Environmental Literacy Components: Voluntary State Curriculum for Science

Skills and Processes of Science*

Grades K – 2	Grades 3 – 5	Grades 6 – 8	Grades 9 – 12 (Goal 1)
PreKindergarten – Grade 2 A. Constructing Knowledge 1. **Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out.** a. Describe what can be learned about things by just observing those things carefully and adding information by sometimes doing something to the things and noting what happens. b. Seek information through reading, observation, exploration, and investigations. c. Use tools such as thermometers, magnifiers, rulers, or balances to extend their senses and gather data. d. Explain that when a science investigation is done the way it was done before, we expect to get a very similar result. e. Participate in multiple experiences to verify that science investigations generally work the same way in different places. f. Suggest things that you could do to find answers to questions raised by observing objects and/or phenomena (events such as, water disappearing from the classroom aquarium or a pet's water bowl). g. Use whole numbers and simple, everyday fractions in ordering, counting, identifying, measuring, and describing things and experiences.	Grades 3 -5 A. Constructing Knowledge 1**. Gather and question data from many different forms of s**cientific investigations **which include reviewing appropriate print resources, observing what things are like** **or what is happening somewhere, collecting specimens for analysis, and doing** **experiments.** a. Support investigative findings with data found in books, articles, and databases, and identify the sources used and expect others to do the same. b. Select and use appropriate tools hand lens or microscope (magnifiers), centimeter ruler (length), spring scale (weight), balance (mass), Celsius thermometer (temperature), graduated cylinder (liquid volume), and stopwatch (elapsed time) to augment observations of objects, events, and processes. c. Explain that comparisons of data might not be fair because some conditions are not kept the same. d. Recognize that the results of scientific investigations are seldom exactly the same, and when the differences are large, it is important to try to figure out why. e. Follow directions carefully and keep accurate records of one's work in order to compare data gathered. f. Identify possible reasons for differences in results from investigations including unexpected differences in the methods used or in the circumstances in which the investigation is carried out, and sometimes just because of uncertainties in observations. g. Judge whether measurements and computations of quantities are reasonable in a familiar context by comparing them to typical values	Grades 6-8 A. Constructing Knowledge 1. **Design, analyze, or carry out simple investigations and formulate appropriate** **conclusions based on data obtained or provided.** a. Explain that scientists differ greatly in what phenomena they study and how they go about their work. b. Develop the ability to clarify questions and direct them toward objects and phenomena that can be described, explained, or predicted by scientific investigations. c. Explain and provide examples that all hypotheses are valuable, even if they turn out not to be true, if they lead to fruitful investigations. d. Locate information in reference books, back issues of newspapers, magazines and compact disks, and computer databases. e. Explain that if more than one variable changes at the same time in an investigation, the outcome of the investigation may not be clearly attributable to any one of the variables. f. Give examples of when further studies of the question being investigated may be necessary. g. Give reasons for the importance of waiting until an investigation has been repeated many times before accepting the results as correct. h. Use mathematics to interpret and communicate data. i. Explain why accurate record-keeping, openness, and replication are essential for maintaining an investigator's credibility with other scientists and society.	**Goal 1** **2. *Expectation*: *The student will pose scientific questions and suggest investigative approaches to provide answers to questions.*** ***Assessment Limits/Indicators*** (1) The student will identify meaningful, answerable scientific questions. (2)[NTB] The student will pose meaningful answerable scientific (3) The student will formulate a working hypothesis. (4) [NTB] The student will test a working hypothesis. (5) The student will select appropriate instruments and materials to conduct an investigation. (6) The student will identify appropriate methods for conducting an investigation (independent and dependent variables, proper controls, repeat trials, appropriate sample size, etc.). (7) The student will use relationships discovered in the lab to explain phenomena observed outside the laboratory. (8) The student will defend the need for verifiable data. **3. *Expectation*: *The student will carry out scientific investigations effectively and employ the instruments, systems of measurement, and materials of science appropriately.*** ***Assessment Limits/Indicators*** (1) [NTB] The student will develop and demonstrate skills in using lab and field equipment to perform investigative techniques. (2) The student will recognize safe laboratory procedures. (3) [NTB] The student will demonstrate safe handling of the chemicals and materials of science. (4) [NTB] The student will learn the use of new instruments and equipment by following instructions in a manual or from oral direction.
B. Applying Evidence and Reasoning 1. **People are more likely to believe your ideas if you can give good reasons for them.** a. Provide reasons for accepting or rejecting ideas examined. b. Develop reasonable explanations for observations made, investigations completed, and information gained by sharing ideas and listening to others' ideas. c. Explain why it is important to make some fresh observations when people give different descriptions of the same thing.	B. Applying Evidence and Reasoning 1. **Seek better reasons for believing something than "Everybody knows that . . ." or** **"I just know" and discount such reasons when given by others.** a. Develop explanations using knowledge possessed and evidence from observations, reliable print resources, and investigations. b. Offer reasons for their findings and consider reasons suggested by others. c. Review different explanations for the same set of observations and make more observations to resolve the differences. d. Keep a notebook that describes observations made, carefully distinguishes actual observations from ideas and speculations about what was observed, and is understandable weeks or months later.	B. Applying Evidence and Reasoning 1. **Review data from a simple experiment, summarize the data, and construct a logical argument about the cause-and-effect relationships in the experiment**. a. Verify the idea that there is no fixed set of steps all scientists follow, scientific investigations usually involve the collection of relevant evidence, the use of logical reasoning, and the application of imagination in devising hypotheses and explanations to make sense of the collected evidence. b. Explain that what people expect to observe often affects what they actually do observe and that scientists know about this danger to objectivity and take steps to try to avoid it when designing investigations and examining data. c. Explain that even though different explanations are given for the same evidence, it is not always possible to tell which one is correct. d. Describe the reasoning that lead to the interpretation of data and conclusions drawn. e. Question claims based on vague statements or on statements made by people outside their area of expertise.	**1. *Expectation*: *The student will explain why curiosity, honesty, openness, and skepticism are highly regarded in science.*** ***Assessment Limits/Indicators*** (1) The student will recognize that real problems have more than one solution and decisions to accept one solution over another are made on the basis of many issues. (2) The student will modify or affirm scientific ideas according to accumulated evidence. (3) The student will critique arguments that are based on faulty, misleading data or on the incomplete use of numbers. (4) The student will recognize data that are biased. (5) The student will explain factors that produce biased data (incomplete data, using data inappropriately, conflicts of interest, etc.).

