6th, 7th, & 8th Grade Science Curriculum

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Middle School Science Curriculum Work Committee

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Introduction

This document serves to meet all requirements for curriculum as per the Middle Township Board of Education and the New Jersey Department of Education and will serve as a guide for lesson planning. Units within the curricular framework for science are designed to be taught in the order in which they are presented. Within the units, the teachers have flexibility of what order to present the standards. Suggested Science and Engineering Practice Standards and Cross-Cutting Concepts are listed in each unit to be imbedded regularly in daily science instruction.

Course Description

Middle School science in Middle Township Public School district is interdisciplinary and covers all four domains of the Next Generation Science Standards: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science. The goal of science education curriculum is to produce students who have gained sufficient knowledge of the practices, crosscutting concepts, and core ideas of science and engineering to engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and to continue to learn about science throughout their lives. They should come to appreciate that science and the current scientific understanding of the world are the result of many hundreds of years of creative human endeavor. It is especially important to note that the above goals are for all students, not just those who pursue careers in science, engineering, or technology or those who continue on to higher education (p. 9, NRC, 2012).
Given this goal, an integrated science curriculum model should drive the formation of middle school science curriculum because:

- The nature of science is complex and multidisciplinary.
- Learning theory research in science shows expert knowledge base develops better through interdisciplinary connections and not through isolated content.
- Effective research-based practices for curriculum and instruction in science and engineering are supported through this approach.

Nature of Science

The nature of science is complex and multidisciplinary. From research about how scientists work, we know that scientists do not work in isolation in their own house of physics, or biology or chemistry but they reach out and create networks of scientists within and across disciplines who can contribute understanding, share ideas, and critique evidence and explanations. As we see in the science of global climate change, scientists work across the fields of geology, physics, and biology to provide evidence, plan investigations, and develop models to represent new ways to think about Earth systems. Important practices like engaging in argument from

evidence, modeling, and communicating information do not occur in isolation but rely on feedback from within and across scientific communities and disciplines. Basing the middle school model curriculum in an integrated model where the students are engaged with a variety of topics at each grade, focused on the connection of ideas across the domains, enhances the interdisciplinary nature of science.

Learning Theory

In the elementary years, students build their understandings of core concepts across all three domains of science: physical, life and Earth and space. Continuing this model in grades 6-8 better supports student learning in that there will not be a large gap of time in which a student does not engage in a specific discipline. This model takes advantage of current research which recognizes that there is variation across children at a given age and that thinking does not develop along a preset roadmap for each student. It allows middle school students to build on what they know and think they understand from their elementary years with the goal in middle school of helping students to revise their knowledge and understanding about those core ideas. Learning theory research shows expert knowledge base develops better through interdisciplinary real-world connections then through isolated content. This is especially important in middle school where motivation is critical to learning. An integrated and better articulated middle school model science curriculum that reflects what we know currently about how children learn science and how their mastery develops over time promotes deeper learning in science. As we know and understand about how students develop understanding while learning content, it informs teachers' practice; if teachers understand where their students are in their understanding of core ideas, and anticipate what students' misconceptions and struggles may be, they are better able to differentiate instruction and provide scaffolding that allows students to develop an integrated and deeper understanding of the science.

Research Based Science Instruction and Curriculum

Effective science instruction can take many forms but includes similar components. According to the Center on Instruction's 2010 report, *Effective Science Instruction: What does the Research Tell Us?*, research-based effective practices of curriculum and instruction important to science learning are: Motivation, Eliciting Students' Prior Knowledge, Intellectual Engagement; Use of Evidence to Critique Claims, and Sense-Making. The integrated model may be better able to support some of these instructional practices especially if it frames curriculum around engaging, relevant, and real-world interdisciplinary questions that will increase student motivation, intellectual engagement and sense-making. Effective science instruction helps middle school students build their understandings and practices, makes connections among and between core concepts and practices, and links to their prior knowledge. Students in grades 6-8 come to understand the natural world in a more scientifically accurate way and understand the nature of science.

