Associate polarity of molecules with shape.
- Relate boiling points to shapes and polarities.
- Describe types of intermolecular forces.
- Describe effects of hydrogen bonds on melting and boiling points.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6gg, 7.6hh, 7.8bb, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Carbon and Organic Compounds**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Describe the bonding properties of carbon.
- Recognize and draw structural formulas for isomers of alkanes, alkenes, and alkynes.
- Relate structures of allotropes to properties of carbon.
- Name and draw structural formulas for simple organic compounds.
- Describe how polymers form.
- Describe properties of different polymer types.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6hh, 7.7j

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: The Mole**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Define the mole.
- Use the periodic table to determine relative atomic mass.
- Use relative atomic mass to determine molar mass.
- Use the factor label method to convert grams to moles, moles to grams.
- Use molar masses to determine percent composition, given a formula.
- Determine an empirical formula, given percent composition.
- Determine an empirical formula from laboratory procedures and data.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6-2.9, 3.3, 3.10-3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.7j, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Chemical Equations**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Translate word equations into formula equations.
- Distinguish between coefficients and subscripts in writing equations.
- Balance chemical equations.
- Interpret equations in terms of ratios and energy terms.
- Calculate energy changes using mole ratios and enthalpies.
- Define and recognize basic chemical reaction types.
- Identify unknown ions by comparison of precipitation reactions.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6, 2.9, 3.3

### **Related Standards**

7.6gg, 7.6hh, 7.7ddd, 7.7ff7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Stoichiometry**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Quantitatively apply ideal gas laws; understand concept of gas density.

### **Evidence of Learning**

The student will:

- Recognize and use mass relationships represented in chemical equations.
- Use mole ratios and molar masses to solve stoichiometric problems.
- Expand use of conversion factors in stoichiometry to include gas properties.
- Identify and use concept of limiting reactants.
- Determine percent yield in a chemical reaction.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6hh, 7.7ddd, 7.7ff, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Causes of Change**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Quantitatively apply ideal gas laws; understand concept of gas density;
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Define and calculate molar heat capacity from data.
- Describe and calculate temperature and enthalpy changes when substances are heated.
- Calculate molar enthalpy from laboratory data.
- Describe melting and boiling point curves and their significance.
- Define entropy and recognize increases and decreases in entropy.
- Describe effects of melting and boiling on enthalpy and entropy.
- Describe the link between nutrition and calorimetry.
- Define molar heat of fusion and molar heat of vaporization.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Gases and Liquids**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- ccc. Quantitatively apply ideal gas laws; understand concept of gas density;
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Describe the general properties of gases.
- Relate the kinetic-molecular theory to the properties of ideal gases.
- Define and use the relationship between pressure and volume for gases.
- Define and use Dalton's Law of Partial Pressures.
- Define and use the relationship between volume and temperature for gases.
- Define and use the combined gas law.
- Identify conditions for less than ideal behavior for gases.
- Interpret a phase diagram.
- Define boiling point in terms of vapor pressure.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Solutions**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Distinguish among solutions, suspensions and colloids.
- Explain the role of solute and solvent.
- Define molarity.
- Solve molarity problems.
- Describe techniques for separation of mixtures into components.
- Describe effects of temperature on solution rate and solubility.
- Relate how molecular polarity affects solubility.
- Define weak and strong electrolytes.
- Define and represent the hydronium ion with a formula.
- Define and describe colligative properties, qualitatively and quantitatively.
- Compare and contrast roles of emulsifiers and surfactants.
- Explain hard water and detergent use.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Chemical Equilibrium**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Distinguish between reactions that go to completion and those that reach equilibrium.
- Define chemical equilibrium.
- Predict effects of stress on equilibrium systems using Le Chatelier's Principle.
- Represent equilibrium constant expressions using concentrations or pressures of reactants and products at equilibrium.
- Calculate equilibrium constants, given concentrations.
- Interpret solubility based on the value of the solubility product constant.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Acids and Bases**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Recognize and describe the properties of strong and weak acids and bases.
- Explain the conductivity of acids and bases.
- Describe and explain the concept of titration.
- Define the ion product constant of water and use it to determine the concentration of hydronium or hydroxide ions.
- State the Bronsted-Lowery definition of acids and bases.
- Differentiate among mono-, di-, and triprotic acids.
- Write equations showing reactions of amphoteric substances.
- Identify conjugate acid / base pairs.
- Perform calculations using the equilibrium constant of an acid.
- Define pH.
- Understand the relationship between pH and the hydronium ion concentration.
- Describe methods of measuring pH.
- Define buffers and describe how buffers resist pH change.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Reaction Rates**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions).