***Environmental literacy connections can be made in every grade and science course through the Skills and Processes of Science.**

Environmental Literacy Components: Voluntary State Curriculum for Science

Skills and Processes of Science*

Grades K – 2

C. Communicating Scientific Information
1. **Ask ,"How do you know?" in appropriate situations and attempt reasonable answers when others ask them the same question.**
a. Describe things as accurately as possible and compare observations with those of others.
b. Describe and compare things in terms of number, shape, texture, size, weight, color, and motion.
c. Draw pictures that correctly portray at least some features of the thing being described and sequence events (seasons, seed growth).
d. Have opportunities to work with a team, share findings with others, and recognize that all team members should reach their own conclusions about what the findings mean.
e. Recognize that everybody can do science and invent things and ideas.

Grades 3 – 5

C. Communicating Scientific Information
1. **Recognize that clear communication is an essential part of doing science because it enables scientists to inform others about their work, expose their ideas to criticism by other scientists, and stay informed about scientific discoveries around the world.**
a. Make use of and analyze models, such as tables and graphs to summarize and interpret data.
b. Avoid choosing and reporting only the data that show what is expected by the person doing the choosing.
c. Submit work to the critique of others which involves discussing findings, posing questions, and challenging statements to clarify ideas.
d. Construct and share reasonable explanations for questions asked.
e. Recognize that doing science involves many different kinds of work and engages men and women of all ages and backgrounds.

Grades 6 – 8

C. Communicating Scientific Information
1. **Develop explanations that explicitly link data from investigations conducted, selected readings and, when appropriate, contributions from historical discoveries.**
a. Organize and present data in tables and graphs and identify relationships they reveal.
b. Interpret tables and graphs produced by others and describe in words the relationships they show.
c. Give examples of how scientific knowledge is subject to modification as new information challenges prevailing theories and as a new theory leads to looking at old observations in a new way.
d. Criticize the reasoning in arguments in which
• Fact and opinion are intermingled
• Conclusions do not follow logically from the evidence given.
• Existence of control groups and the relationship to experimental groups is not made obvious**.**
• Samples are too small, biased, or not representative.
e. Explain how different models can be used to represent the same thing. What kind of a model to use and how complex it should be depend on its purpose. Choosing a useful model is one of the instances in which intuition and creativity come into play in science, mathematics, and engineering
f. Participate in group discussions on scientific topics by restating or summarizing accurately what others have said, asking for clarification or elaboration, and expressing alternative positions.
g. Recognize that important contributions to the advancement of science, mathematics, and technology have been made by different kinds of people, in different cultures, at different times.