Conclusion

Science curriculum should be thematic with a focus on connections among and between core concepts and practices. This approach reinforces the interdisciplinary nature of science and allows for a sequential progression of skills and concepts. This supports developmentally appropriate teaching and assessments. Each grade level has its own specific standards from each science domain that are seen as stepping stones in the progression of learning about a core idea and that meet a specific level of understanding. The idea is to embed technology and engineering in this interdisciplinary progression which would also be coordinated with the New Jersey Student Learning Standards.

Three Dimensions of the Next Generation Science Standards

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like “skills” to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC’s intent is to better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they

provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

Pacing Guide

UNIT TITLE	ENDURING UNDERSTANDINGS	NGSS	TIMEFRAME
1 - Cells: The Basic Unit of Life	• Cells are the smallest unit of life that can be said to be alive. • All living things are made of cells, either one cell or many different numbers and types of cells. • Nonliving things can be composed of cells., from once-living things that have died. • Organisms may consist of one single cell (unicellular) or many different types and numbers of cells (multicellular). • The cell functions as a whole system. • Within cells, special structures are responsible for particular functions (organelles- nucleus, chloroplasts, mitochondria, cell membrane, golgi apparatus, endoplasmic reticulum, etc.) • Within cells, the cell membrane forms the boundary that controls what enter and leaves the cell. • Engineering advances have led to important discoveries in the field of cell. • Complex and microscopic structures and systems in cells can be visualized, modeled, and used to describe how the function of the cell depends on the relationship among its parts. • A model can be used to describe the function of a cell as a whole. • A model can be used to describe how parts of cells contributed to the cell's function. • The structures of the cell wall and cell membrane are related to their function.	**MS – LS1-1** **MS – LS1-2**	**20 days**
2 – Body Systems	• In multicellular organisms, the body is a system of multiple, interacting subsystems. • Subsystems are group of cells that work together to form tissues. • Organs are groups of tissues that work together to form a particular body function. • Tissues and organs are specialized for particular body functions. • Systems may interact with other systems. • Systems may have subsystems and be part of larger complex systems. • Interactions are limited to the circulatory, excretory, digestive, respiratory, muscular and nervous system. • Scientists and engineers are guided by habits of mind such as intellectual, honesty, tolerance of ambiguity, skepticism, and openness to new ideas. • Sense receptors respond to different inputs (electromagnetic, mechanical, chemical). • Sense receptors transmit responses as signals that travel along nerve cells to the brain.	**MS – LS1 - 3** **MS – LS1 - 8**	**30 days**

	• Signals are then processed in the brain. • Brain processing results in immediate behaviors or memories. • Cause-and-effect relationships may be used to predict response to stimuli in natural systems.		
3 – Growth, Development and Reproduction of Organisms	• Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features of reproduction. • Specialized structures for plants affect their probability of successful reproduction. • Some characteristic animal behaviors affect the probability of successful reproduction in plants. • Animals engage in characteristic behaviors that affect the probability of successful reproduction. • There are a variety of characteristic animal behaviors that affect their probability of successful reproduction. • There are a variety of animal behaviors that attract a mate. • Successful reproduction of animals and plants may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability. • Genetic factors as well as local conditions affect the growth of an organism. • Genetic factors affect the growth of organisms. • The factors that influence the growth of organisms may have more than one cause. • Some cause-and-effect relationships in plant and animal systems can only be described using probability.	**MS – LS1-4** **MS – LS1-5**	**30 days**
4 - Ecology	• Organisms and populations of organisms are dependent on their environmental interactions with other living things. • Organisms and populations of organisms are dependent on their environmental interactions with nonliving factors. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with other limited resources. • Access to food, water, oxygen, or other resources constrain organisms' growth and reproduction. • Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. • Mutually beneficial interactions may become so interdependent that each organism requires the other to survive. • The patterns of interactions of organisms with their environment, both its living and nonliving components, are shared.	**MS – LS1 – 6** **MS – LS1 - 7** **MS – LS2 – 1** **MS – LS2 – 2** **MS – LS2 – 3**	**35 days**

