Note to Teachers:

The following list and tables summarize the "inquiry standards," sometimes called Science & Engineering Practices, for both ODE's Ohio Revised Science Standards (released 2011), which is paraphrased from the Next Generation Science Standards (NGSS, released 2013).

IN ADDITION TO TEACHING AND IMPLETMENATING THE CURRENT HIGH SCHOOL SCIENCE CURRICULUM, TEACHERS MUST CONSISTENTLY INCORPORATE AND INTEGRATE THE "INQUIRY AND APPLICATION STANDARDS" INTO DAILY CLASSROOM INSTRUCTION.

<u>OVERVIEW OF STANDARDS</u>

The following List and Table summarizes the "inquiry standards," sometimes called Science & Engineering Practices, for both ODE's Ohio Revised Science Standards (released 2011), which is paraphrased from the Next Generation Science Standards (NGSS). <u>THESE STANDARDS MUST BE ACCOUNTED FOR THROUGHOUT THE CURRICULUM!</u>

<u>ODE's Science Inquiry and Application</u> (From Ohio Revised Science Standards)

All students must use the following scientific processes with appropriate laboratory, safety techniques to construct their knowledge and understanding in all science content areas:

- ☐ Identify questions and concepts that guide scientific investigations;
- ☐ Design and conduct scientific investigations;
- ☐ Use technology and mathematics to improve investigations and communications;
- ☐ Formulate and revise explanations and models using logic and evidence (critical thinking);
- ☐ Recognize and analyze explanations and models; and
- ☐ Communicate and support a scientific argument

<u>Modeling workshops are available nationally that help teachers develop a framework for incorporating guided inquiry in their instruction.</u>