Grades 9 – 12 (Goal 1)

4. *<u>Expectation</u>: The student will demonstrate that data analysis is a vital aspect of the process of scientific inquiry and communication.*

<u>Assessment Limits/Indicators</u>

(1) The student will organize data appropriately using techniques such as tables, graphs, and webs. (for graphs: axes labeled with appropriate quantities, appropriate units on axes, axes labeled with appropriate intervals, independent and dependent variables on correct axes, appropriate title)
(2) The student will analyze data to make predictions, decisions, or draw conclusions.
(3) The student will use experimental data from various investigators to validate results.
(4) The student will determine the relationships between quantities and develop the mathematical model that describes these relationships.
(5) The student will check graphs to determine that they do not misrepresent results.
(6) The student will describe trends revealed by data.
(7) The student will determine the sources of error that limit the accuracy or precision of experimental results.
(8) NTB The student will use models and computer simulations to extend his/her understanding of scientific concepts.
(9) The student will use analyzed data to confirm, modify, or reject a hypothesis.

5. *<u>Expectation</u>: The student will use appropriate methods for communicating in writing and orally the processes and results of scientific investigation.*

<u>Assessment Limits/Indicators</u>

(1) The student will demonstrate the ability to summarize data (measurements/observations).
(2) The student will explain scientific concepts and processes through drawing, writing, and/or oral communication.
(3) NTB The student will use computers and/or graphing calculators to produce the visual materials (tables, graphs, and spreadsheets) that will be used for communicating results.
(4) The student will use tables, graphs, and displays to support arguments and claims in both written and oral communication.
(5) The student will create and/or interpret graphics. (scale drawings, photographs, digital images, field of view, etc.)
(6) The student will read a technical selection and interpret it appropriately.
(7) The student will use, explain, and/or construct various classification systems.
(8) The student will describe similarities and differences when explaining concepts and/or principles.
(9) The student will communicate conclusions derived through a synthesis of ideas.

7. *<u>Expectation</u>: The student will show that connections exist both within the various fields of science and among science and other disciplines including mathematics, social studies, language arts, fine arts, and technology.*

<u>Assessment Limits/Indicators</u>

(1) The student will apply the skills, processes and concepts of biology, chemistry, physics, or earth science to societal issues.
(2) The student will identify and evaluate the impact of scientific ideas and/or advancements in technology on society.

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<table>
<tr><th colspan="4">Earth/Space Science</th></tr>
<tr><th>Grades K – 2</th><th>Grades 3 – 5</th><th>Grades 6 – 8</th><th>Grades 9 – 12 (Goal 2)</th></tr>
<tr><td></td><td>Grade 3

E. Interactions of Hydrosphere and Atmosphere
1. Recognize and describe that water can be found as a liquid or a solid on the Earth’s surface and as a gas in the Earth’s atmosphere.
a. Describe that air is a substance that surrounds us and contains such things as oxygen, water vapor (gas), pollen, dust, etc.
b. Observe and explain what happens when liquid water disappears.
• Turns into water vapor (gas) in the air
• Can reappear as a liquid or solid when cooled, such</td><td>Grade 8
E. Interactions of Hydrosphere and Atmosphere
1. Cite evidence to explain the relationship between the hydrosphere and atmosphere.
a. Describe the composition of the atmosphere and hydrosphere.
b. Recognize and describe the water cycle as the distribution and circulation of Earth’s water through the glaciers, surface water, groundwater, oceans, and atmosphere.
c. Identify and describe how the temperature and precipitation in a geographic area are affected by surface features and changes in atmospheric and ocean content.
• Relative location of mountains
• Volcanic eruptions
• Proximity (closeness) to large bodies of water
• Heat energy of ocean currents</td><td>Goal 2
3. <u>Expectation</u>: The student will explain how the transfer of energy and matter affect Earth systems.

Indicator 1 The student will describe how energy and matter transfer affect Earth’s systems.

Assessment limits:
• Atmospheric circulation (heat transfer systems, phase change, latent heat, pressure gradients, general global circulation, Coriolis effect)
• Oceanic circulation (density differences, daily and seasonal land/sea breezes, Coriolis effect)

Indicator 2 The student will explain how global conditions are affected when natural and human-induced change alters the transfer of energy and matter.