### **Evidence of Learning**

The student will:

- Describe reaction rate in terms of reactant disappearance or product appearance.
- Describe the effect of temperature on reaction rate.
- Describe the effect of concentration on reaction rate.
- Describe the effect of surface area on reaction rate.
- Describe the effect of catalysts on rate.
- Define activation of energy and describe how a catalyst affects activation energy.
- Explain the mechanism of enzyme action in terms of bonds and energy
- Define and give an example of an inhibitor.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: CHEMISTRY - GRADES 11/12**

## **Unit: Electrochemistry**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties.

### **Evidence of Learning**

The student will:

- Describe the relationship between voltage and current.
- Convert voltage and convert to energy.
- Distinguish between anodic and cathodic reactions.
- Define electrode, anode, and cathode.
- Explain the difference between electrolytic, galvanic and equilibrium cells.
- Recognize oxidation / reduction reactions.
- Determine the relative strengths of oxidizing and reducing agents.
- Explain how reactions can be driven by electrolytic cells.
- Describe the electrolytic processes.
- Describe the conditions leading to corrosion and ways to prevent it.
- Predict the direction of cell reactions and explain reactions in terms of electron transfers using standard electrode potentials.

### **Vital Results**

1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.20, 2.1, 2.2, 2.3, 2.5, 2.5, 2.6, 2.9, 3.3, 3.10, 3.12

### **Related Standards**

7.6bbb, 7.6gg, 7.6hh, 7.7ddd, 7.7ff, 7.7j, 7.8bb, 7.8cc, 7.10aa

# **COURSE: PHYSICS - GRADE 12**

## **Unit: Motion, Force, Energy, and Momentum**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- d. Apply forces to objects (e.g. inertia, gravity, friction, push and pull), and observe the objects in motion;
- dd. Observe and demonstrate a qualitative understanding of the relationship between mass, the magnitude of an applied net force, and the resulting change in speed and direction;
- ddd. Use Newton's laws to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion;
- e. Identify and describe several common forms of energy (e.g. light, heat, and sound) and provide examples of sources, as well as some characteristics of the transmission (e.g. light travels in straight lines until it is reflected, refracted, or absorbed);
- ee. Identify and describe common forms of energy (e.g. light, heat, sound, electricity, electromagnetic waves) and their attributes, sources, and transmission characteristic (e.g. radiation, convection, conduction of heat);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).

### **VT Standard 7.15**

Students demonstrate understanding of the earth and its environment, the solar system, and the universe in terms of the systems that characterize them, the forces that affect and shape them over time, and the theories that currently explain their evolution. This is evident when students:

- d. Identify and record characteristics of our solar system (e.g. nine planets, order from sun, and movement of planets in relationship to the sun and moon; calendar);
- dd. Identify, record, model, and explain the relationship of our solar system to the universe (day, year, season; sun, stars, galaxies; gravity, energy, orbits; planet characteristics);
- ddd. Identify, model, and explain the position of our solar system in the universe relative to distance and time (stars and star systems, fusion, instrumentation, and simulations; the universe as a hierarchy of interrelated systems);
- f. Explain how modern view of the universe emerged (e.g. scientific theories, improved instrumentation);
- ff. Explain the emergence of modern views of the universe (past, present and future scientific theories).

### **Evidence of Learning**

The student will:

- Describe uniform motion graphically qualitatively using the equation  $s = vt$ .
- Understand how uniformly accelerated motion differs from uniform motion.
- Learn equations for accelerated motion, and how to apply them in different situations.
- Learn the techniques of area finding and slope-finding as they apply to motion graphs.
- Understand when to apply “tangent to curve” technique to find instantaneous velocity.
- Understand instantaneous velocity using the “limit” concept.
- Learn the difference between vector quantities and scalar quantities.
- Describe vector diagrams in terms of components and resultant; use scale properly.
- Recognize that energy can be transformed from one type to another, and one place to another.