Next Generation Science Standards

8 SCIENCE AND ENGINEERING PRACTICES (From the May 2012 Draft)

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Asking Questions and Defining Problems	A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested. Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify the ideas of others.	Asking questions and defining problems in grades 9–12 builds from grades K–8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and explanatory models and simulations. ☐ Ask questions that arise from phenomena, models, theory, or unexpected results. ☐ Ask questions that require relevant empirical evidence. ☐ Ask questions to determine quantitative relationships between independent and dependent variables. ☐ Ask questions that challenge the premise of an argument, the interpretation of a data set, or the suitability of a design.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Developing and using models	A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.	Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and constructing models to predict and explain relationships between systems and their components in the natural and designed world. ☐ Use multiple types of models to represent and explain phenomena, and move flexibly between model types based on merits and limitations. ☐ Construct, revise, and use models to predict and explain relationships between systems and their components. ☐ Use models (including mathematical and computational) to generate data to explain and predict phenomena, analyze systems, and solve problems. ☐ Design a test of a model to ascertain its reliability. ☐ Examine merits and limitations of various models in order to select or revise a model that best fits the evidence or the design criteria.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Planning and carrying out investigations	Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.	Planning and carrying out investigations to answer questions or test solutions to problems in 9–12 builds on K–8 experiences and progresses to include investigations that build, test, and revise conceptual, mathematical, physical, and empirical models. ☐ Plan and carry out investigations individually and collaboratively and test designs as part of building and revising models, explaining phenomena, or testing solutions to problems. Consider possible confounding variables or effects and ensure the investigation's design has controlled for them. ☐ Evaluate various methods of collecting data (e.g., field study, experimental design, simulations) and analyze components of the design in terms of various aspects of the study. Decide types, how much, and accuracy of data needed to produce reliable measurement and consider any limitations on the precision of the data (e.g., number of trials, cost, risk, time). ☐ Select appropriate tools to collect, record, analyze, and evaluate data. ☐ Plan and carry out investigations and test design solutions in a safe and ethical manner including considerations of environmental, social, and personal impacts. ☐ Planning and carrying out investigations may include elements of all of the other practices.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Analyzing and interpreting data	Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use arrange of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis. Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria— that is, which design best solves the problem within given constraints? Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.	Analyzing data in 9–12 builds on K– 8 and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data. ☐ Use tools, technologies, and/or models (e.g., computational, mathematical) to generate and analyze data in order to make valid and reliable scientific claims or determine an optimal design solution. ☐ Consider limitations (e.g., measurement error, sample selection) when analyzing and interpreting data. ☐ Determine function fits to data, including slope, intercept, and correlation coefficient for linear fits. ☐ Compare and contrast various types of data sets (e.g., self- generated, archival) to examine consistency of measurements and observations. ☐ Evaluate the impact of new data on a working explanation of a phenomenon or design solution.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Using mathematics and computational thinking	In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.	Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. ☐ Use mathematical or algorithmic representations of phenomena or design solutions to create explanations, computational models, or simulations. ☐ Use mathematical expressions to represent phenomena or design solutions in order to solve algebraically for desired quantities. ☐ Use simple limit cases to test mathematical expressions, computer programs or algorithms, or simulations to see if a model "makes sense" by comparing the outcomes with what is known about the real world. ☐ Use statistical and mathematical techniques and structure data (e.g., displays, tables, graphs) to find regularities, patterns (e.g., fitting mathematical curves to data), and relationships in data. ☐ Used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships. ☐ Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Constructing explanations (for science) and designing solutions (for engineering)	The products of science are explanations and the products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.	Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific knowledge, principles, and theories. ☐ Make quantitative claims regarding the relationship between dependent and independent variables. ☐ Apply scientific reasoning, theory, and models to link evidence to claims and show why the data are adequate for the explanation or conclusion. ☐ Construct and revise explanations and arguments based on evidence obtained from a variety of sources (e.g., scientific principles, models, theories) and peer review. ☐ Base casual explanations on valid and reliable empirical evidence from multiple sources and the assumption that natural laws operate today as they did in the past and will continue to do so in the future. ☐ Apply scientific knowledge to solve design problems by taking into account possible unanticipated effects.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Engaging in argument from evidence	Argumentation is the process by which explanations and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.	Engaging in argument from evidence in 9–12 builds from K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world. Arguments may also come from current scientific or historical episodes in science. ☐ Criticize and evaluate arguments and design solutions in light of new evidence, limitations (e.g., trade-offs), constraints, and ethical issues. ☐ Evaluate the merits of competing arguments, design solutions, and/or models. ☐ Evaluate the claims, evidence, and reasoning of currently accepted explanations or solutions as a basis for the merits of the arguments. ☐ Construct a counter-argument that is based in data and evidence that challenges another proposed argument.

Science and Engineering Practices	Defined as…	Grades 9-12 Condensed Practices
Obtaining, evaluating, and communicating information	Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.	Obtaining, evaluating, and communicating information in 9–12 builds on K–8 and progresses to evaluating the validity and reliability of the claims, methods, and designs. ☐ Critically read scientific literature adapted for classroom use to identify key ideas and major points and to evaluate the validity and reliability of the claims, methods, and designs. ☐ Generate, synthesize, communicate, and critique claims, methods, and designs that appear in scientific and technical texts or media reports. ☐ Recognize the major features of scientific and technical writing and speaking and produce written and illustrated texts or oral presentations that communicate ideas and accomplishments.

Note to Teachers:

The following tables summarize the Common Core State Standards of English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

IN ADDITION TO TEACHING AND IMPLETMENATING THE CURRENT HIGH SCHOOL SCIENCE CURRICULUM, TEACHERS MUST CONSISTENTLY INCORPORATE AND INTEGRATE THE "COMMON CORE STATE STANDARDS OF ENGLISH LANGUAGE ARTS & LITERACY IN HISTORY/SOCIAL STUDIES, SCIENCE AND TECHNICAL SUBJECTS" INTO DAILY CLASSROOM INSTRUCTION.

The following Tables summarize the "Literacy in Science and Technical Subjects" for 9-10 & 11-12 Grades. There are Reading Standards & Writing Standards.

Reading Standards for Literacy in Science and Technical Subjects

Each number 1-10 is a College and Career Readiness Anchor Standard

No.	*Grades 9-10 Students*	*Grades 11-12 students*
Key Ideas and Details		
1	Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.
2	Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.	Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.
3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

Craft and Structure		
4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics.	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.
5	Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).	Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.
6	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.	Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.