Assessment limits:
• Atmospheric composition and structure (greenhouse gases, stratospheric ozone concentration and distribution, aerosols, temperature)
• Pollutants (particulates, tropospheric ozone concentration and distribution, acid rain)
• Ocean-atmosphere-land interactions (current changes, continental movement, El Niño, La Niña)
• Cloud cover (amount, type, albedo)
• Climate type and distribution (temperature and precipitation)
• Sea level, glaciers and sea ice, biome location and distribution, emergent and submergent coastlines</td></tr>
<tr><td></td><td>Grade 3

C. Plate Tectonics
1. Gather information and provide evidence about the physical environment, becoming familiar with the details of geological features, observing and mapping locations of hills, valleys, rivers, and canyons.
a. Identify and describe some natural features of continents.
• Mountains
• Valleys
• Rivers
• Canyons
b. Describe the natural features in their immediate outdoor environment, and compare the features with those of another region in Maryland.
c. Identify and describe some features of the ocean floor.
• Mountains
• Valleys
• Canyons
d. Recognize and explain that an ocean floor is land covered by water.

Grade 5
D. Astronomy
1. Identify and compare properties, location, and movement of celestial objects in our solar system.
b. Identify the properties of the planet Earth that make it possible for the survival of life as we know it.
• Temperature
• Location
• Presence of an atmosphere
• Presence of water (solid, liquid, and gas)</td><td></td><td></td></tr>
</table>

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Life Science, Biology			
Grades K – 2	**Grades 3 – 5**	**Grades 6 – 8**	**Grades 9 – 12 (Goal 3)**
	Life Science Grade 5 A. Diversity of Life 1. **Explain the idea that in any particular environment, some kinds of plants and animals survive well, some less well, and some cannot survive at all.** a. Identify and describe features and behaviors of some of the plants and animals living in a familiar environment and explain ways that these organisms are well suited to their environment. b. Based on information about the features and behaviors of animals and plants from very different environments describe reasons that they might not survive if their environment changed or if they were moved from one environment to another. c. State reasons why certain animals such as whales, salmon, could not survive in the Chesapeake Bay. d. Research the kind of environment needed by the Maryland blue crab, the Black-eyed Susan (Maryland's state flower), or another Maryland native organism. e. Explain that the survival of individual organisms and entire populations can be affected by sudden (flood, Tsunami) or slow (global warming, air pollution) changes in the environment.	**Environmental Science Grade 6** A. Natural Resources and Human Needs 1. **Recognize and compare how different parts of the world have varying amounts and types of natural resources and how the use of those resources impacts environmental quality.** a. Identify and describe natural resources as • Land • Fossil fuels • Forests • Water • Wind • Minerals • Wildlife b. Identify and describe the distribution of natural resources around the Earth c. Identify and describe how the natural change processes may be affected by human activities. • Agriculture • Beach preservation • Mining • Development/construction • Stream/river alteration. d. Identify and describe problems associated with obtaining, using, and distributing natural resources. e. Identify possible solutions to problems associated with obtaining, using, and distributing natural resources.	**Goal 3** **5. *Expectation*: The student will investigate the interdependence of diverse living organisms and their interactions with components of the biosphere.** Indicator 3. Investigate how natural and human-made changes in environmental conditions will affect individual organisms and the dynamics of populations. *Assessment Limits:* ▪ *depletion of food* ▪ *destruction of habitats* ▪ *disease* ▪ *natural disasters* ▪ *pollution* ▪ *population increase* ▪ *urbanization* Objectives** ➢ Use scientific data to explain that, although organisms have the capacity to produce populations of infinite size, population growth is limited by environmental factors and resources. ➢ Investigate and explain that environmental problems arise when human activities and technology disrupt the equilibrium in the food web or interfere with the natural biogeochemical cycles. • Habitat destruction • Biogeochemical cycles. Contexts for instruction may include: o use of fossil fuels impact on the carbon cycle o use of inorganic fertilizers impact on the nitrogen cycle o use of water for agricultural, industrial, and residential purposes impact on water cycle • Introduction of non-native species • Eliminating a species from an ecosystem • Climate change • Release of genetically altered organisms into the environment ➢ Investigate and explain how natural events may affect individuals and populations. • Fire • Disease • Climate change • Population increase • Depletion of food