- List a wide variety of examples in which Law of Conservation of Energy apply.
- Demonstrate in the lab that work is done when a force acts through a distance.
- Calculate Input and Output values for work and energy.
- Compare changes in potential energy to changes in kinetic energy.
- Calculate, using equations for PE and KE.
- Recognize that relativistic mass is a different number than rest mass, and that mass depends on relative velocity.
- Recognize that Einstein's interpretation broadens the Energy Conservation Law to include mass as well.
- Perform basic relativistic calculations.
- Examine the difference between "force causes motion" and "force causes acceleration."
- State Newton's Laws of Motion, and be able to identify them in action, from a broad variety of examples.
- Recognize weight as a force, and distinguish weight from mass.
- Solve problems using  $F = ma$ , with emphasis on the overall, or "net" force.
- Understand the meaning of "g" at surface of Earth and elsewhere.
- Recognize that, in a system of two bodies, the action/reaction pair of forces act on different bodies.
- Recognize what is meant by a frame of reference (observer: stationary frame).
- Recognize a limitation of Newton's Laws: they are valid in "inertial" reference frame (non-accelerated).
- Derive the "impulse = change in momentum" relationship from Newton's Second Law.
- Recognize that Force can now be defined as the time rate of change of momentum, or the derivative of momentum.
- Calculate using the Conservation of Momentum principle; two objects, linear motion.
- Demonstrate momentum conservation in the lab, for motions in both one and two planes.
- Solve problems using the " $p$  (before) =  $p$  (after)" method.
- Identify the center of mass of a uniform linear object (rod), or a more complicated object.
- Identify the moving center of mass of two objects before and after their collision.
- Identify collisions that are "elastic" (no lost KE), as well as "inelastic" (some KE lost to heat or permanent deformation).
- Recognize the Conservation Laws (Energy and Momentum) as fundamental, and applicable to modern as well as classical physics.
- Understand that the curved path of a projectile is the result of the force of gravity continually acting on it.
- Map out the entire path of a projectile, given initial conditions.
- Understand orbital motion as a special type of projectile motion.
- Demonstrate that constant force perpendicular to instantaneous velocity causes circular motion.
- Recognize that centripetal acceleration is directed toward the center of a circle, as is the force, which caused the acceleration.
- Note that gravitational force often acts as centripetal force (e.g. planetary motion).
- Recognize that Kepler's Laws of Planetary Motion act as a precursor to Newton's Law of Universal Gravitation.
- Calculate the mass of a central object, which has one or more satellites orbiting about it.
- Be able to quickly calculate the gravitational force on an object that is moving away from a much more massive object, using the inverse square relationship between force and distance.
- Understand the concept of the gravitational field surrounding a massive object, and its relationship to acceleration.
- Distinguish between "apparent weight" and actual weight, especially for objects in orbit.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.6, 1.8, 1.10, 1.11, 1.13, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 3.3, 3.10, 3.11, 3.15

### **Related Standards**

7.5a, 7.5aa, 7.6a, b, c, d, e, f, g, h, 7.6aa, bb, cc, ff, gg, hh, 7.6aaa, bbb, 7.7a, g, 7.7cc, dd, ee, ff, 7.7aaa, bbb, ccc, ddd, 7.8b, c, e, 7.8aa, bb, cc, 7.8aaa, bbb, ccc, ddd, 7.9a, b, 7.10a, b, c, d, e, f, g, 7.10aa, bb, cc, dd, ee, 7.10bbb, 7.11a, b, c, aa

# **COURSE: PHYSICS - GRADE 12**

## **Unit: Waves, Sound, and Light**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- d. Apply forces to objects (e.g. inertia, gravity, friction, push and pull), and observe the objects in motion;
- dd. Observe and demonstrate a qualitative understanding of the relationship between mass, the magnitude of an applied net force, and the resulting change in speed and direction;
- ddd. Use Newton's laws to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion;
- e. Identify and describe several common forms of energy (e.g. light, heat, and sound) and provide examples of sources, as well as some characteristics of the transmission (e.g. light travels in straight lines until it is reflected, refracted, or absorbed);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation of energy; and understand that light and some particles have wave and particle properties (diffraction).