Integration of Knowledge and Ideas		
7	Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
8	Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.	Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.
9	Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.	Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.
Range of Reading and Level of Text Complexity		
10	By the end of grade 10, read and comprehend science/technical texts in the grades 9–10 text complexity band independently and proficiently.	By the end of grade 12, read and comprehend science/technical texts in the grades 11–CCR text complexity band independently and proficiently.

The following Tables summarize the "Literacy in Science and Technical Subjects" for 9-10 & 11-12 Grades. There are Reading Standards & Writing Standards.

Writing Standards *for Literacy in Science and Technical Subjects*

Each number 1-10 is a College and Career Readiness Anchor Standard

No.	*Grades 9-10 Students*	*Grades 11-12 students*
Text Types and Purposes		
1	Write arguments focused on discipline-specific content. a. Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns. c. Use words, phrases, and clauses to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between	Write arguments focused on discipline-specific content. a. Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence. b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases. c. Use words, phrases, and clauses as well as varied syntax to link the major sections of the text, create cohesion, and clarify the relationships between claim(s) and reasons, between reasons and evidence, and between claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.

	claim(s) and counterclaims. d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. e. Provide a concluding statement or section that follows from or supports the argument presented.	
2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize ideas, concepts, and information to make important connections and distinctions; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with well-chosen, relevant, and sufficient facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence	Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. a. Introduce a topic and organize complex ideas, concepts, and information so that each new element builds on that which precedes it to create a unified whole; include formatting (e.g., headings), graphics (e.g., figures, tables), and multimedia when useful to aiding comprehension. b. Develop the topic thoroughly by selecting the most significant and relevant facts, extended definitions, concrete details, quotations, or other information and examples appropriate to the audience's knowledge of the topic. c. Use varied transitions and sentence structures to link the major sections of the text, create cohesion, and clarify the relationships among complex ideas and concepts. d. Use precise language, domain-specific vocabulary and techniques such as metaphor, simile, and analogy to manage the complexity of the topic; convey a knowledgeable stance in a style

	structures to link the major sections of the text, create cohesion, and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to manage the complexity of the topic and convey a style appropriate to the discipline and context as well as to the expertise of likely readers. e. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing. f. Provide a concluding statement or section that follows from and supports the information or explanation presented (e.g., articulating implications or the significance of the topic).	that responds to the discipline and context as well as to the expertise of likely readers. e. Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).
3	Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In history/social studies, students must be able to incorporate narrative accounts into their analyses of individuals or events of historical import. In science and technical subjects, students must be able to write precise enough descriptions of the step-by-step procedures they use in their investigations or technical work that others can replicate them and (possibly) reach the same results.	