	• Interactions within ecosystems have patterns that can be used to identify cause-and-effect relationships. • Patterns of interactions among organisms across multiple ecosystems can be predicted. • Patterns of interactions can be used to make predictions about the relationships among and between organisms and abiotic components of ecosystems. • Photosynthesis has a role in the cycling of matter and flow of energy into and out of organisms. • The flow of energy and cycling of matter can be traced. • Plants, algae and many microorganisms use the energy from light to make sugars (food) from carbon dioxide in the atmosphere and water through the process of photosynthesis, which also releases oxygen. • Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy. • Food webs are models that demonstrate how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem. • Transfers of matter into and out of the physical environment occur at every level. • Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments. • The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts.		
5 – Biodiversity and Humans	• Ecosystems are dynamic in nature. • The characteristics of ecosystems can vary over time. • Disruptions to any physical or biological component of an ecosystem can lead to shifts in all the ecosystem's populations. • Small changes in one part of an ecosystem might cause large changes in another part. • Patterns in data about ecosystems can be recognized and used to make warranted inferences about changes in populations. • Evaluating empirical evidence can be used to support arguments about changes to ecosystems. • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic systems. • The completeness, or integrity, of an ecosystem's biodiversity is often used as a measure of its health. • Changes in biodiversity can influence humans' resources, such as food, energy and	**MS – LS2-4** **MS – LS2–5** **MS – ESS3-3** **MS – ETS1-1** **MS – ETS1-3**	**30 days**

	medicine. • Changes in biodiversity can influence ecosystem services that humans rely on. • There are systematic processes for evaluation solutions with respect to how well they meet the criteria and constraints of a problem. • A solution needs to be tested and modified on the basis of the test results, in order to improve it. • Models of all kinds are important for testing solutions. • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.		
6 – Waves and the Electromagnetic Spectrum	• A simple wave has a repeating pattern with a specific wavelength, frequency and amplitude. • Describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. • Graphs and charts can be used to identify patterns in data. • Waves can be described with both qualitative and quantitative thinking. • When light shines on an object, it is reflected, absorbed or transmitted through the object, depending on the object's material and frequency (color) of the light. • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g. , air and water, air and glass) where the light path bends. • A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. • Waves are reflected, absorbed, or transmitted through various materials. • A sound wave needs a medium through which it is transmitted. • Because light can travel through space, it cannot be a matter wave, like sound or water waves. • The structure of a wave can be modified to serve particular functions by taking into account properties of different materials and how materials can be shaped and used. • Structures can be designed to use properties of waves to serve particular functions. • Waves can be used for communication purposes. • Digitized signals (wave pulses) are a more reliable way to encode and transmit information than are analog signals. • Wave-related technologies extend the measurement, exploration, modeling and computational capacity of scientific investigations.	**MS – PS4-1** **MS – PS4-2** **MS – PS4-3**	**20 days**

Content Area:	**Life Science - Structure, Function and Information Processing of Cells**	**Grade(s) 6th**
Unit Plan Title:	**Unit 1 - Cells: The Basic Unit of Life**	

Overview/Rationale

How do cells contribute to the functioning of an organism?
Students demonstrate age appropriate abilities to plan and carry out investigations to develop evidence that living organisms are made of cells. Students gather information to support explanations of the relationship between structure and function in cells. They are able to communicate an understanding of cell theory and understand that all organisms are made of cells. Students understand that special structures are responsible for particular functions in organisms. They then are able to use their understanding of cell theory to develop and use physical and conceptual models of cells. The crosscutting concepts of scale, proportion, and quantity and structure and function provide a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in planning and carrying out investigations, analyzing and interpreting data, and developing and using models. Students are also expected to use these science and engineering practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-LS-1, MS-LS1-2

Disciplinary Core Ideas

LS1.A: Structure and Function

- All living things are made up of cells, which is the smallest unit that can be said to be alive. An organism may consist of one single cell (unicellular) or many different numbers and types of cells (multicellular). (MS-LS1-1)
- Within cells, special structures are responsible for particular functions, and the cell membrane forms the boundary that controls what enters and leaves the cell. (MS-LS1-2)