### **Evidence of Learning**

The student will:

- Understand that the restoring force in SHM is proportional to distance.
- Recognize Hooke's Law as a special case of Newton's 2<sup>nd</sup> Law.
- Distinguish between period and frequency.
- Note the connections among linear, circular, and vibrating motion.
- Solve problems involving position and velocity of vibrating motion, using sine and cosine functions.
- Understand the relationship between KE and PE in vibrating motion.
- Develop clear understanding of basic terminology: wavelength, frequency, period, amplitude, angular frequency, phase, interference, reflection, refraction, diffraction.
- Predict period of pendulum or spring by using period equation.
- Recognize that all of the various types of waves are propagations of a disturbance.
- Note difference between longitudinal and transverse waves.
- Understand how wave speed is affected by density of medium.
- Understand that waves transmit energy.
- Be able to solve problems using the velocity = wavelength X frequency equation.
- Demonstrate, using a diagram, how superposition allows waves to be added.
- Understand interference in the context of superposition.
- Be able to recognize a standing wave, and to identify the nodes or nodal lines.
- Understand the connection between pitch and frequency.
- Recognize that sound will travel through matter of different phases, but not a vacuum.
- Understand how sounding boards and boxes can amplify sound.
- Be able to explain the phenomenon of beats.
- Recognize the phenomenon of resonance, and understand that it depends on the concept of the natural frequency of an object.
- Understand the decibel scale as a power of ten scale, and be able to use a table of decibel values.
- Describe color in terms of wavelength or frequency.
- Understand a light ray as the direction of propagation of the light wave.
- Recognize that the bending of light or other waves around obstacles is dependent on wavelength.

- Understand that the angle of incidence for light reflected from a smooth surface is equal to the angle of reflection.
- Understand refraction as a consequence of change of speed of light.
- Be able to use Snell's Law to find the critical angle for a pair of substances.
- Understand that the lenses are based on the principle of refraction of light.
- Be able to find focal lengths of lenses and curved mirrors.
- Understand the difference between real and virtual images.
- Understand Young's experiment in the context of the wave model of light.
- Be able to relate interference patterns in a ripple tank to patterns for light.
- Recognize diffraction as an effect due to interference.
- Understand diffraction and interference as common wave phenomena that occur in water waves, sound waves, visible light waves, and electromagnetic waves other than visible light.
- Recognize that light reflected off a boundary can undergo a  $180^\circ$  phase change, equivalent to additional  $\frac{1}{2} \lambda$  of path difference.
- Understand how a Michelson interferometer uses path and interference fringes to make measurements.
- Understand how diffraction gratings, spectroscopes, and spectrometers can make sharp spectral lines that can be understood as resulting from constructive interference.
- Be able to explain polarization of light.

### **Vital Results**

1.2, 1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.18, 1.20, 1.22, 2.1-2.3, 2.5-2.9, 3.3, 3.10, 3.11

### **Related Standards**

7.6a, b, c, d, e, f, g, 7.6aa, bb, cc, dd, ee, ff, gg, 7.6aaa, bbb, 7.7a, b, d, e, f, g, h, I, j, 7.7cc, dd, ee, ff, 7.6aaa, bbb, ccc, ddd, 7.9a, b, 7.10a, b, c, d, 7.10aa, bb, cc, dd, 7.11a

# **COURSE: PHYSICS - GRADE 12**

## **Unit: Electricity, Magnetism, and E-M Radiation**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- ddd. Use Newton's laws to explain quantitatively the effects of applied forces; observe, explain, and model object motion in a plane; qualitatively investigate conservation of momentum as it relates to collisions, and investigate the mechanics of rolling motion;
- f. Observe and record the effects of electric charge (e.g. charges repel, batteries); investigate magnetic and non-magnetic materials, and materials that are conductors and non-conductors of electricity;
- ff. Investigate the relationship between electricity and magnetism (e.g., in electric motors);
- fff. Understand that alternating magnetic fields generate electric fields, and vice versa (e.g. radio waves, x-rays).

### **Evidence of Learning**

The student will:

- Distinguish between charges at rest and charges in motion.
- Be able to give evidence to support the idea of different types of charge.
- Understand why conductors allow charges to flow more easily than insulators.
- Understand the reason that a Faraday cage limits excess charge to the outside of the cage.
- Relate Coulomb's Law to the Law of Universal Gravitation.
- Recognize that there is a fundamental amount of charge, and that we normally encounter integer multiples of that amount.
- Understand that current can refer to the movement of electrons in wires, as well as the movement of ions in solution.
- Understand that pressure difference in a fluid system is analogous to voltage difference in an electrical system.
- Be able to construct circuits and make measurements with voltmeters and ammeters.
- Understand the concept of resistance as both a way to limit the current by allowing electrical energy to dissipate as heat and as the ratio of voltage to current.
- Understand how Joule's Law relates resistance, power, and current.
- Perform experiments in which mechanical energy changes can be compared to electrical energy changes.
- Be able to apply Ohm's Law to series and parallel circuits.
- Understand the difference between resistance and resistivity.
- Understand the meaning of electric field both as space around a charged object and as a ratio of force per charge.
- Recognize that voltage must decrease as one moves away from the source of the charge.
- Understand the device called the capacitor as an application of our understanding of the field.
- Understand how capacitors are used in circuits, and the difference encountered when they are wired in a series as compared to parallel.
- Understand how resistors are used in circuits, and the difference encountered when they are wired in a series as compared to parallel.
- Be able to solve problems, on paper and with breadboard circuits, in which combinations of resistors are used.
- Understand that charge is a conserved quantity.
- Recognize that voltmeters and ammeters (analog type) rely on the magnetic effect of moving charges to produce a force proportional to the current or voltage.
- Understand that charged particles moving in a magnetic field can be deflected.
- Be able to solve for the strength of a magnetic field by understanding that it depends on the force per moving charge.

- Recognize that the Earth’s magnetic field can be drawn as field lines, with directionality, on and within the globe.
- Understand that a voltage can be induced in a conductor that is moved across a magnetic field.
- Understand Lenz’s Law as a consequence of the Law of Conservation of Energy.
- Understand the principles governing the operation of motors, generators, and transformers.
- Understand that electric power is the product of voltage and current.
- Recognize power outputs of primary and secondary coils as the result of energy conservation.
- Be able to determine that electromagnetic induction takes place only when a voltage is changing.
- Understand why transformers are used to send electric energy long distances over transmission lines.
- Understand how coils used in AC circuits can be described in terms of their inductance, reactance, resistance, and impedance.
- Examine the characteristics of solid-state diodes in circuits.
- Understand the concept of rectification at both the circuit and the semi-conductor junction levels.
- Understand how a transistor can amplify a current.
- Understand the basic structure of an IC.
- Recognize IC’s in circuit boards of calculators and computers.
- Understand that electric oscillations are analogous to mechanical oscillations of a spring.
- Use LC circuits to produce electric oscillations.
- Understand that a changing electric field (such as produced by an AC circuit) can give rise to a changing magnetic field, and vice versa.
- Understand how the interaction between electric and magnetic fields can produce a self-propagating wave, with no need for a medium, and with no loss of energy through empty space.

### **Vital Results**

1.2, 1.3, 1.6, 1.8, 1.13, 1.15, 1.17, 1.18, 1.20, 1.22, 2.1-2.3, 2.5-2.9, 3.3, 3.10

### **Related Standards**

7.6a, b, c, d, e, f, g, h, 7.6aa, bb, cc, dd, ee, ff, gg, 7.7a, b, c, d, e, f, g, h, j, 7.8b, c, e, 7.8bb, cc, 7.8bbb, ccc, ddd, 7.9a, b, 7.10a, b, c, d, e, f, 7.10bb, cc, dd, 7.11a, 7.17a, b, c, 7.18a, b, c, d, 7.19a, b, 7.19aa, bb, 7.19aaa, bbb

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Chemistry of Life**

### **VT Standard 7.12**

Students understand forces and motion, the properties and composition of matter, and energy sources and transformations. This is evident when students:

- aaa. Observe and measure characteristic properties of, and chemical reactions between, one substance and another to distinguish between them; explain the structure of matter using the periodic properties of elements;
- bbb. Demonstrate an understanding of the atomic structure of matter in relationship to the periodic table, bonding, elements and compounds; demonstrate an understanding of the conservation of matter; understand how radioactive elements decay (e.g., half life, alpha and beta emissions);
- eee. Provide examples of transformations of energy from one form to another; provide examples of conservation energy; and understand that light and some particles have wave and particle properties (diffraction).

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms, both as individual entities and as components of larger systems;
- ccc. Describe, model, and explain the principles of the interdependence of all systems that support life.