Production and Distribution of Writing		
4	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.	Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
5	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience	Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
6	Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.	Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.
Research to Build and Present Knowledge		
7	Conduct short as well as more sustained research projects to answer a question (including a self- generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.	Conduct short as well as more sustained research projects to answer a question (including a self- generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
9	Draw evidence from informational texts to support analysis, reflection, and research.	Draw evidence from informational texts to support analysis, reflection, and research.
Range of Reading and Level of Text Complexity		
10	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.	Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grading Period One: 9 WEEKS			
Unit One: Sustainability and the Human Endeavor (ES 1; ER 2; ER 3)	**Clear Learning Targets**	**Recommended Lab Themes/Material Science/ Intervention/Extension**	**Resources:** **The textbook is to be used as a resource only.**
	The student will be able to: ☐ Define sustainability ☐ Discuss the issue of ecological "footprint" and how humans can attain and maintain sustainability. ☐ Provide examples that illustrate the social, political and economic aspects of environmental science. ☐ Evaluate the competing interests for scarce water resources by industry or geographic/ethnic groups and the role of this competition in global conflicts. ☐ Explain conflicting ethical concerns regarding activities that affect the environment ☐ Define environmental racism and its effect on environmental efforts and laws ☐ Correlate air and water quality around the globe to socioeconomic status of the local population ☐ Describe how costs and values are assigned to natural resources and environmental concerns ☐ Describe the events leading up to, the main points and the impacts of major ecological laws ○ Endangered Species Act ○ Clean Water Act ○ Clean Air Act ☐ Provide examples of actions you can take to protect the environment ☐ Define scientific models ☐ List benefits and shortcomings of using models to describe natural processes ☐ Distinguish between matter and energy ☐ Demonstrate energy conservation within a system by describing conversions of energy from each form to another ☐ Describe chemical measurements that are important to environmental science ☐ Compare and contrast energy efficiency, conserving energy and conservation of energy ☐ List the major sources of energy available to the biosphere ☐ List the major categories of energy uses by humans	**Suggested Labs:** Everybody Lives Downstream http://techalive.mtu.edu/meec/module01/Downstream.htm **Lab Themes:** Ethical Use of Resources Law of Conservation of Energy **Activities:** The People Paradox: NOVA *(can be used in Unit 3 as well) online* Tragedy of the Commons Ecological Footprint Activity **Intervention:** "A Long Walk to Water" by Linda Sue Park (available online) **Extension:** Water availability in Sub-Saharan Africa https://www.youtube.com/watch?v=NQD_ZhKYT7Q **Vocabulary:** environmental racism, conservation, sustainability, per capita, environmental capital	**Chapters:** 1, 2, 14, & 17 **Supplements:** 1, 3 and 4 **Case Studies:** Colorado River Use **Videos:** World in Balance NOVA Why are some countries rich and others poor? (YouTube) Ecological Footprint Explained (YouTube) Introductory videos on the Tragedy of the Commons: Part 1- https://www.youtube.com/watch?v=KZDjPnzoge0 Part 2- https://www.youtube.com/watch?v=IVwk6VIxBXg **Websites:** The Habitable Planet: Demographics http://www.learner.org/courses/envsci/interactives/demographics / Water Resources Bozeman Science https://www.youtube.com/watch?v=IDAj5T1ST7o

Textbook: Environmental Science 15th Edition by Miller, Spoolmen
This pacing guide is based on days. A day is a 50 minute period and should be adjusted to fit alternative schedules.

Grading Period Two: 5 WEEKS

Unit		Clear Learning Targets	Recommended Lab Themes/Material Science/ Intervention/Extension	Resources: The textbook is to be used as a resource only.
Unit Two: The Biosphere (ES 1-5; ER 5; GP 4, 5, 8)		**The student will be able to:** ☐ Define major characteristics the Biosphere (ecosystems/biomes) ☐ Distinguish between abiotic and biotic factors and their effects on an ecosystem. ☐ List the variables that determine if an ecosystem demonstrates equilibrium. ☐ Describe evolutionary processes and discuss factors that cause adaptations. ☐ Describe how evidence and inference are used to support biological and geological evolution ☐ Demonstrate conservation of mass within a system by describing the conversion of matter from each substance to another ☐ Explain the importance of biodiversity and the factors that impact it.	**Suggested Labs:** Law of Conservation of Mass Lab http://www.troup.org/userfiles/929/My%20Files/Science/MS%20Science/8th%20Science/Matter/conservation_matter/conservation_mass_lab2.pdf?id=8053 Biomagnification: https://blogs.cornell.edu/cibt/files/2015/05/Biomagnification-Lab-Todd-Shuskey-12qtxb5.pdf Seeds, Leaves, and Fingers **Lab Themes:** Geologic Timeline Evolution (as it relates to biodiversity) Conservation of Mass and Energy Ecological Succession **Intervention:** Food Web Interactions (Aurum Science) Carbon Cycle Game (on web) **Extension:** Trophic cascades short film (HHMI) **Vocabulary:** biosphere, abiotic, biotic, adaptation, natural selection, conservation of mass, food web, matter, energy, trophic level biomass, primary successions, secondary succession	**Chapters**: 3 & 4 **Supplements:** CK-12 Foundation Nature Unbound (Missouri Curriculum) https://www.nature.com/scitable/knowledge/library/the-conservation-of-mass-17395478 (article) **Case Studies:** Cat Drop worksheet (in file) **Videos:** Crash Course Ecology (YouTube) https://www.youtube.com/watch?v=sjE-Pkjp3u4&list=PL8dPuuaLjXtNdTKZkV_GiIYXpV9w4WxbX Planet Earth: Pole to Pole (Discovery) Evolution (PBS) http://www.pbs.org/wgbh/evolution/ Bozeman Ecosystems: https://www.youtube.com/watch?v=FhaldPmkoNE