Science and Engineering Practices

SEP- 2: Developing and Using Models

- Develop a model to describe phenomena. (MS-LS1-2)

SEP-3: Planning and Carrying Out Investigations

- Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of an investigation. (MS-LS1-1)

SEP-7: Engaging in Argument from Evidence

- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)

SEP-8: Obtaining, Evaluating, and Communicating Information

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)

Cross-Cutting Concepts

CCC-3: Scale, Proportion, and Quantity

- Phenomena that can be observed at one scale may not be observable at another scale. (MS-LS1-1)

CCC-6: Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS1-2)

CCC-4: Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS1-1)

Science Is a Human Endeavor

- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

Technology Standard(s)

8.1.8.D.4-Assess the credibility and accuracy of digital content
8.1.8.E.1- Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem
8.2.8.C.1- Explain how different teams/groups can contribute to the overall design of a product
8.2.8.C.2- Explain the need for optimization in a design process
8.2.8.C.4- Identify the steps in the design process that would be used to solve a designated problem

Interdisciplinary Standard(s)

ELA/Literacy

- **RI.6.8** - Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-3)
- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3)
- **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add

interest. (MS-LS1-2)

- **WHST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3)
- **WHST.6-8.8** - Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS1-8)

Mathematics

- **6.EE.C.9** - Use variables to represent two quantities, such as the number of cells that make up an organism and units representing the size or type of the organism and determine the relationship between these two variables. Use variables to help determine the ratio of the cell's surface area to its volume. (MS-LS1-1), (MS-LS1-2), (MS-LS1-3)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Cells are the smallest unit of life that can be said to be alive.
- All living things are made of cells, either one cell or many different numbers and types of cells.
- Nonliving things can be composed of cells., from once-living things that have died.
- Organisms mayconsist of one single cell (unicellular) or many different types and numbers of cells (multicellular).
- The cell functions as a whole system.
- Within cells, special structures are responsible for particular functions (organelles-nucleus, chloroplasts, mitochondria, cell membrane, golgi apparatus, endoplasmic reticulum, etc.)
- Within cells, the cell membrane forms the boundary that controls what enter and leaves the cell.
- Engineering advances have led to important discoveries in the field of cell.
- Complex and microscopic structures and systems in cells can be visualized, modeled, and used to describe how the function of the cell depends on the relationship among its parts.
- A model can be used to describe the function of a cell as a whole.
- A model can be used to describe how parts of cells contributed to the cell's function.
- The structures of the cell wall and cell membrane are related to their function.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- What is a cell and what is the cell theory?
- What do the traits of cells tell you about their jobs?

- How do the parts of a cell work?
- How do the functions of cells support an entire organism?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
	Global Awareness	**E,T,A**	**Critical Thinking & Problem Solving**
	Environmental Literacy	**E,T,A**	**Creativity and Innovation**
X	**Health Literacy**	**E,T,A**	**Collaboration, Teamwork and Leadership**
	Civic Literacy	**E,T,A**	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy		**Communication and Media Fluency**
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
E,T,A	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E,T,A	**CRP4. Communicate clearly and effectively with reason**
	CRP5. Consider the environmental, social and economic impacts of decisions
E,T,A	**CRP6. Demonstrate creativity and innovation**
E,T	**CRP7. Employ valid and reliable research strategies**
E,T,A	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**

	E,T,A	**CRP9. Model integrity, ethical leadership and effective management**
		CRP10. Plan education and career paths aligned to personal goals
		CRP11. Use technology to enhance productivity
	E,T,A	**CRP12. Work productively in teams while using cultural global competence**

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
• Cells are the smallest unit of life. • All living things are made of cells, either one or many. • Cells that can be observed at one scale may not be observable at another scale. • Nonliving things can be composed of cells, from once-living things that have died. • Engineering advances have led to the important discoveries in cell theory. • Every organelle in a cell is responsible for particular functions. • The cell functions as a whole system.	• Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells. MS-LS1-1 (**Clarification Statement:** Emphasis is on developing evidence that living things are made of cells, distinguishing between living and non-living things, and understanding that living things may be made of one cell or many and varied cells.) • Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function. MS-LS1-2 (**Clarification Statement:** Emphasis is on the cell functioning as a whole system and the primary role of identified parts of the cell, specifically the nucleus, chloroplasts, mitochondria, cell membrane, and cell wall. **Assessment Boundary:** . Assessment of the function of the organelles is limited to their relationship to the whole cell. Assessment does not include the biochemical function of cells or cell parts.)