****Objectives for Biology indicators are taken from the Draft Biology VSC.**

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Life Science, Biology			
Grades K – 2	**Grades 3 – 5**	**Grades 6 – 8**	**Grades 9 – 12 (Goal 3)**
		Environmental Science Grade 7 A. Natural Resources and Human Needs 1. **Recognize and explain the impact of a changing human population on the use of natural resources and on environmental quality.** a. Based on data identify and describe the positive and negative impacts of an increasing human population on the use of natural resources b. Recognize and describe the decreasing dependence on local resources due to the impact of available transportation. B. Environmental Issues 1. **Recognize and describe that environmental changes can have local, regional, and global consequences.** a. Identify and describe a local, regional, or global environmental issue. b. Identify and describe that different individuals or groups are affected by an issue in different ways. **Environmental Science Grade 8** B. Environmental Issues 1. **Recognize and explain how human activities can accelerate or magnify many naturally occurring changes.** a. Based on data from research identify and describe how natural processes change the environment. • Cyclic climate change • Sedimentation in watersheds • Population cycles • Extinction b. Identify and describe how human activities produce changes in natural processes: • Climate change • Loss of habitat • Introduction of nonnative species • Cycling of matter	**6. *Expectation:* The student will investigate a biological issue and develop an action plan.** **Indicator1 The student will analyze the consequences and/or trade-offs between technological changes and their effect on the individual, society, and the environment. They may select topics such as bioethics, genetic engineering, endangered species, or food supply.** **Indicator 2 The student will investigate a biological issue and be able to defend their position on topics such as animal rights, drug and alcohol abuse, viral diseases (e.g., AIDS), genetic engineering, bioethics, biodiversity, population growth, global sustainability, or origin of life.**
	Earth/Space Science Grade 3 E. Interactions of Hydrosphere and Atmosphere 1. **Recognize and describe that water can be found as a liquid or a solid on the Earth's surface and as a gas in the Earth's atmosphere.** a. Describe that air is a substance that surrounds us and contains such things as oxygen, water vapor (gas), pollen, dust, etc. b. Observe and explain what happens when liquid water disappears. • Turns into water vapor (gas) in the air • Can reappear as a liquid or solid when cooled, such as clouds, fog, rain, snow, etc.	**Life Science Grade 7** E. Flow of Matter and Energy 1. **Explain that the transfer and transformation of matter and energy links organisms to one another and to their physical setting.** f. Provide evidence that supports the premise "In the flow of matter system the total amount of matter remains constant even though its form and location change." • Carbon cycle • Nitrogen cycle	**1. *Expectation:* The student will be able to explain the correlation between the structure and function of biologically important molecules and their relationship to cell processes.** Indicator 3 The student will be able to compare the transfer and use of matter and energy in photosynthetic and non-photosynthetic organisms. ***Assessment limits*** • *water cycle (movement of water between living systems and the environment)* • *carbon cycle (movement of carbon between living systems and the environment, cyclic relationship between photosynthesis and respiration)* • *nitrogen cycle (roles of bacteria; human impact)*

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Life Science, Biology			
Grades K – 2	**Grades 3 – 5**	**Grades 6 – 8**	**Grades 9 – 12 (Goal 3)**
	Earth/Space Science Grade 5 E. Interactions of Hydrosphere and Atmosphere 1. **Recognize and describe that the amount of water on Earth continues to stay the same even though it may change from one form to another.** a. Describe how water on Earth changes. • Condensation • Precipitation • Evaporation b. Explain that the sun is the main source of energy that causes the changes in the water on Earth. c. Describe the relationship between the amount of energy from the sun and the quantity of water that is changed. d. Describe the processes that maintain a continuous water cycle.		**Objectives**** ➢ Identify and describe how atoms and molecules needed by organisms cycle among the living and nonliving components of the biosphere. • Water cycle: movement of water between living systems and the environment o Role of water in living systems • Carbon cycle: movement of carbon between living systems and the environment o Role of carbon in living systems o Cyclic relationship between photosynthesis and cell respiration • Nitrogen cycle: movement of nitrogen between living systems and the environment o Roles of bacteria o Human impact on the nitrogen cycle
	Earth/Space Science Grade 3 E. Flow of Matter and Energy 1. **Recognize that materials continue to exist even though they change from one form to another.** a. Identify and compile a list of materials that can be recycled. b. Identify what happens to materials when they are recycled. c. Observe and record the sequence of changes that occur to plants and animals that die and decay. d. Ask and develop possible answers to questions about what happens to the materials that living things are made of when they die.		
			2 ***Expectation*: The student will demonstrate an understanding that all organisms are composed of cells which can function independently or as part of multicellular organisms.** **Indicator 2 The student will conclude that cells exist within a narrow range of environmental conditions and changes to that environment, either naturally occurring or induced, may cause changes in the metabolic activity of the cell or organism.** Assessment limits: • pH • temperature • light • water • oxygen • carbon dioxide • radiation (role in cancer or mutations) • toxic substances (natural, synthetic)