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Grading Period Two: 4 WEEKS

	Clear Learning Targets	Recommended Lab Themes/Material Science/ Intervention/Extension	Resources: The textbook is to be used as a resource only.
Unit Three: Population (GP 1; ER 1)	**The student will be able to:** ☐ Discuss the trends and changes in human population during the 20th and 21st centuries ☐ Describe interaction of climate, biotic influences to discuss patterns of human habitation ☐ Relate global human population patterns and changes to environmental events or cycles. ☐ Classify and define developed and developing countries. ☐ Evaluate demographics and trends using growth curves, projections, and age structures. ☐ Evaluate effects of population growth trends on resources (food, energy) and the environment ☐ Describe methods for helping population growth maintain sustainability	**Suggested Labs:** Duckweed Lab **Lab Themes:** Population Growth Rates Carrying Capacity **Intervention:** Analyzing the Demographics of a Country (Aurum Science) Population Pyramid Activities (Holt) Demographic Transition Foldable **Extension:** African American Populations: The Great Migration http://www.inmotionaame.org/gallery/index.cfm;jsessionid=f8301472241519211741503?migration=7&topic=99&type=image&bhcp=1 **Vocabulary:** population change, birth rate, death rate, fertility rate, infant mortality rate, replacement-level fertility rate, total fertility rate, life expectancy, migration, age structure, demographic transition, family planning, immigration, emigration	**Chapters**: 5 & 6 **Supplements/Suggested Activities:** World Population Map Activity (Population Connection) **Case Studies:** The Great Migration (uses extension link) The Return to the South http://www.inmotionaame.org/migrations/landing.cfm?migration=11 **Videos:** World in Balance: A People Paradox (NOVA) Eyes of Nye: Human Population (YouTube) Overpopulation: https://www.youtube.com/watch?v=QsBT5EQt348 **Websites:** US Census Bureau: https://www.census.gov/programs-surveys/international-programs.html

Textbook: Environmental Science 15th Edition by Miller, Spoolmen
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Grading Period Three: 5 WEEKS			
Unit Four: Climate, Hydrosphere and Atmosphere (ES 2, 4, 5; ER 2; GP 3, 6)	**Clear Learning Targets**	**Recommended Lab Themes/Material Science/ Intervention/Extension**	**Resources: The textbook is to be used as a resource only.**
	The student will be able to: ☐ Describe major characteristics for the atmosphere (layers, composition, meteorological events) and hydrosphere (weather, cryosphere) ☐ Trace the movement of energy within and among the hydrosphere and atmosphere. ☐ Describe the mechanisms that cause land and sea breezes. ☐ Evaluate the differences and similarities between la nina and el nino. ☐ Describe how external influences (e.g. moon phases and seasonal solar radiation) can affect mass and energy changes occurring in various weather patterns. ☐ Apply the concepts of observation and inference to studies of the sources and effects of global climate change ☐ Describe how climate affects biosphere, hydrosphere and lithosphere. ☐ List the biotic and abiotic factors that impact climate and identify climate trends. ☐ Describe causes and effects of climate changes. ☐ Analyze the costs and benefits of proposed solutions for slowing climate change ☐ Detail and analyze sources of air and water contamination and pollution, both primary and secondary. ☐ Compare and contrast the effects of greenhouse gases and ozone depleting gases ☐ Explain the impact of rising CO_2 levels on the oceans (rising sea levels, acidification)	**Suggested Labs:** Methyl Bromide Lab (Holt) Getting to the Core: the link between CO_2 and Temperature (EPA) https://www3.epa.gov/climatechange//kids/documents/temp-and-co2.pdf **Lab Themes:** Density and Pressure Glacial Melt Rates Convection Current **Intervention:** Stacking Up The Atmosphere (NOAA) https://www.climate.gov/teaching/resources/stacking-atmosphere **Extension:** What is the cryosphere? https://nsidc.org/cryosphere/allaboutcryosphere.html Zombie Viruses in the melting permafrost https://www.npr.org/sections/goatsandsoda/2018/01/24/575974220/are-there-zombie-viruses-in-the-thawing-permafrost **Vocabulary:** cryosphere, ozone, stratosphere, convection currents, Kyoto Protocol, Paris Accords, el nino, la nina	**Chapters**: 7 & 15 **Supplements:** Carbon through the seasons (EPA)https://archive.epa.gov/climatechange/kids/documents/carbon-through-the-seasons.pdf El Nino/La Nina Foldable (digital) **Case Studies:** Effects of Global Warming LP (EPA) Urban Heat Islands (Article) **Videos:** Ice core and CO_2 data https://www.youtube.com/watch?v=8BgD9xul16g 6° Could Change the World (NatGeo)http://www.natgeotv.com/ca/six_degrees An Inconvenient Truth part I and II **Websites:** Ice Core Research Center https://bpcrc.osu.edu/groups/ice-core-paleoclimatology-group Coral Bleaching- Documentary https://www.npr.org/2017/07/13/536644965/chasing-coral-documentary-vividly-chronicles-a-growing-threat-to-oceans