### **Evidence of Learning**

The student will:

- Understand the principles of general chemistry.
- Understand that living things are open energy systems.
- Understand that increasing levels of organization and complexity yield “emergent properties” associated with life.
- Understand that polarity of water molecules results in hydrogen bonding.
- Understand that organisms depend on the properties of water.
- Consider evolution in relation to the fitness of the environment.
- Understand the general principles of organic chemistry.
- Understand carbon atoms as versatile building blocks, variations in carbon skeletons and isomers.
- Recognize the functional groups, hydroxyl, carbonyl, carboxyl, amino, sulfhydryl, and phosphate.
- Understand life’s metabolic pathways, metabolic regulatory systems and structural organization.
- Understand life’s energy transformations and the laws of thermodynamics.
- Understand the chemistry of enzymes.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.20, 1.21, 1.22

### **Related Standards**

7.11aa, bb, cc, 7.11aaa

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Structure and Function of Cells**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms, both as individual entities and as components of larger systems;
- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g. chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **Evidence of Learning**

The student will:

- Survey cell organelles, structure and function.
- Compare cellular organization of plants and animals.
- Understand that the cell is a living unit greater than the sum of its parts.
- Understand the upper and lower limits to cell size.
- Use the technology and techniques of microscopy.
- Understand the cell membrane and the physics and chemistry of cell transport, diffusion, osmosis, active and passive transport.
- Understand the structure and function of transport proteins.
- Understand the historical perspective on the development of the fluid mosaic model of membrane structure.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3

### **Related Standards**

7.6aaa, bbb, ff, gg, hh, i, j

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: The Reproduction of Cells**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aa. Identify, model, and explain the structure and function (e.g. cells, tissues, organs, systems) of organisms, both as individual entities and as components of larger systems;
- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms (plants, animals, microorganisms) and the structures and functions of the cell (e.g. chemical reactions, diffusion of materials, direction by DNA of the synthesis of proteins, regulation, differentiation).

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

- aa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g. gene mutations, gene combinations);
- bb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce;
- cc. Analyze and describe how the health of human beings is affected by disease passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Understand cell division in functions in reproduction, growth and repair.
- Understand mitosis, genome of eukaryotes, stages of cell division.
- Understand cytokinesis.
- Understand internal and external cues for the control of cell division.
- Compare cancer to normal cell division.
- Understand meiosis.
- Compare asexual and sexual reproduction.
- Understand three sexual life cycles: sexual, asexual, and alternation of generations.
- Understand genetic variation and sexual life cycles (independent assortment, crossing over, and random fertilization).
- Understand evolutionary adaptation and cellular reproduction.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.6aaa, bbb, ff, gg, hh, i, j

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Independent Research Project**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life.

### **Evidence of Learning**

The student will:

- Demonstrate principles of the scientific method.
- Integrate many branches of specialized science and mathematics in solving problems in biology.

### **Vital Results**

1.5, 1.6, 1.8, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.2, 2.3, 2.4, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 2.14, 3.1, 3.2, 3.7, 3.14

### **Related Standards**

1.6aa, 1.8g, h, 1.17aa, bb, cc, aaa, bbb, ccc, dd, 2.2aa, bb, cc, dd, ee, aaa, 2.3aa, bb, aaa, bbb, c, 2.4a, b, c, d, e, f, 2.14a, b, c, 3.7c, d, e, f, cc, 3.14b, dd

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Cellular Respiration and Photosynthesis**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms).

### **Evidence of Learning**

The student will:

- Understand cellular respiration and photosynthesis as the primary energy yielding pathways in living things.
- Give an evolutionary overview of cellular respiration, fermentation, and photosynthesis.
- Compare the structure and function of mitochondria and chloroplasts.
- Understand redox reactions from released energy when electrons move closer to electronegative atoms.
- Understand glycolysis, Krebs cycle, and electron transport.
- Understand that catabolism/anabolism and that respiration has connections to many metabolic pathways.
- Understand photosynthesis as a redox process.
- Describe photosynthesis, light reactions, and Calvin Cycle.
- Describe the pigments of photosynthesis.
- Understand photosystems I and II.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.11a, bb, cc, aaa, bbb, 7.12ee, bbb, eee

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Molecular Basis of Inheritance, Gene Expression, and Biotechnology**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms);
- ccc. Describe, model, and explain the principles of the interdependence of all systems that support life (e.g. flow of energy, ecosystems, life cycles, cooperation and competition, human population impacts on the world ecological system), and apply to local, regional, and global systems; and
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