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Chemistry			
Grades K – 2	**Grades 3 – 5**	**Grades 6 – 8**	**Grades 9 – 12 (Goal 4)**
	Chemistry Grade 3 A. Structure of Matter 1. **Identify ways to classify objects using supporting evidence from investigations of observable properties.** a. Classify objects based on their observable properties. b. Provide reasons for placing the objects into groups. c. Compare classifications with those of others.	**Chemistry Grade 8** A. Structure of Matter 1. **Provide evidence to explain how compounds are produced.** a. Describe how elements form compounds and molecules. b. Investigate and describe what happens to the properties of elements when they react chemically with other elements. c. Based on data from investigations and research compare the properties of compounds with those of the elements from which they are made.	**Goal 4** **2. *Expectation*: The student will explain how the properties of compounds are related to the arrangement and type of atoms they contain.** **Indicator 1 The student will explain how the properties of a molecule are determined by the atoms it contains and their arrangement.** Assessment limits: • polar and nonpolar molecules ("like dissolves like" and why; not to include prediction of polarity from shape) • shapes of molecules (limited to linear, bent/angular, tetrahedral) • water (definition and explanation of shape and polarity of molecule, observed changes in density as phases change, use as a "universal" solvent; conceptual understanding of hydrogen bonding, high surface tension, high specific heat) **Indicator 2 The student will explain why organic compounds are so numerous and diverse.** Assessment limits: • inorganic and organic compounds (define in terms of carbon content; do not include CO, CO_2, or carbonates as organic compounds; definition of hydrocarbons) • ability of carbon to form chains and make rings (recognize, but not produce structural formulas) **3. *Expectation*: The student will apply the basic concepts of thermodynamics (thermochemistry) to phases of matter and phase and chemical changes.** **Indicator 1 The student will explain that thermal energy in a material consists of the ordered and disordered motions of its colliding particles.** Assessment limits: • thermal energy (differentiate between thermal energy and temperature) • phase changes • heating / cooling (temperature vs. time) curve (interpret the different parts of the curve in terms of motion / kinetic energy and organization of the particles; changes in particle motion and organization between phase changes; identify melting/freezing and boiling point; not to include potential energy or calculations of Q) **Indicator 3 The student will explain why the interactions among particles involve a change in the energy system.** Assessment limits: • exothermic change (bond formation; dissociation; thermal energy released; no predictions/calculations of ΔH) • endothermic change (bond breaking; dissociation; thermal energy absorbed; no predictions/calculations of ΔH)

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Chemistry			
Grades K – 2	**Grades 3 – 5**	**Grades 6 – 8**	**Grades 9 – 12 (Goal 4)**
			5. *Expectation* The student will explain that matter undergoes transformations, resulting in products that are different from the reactants. Indicator1 The student will describe the general types of chemical reactions. Assessment limits: • synthesis and decomposition (definition; identify type given balanced formula equation or written description) • combustion (definition; identify type given balanced formula equation or written description) • single displacement (definition; identify type given balanced formula equation or written description; apply activity series to determine if reaction will occur) • double displacement (definition; identify type given balanced formula equation or written description; apply solubility rules to predict if a precipitate will form) **Indicator2 The student will balance simple equations (not to include redox reactions).** Assessment limits: • Law of Conservation of Mass (apply to reactions to account for the same number of atoms of each type appearing in both the reactants and products) • coefficients (define; use to balance symbolic equations; explain meaning in symbolic equations; differentiate between the use and meaning of coefficients and subscripts) **Indicator 3 The student will demonstrate that adjusting quantities of reactants may affect the amounts of products formed.** Assessment limits: • use of coefficients in a balanced equation to predict amounts of reactants and products (at the molecular/mole level – no mass-mass calculations) • changing the amount of reactant(s) may change the amount of product(s) formed (no calculations) **Indicator 4 The student will recognize that chemical reactions occur at different speeds.** Assessment limits: • reaction rate (in order for atoms to react they must collide with sufficient energy; reaction rate increases as frequency of molecular collisions increases) • effects of surface area, temperature, and concentration on the frequency and energy of molecular collisions (no calculations or specific concentration units) • catalysts (definition; conceptual understanding of behavior)