Textbook: Environmental Science 15th Edition by Miller, Spoolmen
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Grading Period Three: 4 WEEKS

Unit		Clear Learning Targets	Recommended Lab Themes/Material Science/ Intervention/Extension	Resources: The textbook is to be used as a resource only.
Unit Five: Water Resources and Water Pollution (ES 4, 5; ER 3; GP 2)		**The student will be able to:** ☐ Explain the matter and energy changes that occur during the water cycle ☐ Describe the requirements of "potable" water and changes in its availability. ☐ Describe and model how the lithosphere affects the movement of water and the flow of contaminants ☐ Describe the amounts, locations and sources of fresh water for farming, drinking and washing ☐ Differentiate methods for testing water quality against the requirements for potable water ☐ Create a representation of pollutant concentrations on the ppm and ppb levels ☐ Explain the processes used to purify water of poor quality, both natural and man-made.	**Suggested Labs:** Benthic Bugs - healthy water healthy people **Lab Themes:** Water chemistry (pH, Dissolved Oxygen, conductivity, etc) Water quality comparison - chemistry Water purification **Intervention:** "Stinky Clean" foldable **Extension:** "Dirty Water...so what?" - The Water Project Build a watershed (EPA) The Water Crisis activity **Vocabulary:** potable, surface water, ground water, physical vs economic water scarcity, watershed, aquifer, porosity permeability, recharge zone, reservoir, irrigation, desalination, point source pollution, non-point source pollution	**Field Trip:** Spruce Run - water quality (chemistry and macroinvertebrate) OR Water treatment plant **Chapters**: 11 **Supplements/Suggested Activities:** "Water, Water, Anywhere" - The Water Project Loop Lake - Healthy Water Healthy People **Case Studies:** **Ch.11** - Water and Water Pollution: *Water Conflicts in the middle East: A preview of the Future* **Videos:** Last Call at the Oasis (check online for clips) Erin Brockovich *(R-rated; use discretion or clips)* A Civil Action *(use clips)* **Websites:** The Water Project https://www.epa.gov/students/lesson-plans-teacher-guides-and-online-environmental-resources-educators Healthy water, Healthy people https://www.projectwet.org/sites/default/files/content/documents/hwhhhp_guide_v2_en.pdf