- aa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g. gene mutations, gene combinations);
- bb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce;
- cc. Analyze and describe how the health of human beings is affected by disease passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems;
- dd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Understand the search for genetic material that led to DNA.
- Understand evidence that DNA can transform bacteria.
- Understand that viral DNA can transform cells.
- Understand the evidence that DNA is the genetic material in cells.
- Recognize the significance of a common genetic language.
- Understand DNA structure and replication.
- Understand enzymes that proofread DNA and control mutations.
- Understand DNA/RNA and protein synthesis, transcription and translation.
- Understand how genes control metabolism.
- Compare gene expression in prokaryotes and eukaryotes.
- Understand operons, transposons and signal sequences in genes.
- Compare genomes in viruses, bacteria, and eukaryotes.
- Understand the basic principles of gel electrophoresis.
- Understand methods, techniques, and prospects for biotechnology, PCR, gene therapy, and genetic engineering.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.5aaa, 7.7aaa, bbb, ccc, ddd, eee, ff, h, i, j, 7.11aaa, 7.12fff, 7.18aaa, d, 7.19a, aaa, bbb

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Genetics**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- aaa. Demonstrate understanding of the uniqueness of the cell in different organisms and the structures and functions of cells.

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

- aa. Explain and model how information passed from parents to offspring is coded in DNA molecules (e.g. gene mutations, gene combinations);
- cc. Analyze and describe how the health of human beings is affected by disease passed through DNA, environmental factors, and activities that deliberately or inadvertently alter the equilibrium in ecosystems.

### **Evidence of Learning**

The student will:

- Describe Mendel's laws and how he derived them.
- Understand that genetics depend on the laws of chance.
- Understand modes of inheritance: co-dominance, multiple alleles, pleiotropy, epistasis, polygenic inheritance.
- Understand pedigree analysis.
- Compare nature and nurture.
- Understand Morgan and the chromosome theory of inheritance.
- Understand linked traits.
- Map chromosomes using the frequency of crossing over among linked traits.
- Understand chromosomes and the inheritance of sex.
- Describe sex-linked disorders in humans.
- Describe human chromosomal alternations and disorders.
- Understand drosophila inheritance.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.5aaa, 7.9aaa, bbb, ccc, ddd, ee

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Evolution**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

- bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms);
- ddd. Explain and justify how natural selection and its evolutionary consequences provide a scientific explanation for the fossil record of ancient life forms.

### **Evidence of Learning**

The student will:

- Understand descent with modification, Natural Selection.
- Compare Charles Darwin and Lamarck.
- Describe biogeography.
- Understand microevolution.
- Understand punctuated equilibrium and population genetics.
- Describe the Hardy-Weinberg theorem; Darwin and Mendel.
- Understand gene flow, mutations, nonrandom mating, and genetic drift.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10

### **Related Standards**

7.5aaa, 7.6, 7.7aaa, bbb, ccc, ddd, eee, ff, h, i, j, 7.11aaa, 7.12fff, 7.18aaa, d, 7.19a, aaa, bbb

# **COURSE: BIOLOGY II - GRADE 12**

## **Unit: Structure and Function in Organisms**

### **VT Standard 7.13**

Students understand the characteristics of organisms, see patterns of similarity and differences among living organisms, understand the role of evolution, and recognize the interdependence of all systems that support life. This is evident when students:

bbb. Demonstrate understanding of how biological organisms are classified into a hierarchy of groups and subgroups based upon similarities that reflect their evolutionary relationships (e.g. plants, animals, microorganisms).

### **VT Standard 7.14**

Students demonstrate understanding of the human body – heredity, body systems, and individual development – and understand the impact of the environment on the human body. This is evident when students:

bb. Demonstrate an understanding that human beings have complex biochemical systems that enable them to function and reproduce;

dd. Identify, explain, and analyze the pattern of human development.

### **Evidence of Learning**

The student will:

- Understand that living organisms are open energy systems.
- Understand how structures complement function.
- Describe tissues, organs, and the organ system.
- Understand that Body Plans differ, survival problems do not.
- Compare the major organ systems among several groups of vertebrates.
- Compare the physiology of plants and animals emphasizing commonality in function and diversity in structure.
- Describe systems of self-defense.
- Understand immunity to disease.

### **Vital Results**

1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.8, 1.10, 1.13, 1.14, 1.15, 1.17, 1.18, 1.19, 1.20, 1.21, 1.22, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.9, 2.14, 3.10