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Physics			
Grades K – 2	**Grades 3 – 5**	**Grades 6 – 8**	**Grades 9 – 12 (Goal 5)**
	Physics Grade 3 B. Thermodynamics 1. **Recognize and describe that heat is transferred between objects that are at different temperatures.** a. Recognize and describe that the temperature of an object increases when heat is added and decreases when heat is removed. b. Recognize and describe that heat will flow between object at different temperatures until they reach the same temperature. Grade 4 B. Thermodynamics 1. **Provide evidence that heat can be transferred in different ways.** a. Recognize and explain that heat can be transferred either by direct contact between objects at different temperatures or without direct contact. • A spoon in hot water • Heat from a flame b. Observe, describe, and compare materials that readily conduct heat and those that do not conduct heat very well. c. Classify materials as conductors or insulators based on how	**Physics Grade 8** B. Thermodynamics 1. **Describe and cite evidence that heat can be transferred by conduction, convection and radiation.** a. Based on observable phenomena, identify and describe examples of heat being transferred through conduction and through convection. b. Based on observable phenomena, identify examples to illustrate that radiation does not require matter to transfer heat energy. c. Research and identify the types of insulators that best reduce heat loss through conduction, convection, or radiation.	**Goal 5** **3. *Expectation*: The student will recognize and relate the laws of thermodynamics to practical applications.** **Indicator 1 The student will relate thermodynamics to the balance of energy in a system.** Assessment limits: • Thermal equilibrium (conditions and definition, differentiate between heat energy and temperature) • Heat energy transfer (conduction, convection, radiation) • Application of heat energy to the Law of Conservation of Energy • Irreversibility of heat energy transformations • Specific heat and calorimetry (both describe and calculate)
		Physics Grade 6 C. Electricity and Magnetism 2. **Cite evidence supporting that electrical energy can be produced from a variety of energy sources and can itself be transformed into almost any other form of energy.** a. Research and identify various energy sources and the energy transforming devices used to produce electrical energy • Wind (generators, wind mills) • Sun (solar cells) • Water(turbines) • Fossil fuels (engines)	**2. *Expectation*: The student will know and apply the laws of electricity and magnetism and explain their significant role in nature and technology.** **Indicator 3 The student will qualitatively describe the applications of electromagnetic induction.** Assessment limits: • Electromagnetic induction (definition) • Motors (energy transformations) • Generators (energy transformations)
			1. *Expectation*: The student will know and apply the laws of mechanics to explain the behavior of the physical world. **Indicator 5 The student will analyze systems with regard to the conservation laws.** Assessment limits: • Conservation of momentum (applications and calculation in one dimension) • Conservation of energy (relationship between potential and kinetic)
			5. *Expectation*: The student will investigate certain topics in modern physics. **Indicator 2 The student will qualitatively explain the processes associated with nuclear energy and its applications.** Assessment limits: • Radioactive decay (half-life; alpha, beta, and gamma emission processes) • Fission/fusion (distinguish between, compare with other sources of energy)

Environmental Literacy Components: Voluntary State Curriculum for Science

Environmental Science

Grades K – 2

Environmental Science Grade 1
B. Environmental Issues

1. Recognize that caring about the environment is an important human activity.
a. Recognize and describe that individual and group actions, such as recycling help the environment
b. Recognize and describe that individual and group actions, such as littering harm the environment.
c. Give reasons why people should take care of their environments.

Grades 3 – 5

Environmental Science Grade 4
B. Environmental Issues

1 **Recognize and describe that people in Maryland depend on, change, and are affected by the environment.**
a. Identify and describe that human activities in a community or region are affected by environmental factors
• Presence and quality of water
• Soil type
• Temperature
• Precipitation.

Environmental Science Grade 5
A. Natural Resources and Human Needs

1. **Recognize and explain how renewable and nonrenewable natural resources are used by humans in Maryland to meet basic needs.**
a. Identify and compare Maryland's renewable resources and nonrenewable resources.
b. Describe how humans use renewable natural resources, such as plants, soil, water, animals.
c. Describe how humans use nonrenewable natural resources, such as oil, coal, natural gas, minerals, including metals

Grades 6 – 8

Environmental Science Grade 6
A. Natural Resources and Human Needs

1. **Recognize and compare how different parts of the world have varying amounts and types of natural resources and how the use of those resources impacts environmental quality.**
a. Identify and describe natural resources as
• Land
• Fossil fuels
• Forests
• Water
• Wind
• Minerals
• Wildlife
b. Identify and describe the distribution of natural resources around the Earth
c. Identify and describe how the natural change processes may be affected by human activities.
• Agriculture
• Beach preservation
• Mining
• Development/construction
• Stream/river alteration
d. Identify and describe problems associated with obtaining, using, and distributing natural resources.
e. Identify possible solutions to problems associated with obtaining, using, and distributing natural resources.

Environmental Science Grade 7
A. Natural Resources and Human Needs

1. **Recognize and explain the impact of a changing human population on the use of natural resources and on environmental quality.**
a. Based on data identify and describe the positive and negative impacts of an increasing human population on the use of natural resources
b. Recognize and describe the decreasing dependence on local resources due to the impact of available transportation.

Grades 9 – 12 (Goal 6)

Goal 6
3. *Expectation*: The student will analyze the relationships between humans and the earth's resources.