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Grading Period Four: 3 WEEKS			
Unit Six: Food, Soil and Pest Management (ER 1, 4; GP 4, 7, 8)	**Clear Learning Targets**	**Recommended Lab Themes/Material Science/ Intervention/Extension**	**Resources: The textbook is to be used as a resource only.**
	The student will be able to: ☐ Discuss requirements for land to be suitable for farming and human habitation ☐ Determine the fractions of earth's land masses that are used for farming and human habitation ☐ Describe the processes leading to loss of habitable lands including erosion and desertification ☐ Classify types of agriculture and food production. ☐ Evaluate the positive and negative impacts of fertilizers and pesticides. ☐ Assess the impact of agricultural runoff on lakes and rivers. ☐ Describe significant improvements to agriculture and food processing throughout history ☐ Predict future food production needs and potential ways for meeting those needs. **Vocabulary:** food security, food insecurity, chronic undernutrition, hunger, chronic malnutrition, plantation agriculture, high input agriculture, traditional subsistence agriculture, traditional intensive agriculture, polyculture, green revolution, aquaculture, soil erosion, desertification, salinization, waterlogging, pest, pesticides, integrated pest management, soil conservation, organic fertilizer, inorganic fertilizer, animal manure, green manure, compost	**Suggested Labs:** Soil Testing using any soil testing kit **Lab Themes:** Nutrient Cycling **Intervention:** Science Focus: Soil is the Base of Life on Land Individuals Matter: Rachel Carson, Science Focus: Ecological Surprises The Law of Unintended Consequences Science Focus: The Land Institute and Perennial Polyculture **Extension:** *Silent Spring* By Rachel Carson Case Study: Industrialized Food Production in the United States Case Study: Brazil The World's Emerging Food Superpower Case Study: Soil Erosion in the United States The Green Revolution https://www.thoughtco.com/green-revolution-overview-1434948	**Chapters**: 10 **Supplements**: Soil Horizons Interactive https://www.classzone.com/books/ml_science_share/vis_sim/esm05_pg113_soil/esm05_pg113_soil.swf, **Case Studies:** Core Case Study: Is Organic Agriculture the Answer? **Videos:** Soil Horizons Explained https://www.youtube.com/watch?v=I-QTjbBTUbY, Soil Formation https://www.youtube.com/watch?v=NGuKufvQw8c, Energy Flow and Nutrient Cycling https://www.youtube.com/watch?v=urmKLXwv_50 **Websites:** Bozeman Science: Geology https://www.youtube.com/watch?v=acwSG17e_lQ USDA: Natural Resources Conservation Service Soils https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/7thru12/, EPA: Lesson Plans, Teacher Guides and Online Environmental Resources for Educators https://www.epa.gov/students/lesson-plans-teacher-guides-and-online-environmental-resources-educators

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Grading Period Four: 4 WEEKS

Unit		Clear Learning Targets	Recommended Lab Themes/Material Science/ Intervention/Extension	Resources: The textbook is to be used as a resource only.
Unit Seven: Geology, Mineral and Energy (ER 1, 4; ES 3, 5)		**The student will be able to:** ☐ Define major characteristics for each of the lithosphere (geologic structure, events and processes) ☐ Compare geological events and processes and how the tectonic plates are involved. ☐ List geochemical cycles and the factors that affect them. ☐ Explain how geologic events impact earth's systems (biogeochemical cycles) ☐ Define mass and energy cycles during the formation, extraction, refining and utilization of fossil fuels. ☐ Detail the environmental impact of extracting, storing, using and refining non-renewable resources. ☐ Compare and contrast alternatives to fossil fuels, such as biofuels. ☐ Describe the energy transformation that occur during the generation of electricity from ○ fossil fuels (coal, natural gas, petroleum), ○ Nuclear ○ hydro-electric, ○ wind, and ocean waves ○ solar photovoltaic ○ fuel cells **Vocabulary:** geology, core, mantle, asthenosphere, crust, lithosphere, tectonic plates, volcano, earthquakes, tsunami, mineral, rock, sedimentary rock, igneous rock, metamorphic rock, mineral resource, ore, high-grade ore, low-grade ore, reserves, surface mining, overburden, spoils, open-pit mining, strip mining, area strip mining, contour strip mining, mountaintop removal, subsurface mining, fossil fuels, petroleum, crude oil, tar sand, oil sand, shale oil, natural gas, liquefied petroleum gas (LPG), liquefied natural gas (LNG), synthetic natural gas (SNG), nuclear fuel cycle, energy efficiency, passive solar heating system, active solar heating system, photovoltaic/solar cells, geothermal energy	**Suggested Labs:** Cookie Mining **Lab Themes:** Conservation of Mass and Energy Mineralogy **Intervention:** Coal Mining Reading Science Focus: Net Energy is the Only Energy that Really Counts Science Focus: The Quest to Make Hydrogen Workable **Extension:** Case Study: Revisiting the Real Cost of Gold The U.S. General Mining Law of 1872 Case Study: Industrial Ecosystems Copying Nature Case Study: The Growing Problem of Coal Ash Case Study: Chernobyl the World's Worst Nuclear Power Plant Accident Case Study: Dealing with Radioactive Wastes in the United States Case Study: Is Biodiesel the Answer? Case Study: Is Ethanol the Answer?	**Chapters**: 12 & 13 **Supplements:** NOVA Labs: Energy Lab http://www.pbs.org/wgbh/nova/labs/lab/energy/ **Case Studies:** Core Case Study: The Real Cost of Gold Core Case Study: Armory Lovis and the Rocky Mountain Institute **Videos:** Geology Kitchen https://www.youtube.com/watch?v=pg_jKJFbA2A, **Websites:** National Geographic: Interactive Maps https://www.nationalgeographic.org/maps/alternative-energy-use EPA: Lesson Plans, Teacher Guides and Online Environmental Resources for Educators https://www.epa.gov/students/lesson-plans-teacher-guides-and-online-environmental-resources-educators

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Grading Period Four: 2 WEEKS				
Unit Eight: Waste Management (ER 4; GP9)		**Clear Learning Targets**	**Recommended Lab Themes/Material Science/ Intervention/Extension**	**Resources: The textbook is to be used as a resource only.**
		The student will be able to: ☐ List the kinds of solid waste humans produce ☐ Assess the sustainability of various methods of trash disposal (landfills, trash-to-steam, recycling, etc.). ☐ Discuss efforts to reduce the amounts solid wastes by manufacturers and consume	**Suggested Labs:** **Lab Themes:** Conservation of Mass, Sustainability, recycling **Intervention:** Case Study: Solid Waste in the United States Case Study: Hazardous Waste Regulation in the United States Case Study: Lead is Highly Toxic Pollutant Build a Landfill model http://www.wakegov.com/recycling/recycle/ftb/Documents/Lesson%20Plans/STL_LFModel_Re.pdf **Extension:** Science Focus: Garbology Individuals Matter: Mike Biddle's Contribution to Recycling Plastics Science Focus: Bioplastics **Vocabulary:** solid waste, industrial solid waste, municipal solid waste (MSW), toxic waste, waste management, waste reduction, integrated waste management, primary recycling, secondary recycling, materials recovery facilities, composting, open dumps, sanitary landfills, hazardous waste	**Field Trip:** SWACO **Chapters**: 16 **Supplements:** Waste Management STEM Challenge http://www.spacegrant.hawaii.edu/class_acts/Waste.html Utah Waste Management Resource https://www.wm.com/location/utah/ut/_documents/UT_Teachersresourceguide.pdf **Case Studies** Drowning in E-Waste **Videos:** Waste Management and recycling https://www.youtube.com/watch?v=HjNv_iTsXn8 **Websites:** https://www.epa.gov/students/lesson-plans-teacher-guides-and-online-environmental-resources-educators Cornell Waste Management Institute http://cwmi.css.cornell.edu/TrashGoesToSchool/Activities9-12.html Garbage Dreams https://www-tc.pbs.org/independentlens/garbage-dreams/classroom/04_garbagedreams_lesson.pdf TeachEngineering https://www.teachengineering.org/lessons/view/cub_environ_lesson04 Missouri Environmental Education Association https://www.meea.org/lessons/5-problems/waste.shtml
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