Indicator 1 The student will evaluate the interrelationship between humans and air quality.
Assessment limits:
- ozone
- greenhouse gases
- volatile organic compounds (smog)
- acid rain
- indoor air
- human health

Indicator 2 The student will evaluate the interrelationship between humans and water quality and quantity.
Assessment limits:
- fresh water supply
- point source/nonpoint source pollution
- waste water treatment
- thermal pollution
- Chesapeake Bay and its watershed
- eutrophication
- human health

Indicator 3 The student will evaluate the interrelationship between humans and land resources.
Assessment limits:
- wetlands
- soil conservation
- mining
- solid waste management
- land use planning
- human health

Indicator 4 The student will evaluate the interrelationship between humans and biological resources.
Assessment limits:
- food production/agriculture
- forest and wildlife resources
- species diversity/genetic resources
- integrated pest management
- human health

Indicator 5 The student will evaluate the interrelationship between humans and energy resources.
Assessment limits:
- renewable
- nonrenewable
- human health

Environmental Literacy Components: Voluntary State Curriculum for Science

<table>
<tr><th colspan="4">Environmental Science</th></tr>
<tr><th>Grades K – 2</th><th>Grades 3 – 5</th><th>Grades 6 – 8</th><th>Grades 9 – 12 (Goal 6)</th></tr>
<tr>
<td>Environmental Science Grade 2
B. Environmental Issues

1. Recognize and describe that the activities of individuals or groups of individuals can affect the environment.
a. Identify and describe that individual and group actions, such as turning off lights, conserving water, recycling, picking up litter, or joining an organization can extend the natural resources of the environment.
b. Identify and describe that individual and group actions, such as leaving lights on, wasting water, or throwing away recyclables, can limit the natural resources of the environment.</td>
<td>Environmental Science Grade 5
B. Environmental Issues

1. Recognize and explain that decisions influencing the use of natural resources may have benefits, drawbacks, unexpected consequences, and tradeoffs.
a. Identify and describe personal and community behaviors that waste natural resources and/or cause environmental harm and those behaviors that maintain or improve the environment.
b. Identify and describe that individuals and groups assess and manage risk to the environment differently.

2. Recognize and describe that consequences may occur when Earth’s natural resources are used.
a. Explain how human activities may have positive consequences on the natural environment.
• Recycling centers
• Native plantings
• Good farming practice
b. Explain how human activities may have a negative consequence on the natural environment.
• Damage or destruction done to habitats
• Air, water, and land pollution
c. Identify and describe that an environmental issue affects individuals and groups differently.</td>
<td>Environmental Science Grade 6
B. Environmental Issues

1. Recognize and explain that human caused changes have consequences for Maryland’s environment as well as for
other places and future times.
a. Identify and describe a range of local issues that have an impact on people in other places.
b. Recognize and describe how environmental change in one part of the world can have consequences for other parts of the world.
c. Identify and describe that ecosystems can be impacted by human activities.
• Protection of the Chesapeake Bay watershed
• Resource acquisition and use
• Land use decisions (agriculture, mining, and development)
• Recycling
• Use and disposal of toxic substances

Environmental Science Grade 7
B. Environmental Issues

1. Recognize and describe that environmental changes can have local, regional, and global consequences.
a. Identify and describe a local, regional, or global environmental issue.
b. Identify and describe that different individual people or groups of people are affected by an issue in different ways.</td>
<td>4. Expectation The student will develop and apply knowledge and skills gained from an environmental issue investigation to an action project which protects and sustains the environment.

Indicator1 Identify an environmental issue and formulate related research questions.
Methods of gathering information may include
• writing letters
• performing a literature search
• using the internet
• interviewing experts

Indicator 2 Design and conduct the research.
Methods of data collection may include
• field or laboratory
• questionnaire/opinionnaire

Indicator 3 Interpret the findings to draw conclusions and make recommendations to help resolve the issue.

Indicator 4 Apply the conclusions to develop and implement an action project.
Methods of implementation may include
• physical action
• persuasion
• consumer action
• political action

Indicator 5 Analyze the effectiveness of the action project in terms of achieving the desired outcomes.</td>
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<td>Electricity and Magnetism Grade 6

2. Cite evidence supporting that electrical energy can be produced from a variety of energy sources and can itself
be transformed into almost any other form of energy.
a. Research and identify various energy sources and the energy transforming devices used to produce electrical energy
• Wind (generators, wind mills)
• Sun (solar cells)
• Water(turbines)
• Fossil fuels (engines)
b. Cite examples that demonstrate the transformation of electrical energy into other forms of energy.
c. Investigate and describe that some materials allow the quick, convenient, and safe transfer of electricity (conductors), while others prevent the transfer of electricity (insulators).
d. Identify and describe the energy transformations in simple electric circuits.</td>
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