Assessment Evidence:

Formative:	**Summative Assessment Measures*:***
(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)	*(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will*

• Conduct an investigation to produce data supporting the concept that living things may be made of one or many cells • Distinguish between living and nonliving things • Observe different types of cells that can be found in the makeup of living things • Compare a cell to a real-life working system, using a model to describe the function of a cell as a whole (ie: a factory, amusement park, school, etc.) • Develop and use a model to describe the parts of a cell and each corresponding function • Compare and contrast animal and plant cells	*students reflect upon and self- assess their learning?)* ***Attach all Benchmarks*** • Unit Test • Quizzes • Edible Cell Project

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** • Interactive notebook with essential questions, vocabulary and guided notes in flipables • Classroom discussion of labs and activities to ensure understanding • Analogies of cells used to model a working system • Diagrams of cells • Do Now questions and written answers • Answers to LEQ and "AHAs" (interactive notebook) Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences).

	• Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Topic selection by interest • www.cellsalive.com • A Busy Factory Website (http://www.slcschools.org/departments/curriculum/science/grade-7-to-8/grade-7/documents/s3-o2-lesson-cell-as-a-factory-website-pdf.pdf) • Cell Structure Lab (http://ngss.nsta.org/Resource.aspx?ResourceID=525) • Textbook

Suggested Time Frame:	20 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Structure, Function and Information Processing	Grade(s) 6th
Unit Plan Title:	Unit 2- Body Systems	

Overview/Rationale

In this unit students develop a basic understanding of the role of cells in body systems and how those systems work to support the life functions of the organism. Students will construct explanations for the interactions of systems in cells and organisms. Students understand that special structures are responsible for particular functions in organisms, and that for many organisms, the body is a system of multiple-interaction subsystems that form a hierarchy, from cells to the body. Students construct explanations for the interactions of systems in cells and organisms and for how organisms gather and use information from the environment. The crosscutting concepts of systems and system models and cause and effect provide a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in engaging in argument from evidence and obtaining, evaluating, and communicating information. Students use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Science Standards (Established Goals)

MS-LS1-3, MS-LS1-8

Disciplinary Core Ideas

LS1.A: Structure and Function

- In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions. (MS-LS1-3)

LS1.D: Information Processing

- Each sense receptor responds to different inputs (electromagnetic, mechanical, chemical), transmitting them as signals that travel along nerve cells to the brain. The signals are then processed in the brain, resulting in immediate behaviors or memories. (MS-LS1-8)

Science and Engineering Practices

SEP-8: Obtaining, Evaluating, and Communicating Information

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS1-8)

SEP-7: Engaging in Argument from Evidence

- Use an oral and written argument supported by evidence to support or refute an explanation or a model for a phenomenon. (MS-LS1-3)

Cross-Cutting Concepts

CCC-2: Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8)

CCC-4: Systems and System Models

- Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3)

Science Is a Human Endeavor

- Scientists and engineers are guided by habits of mind such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas. (MS-LS1-3)

Technology Standard(s)

8.1.8.E.1- Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem
8.1.8.F.1- Plan and manage activities to develop a solution or complete a project

Interdisciplinary Standard(s)

ELA/Literacy

- **RI.6.8** - Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-3)
- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-3)
- **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2)
- **WHST.6-8.8** - Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS1-8)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- In multicellular organisms, the body is a system of multiple, interacting subsystems.

- Subsystems are group of cells that work together to form tissues.
- Organs are groups of tissues that work together to form a particular body function.
- Tissues and organs are specialized for particular body functions.
- Systems may interact with other systems.
- Systems may have subsystems and be part of larger complex systems.
- Interactions are limited to the circulatory, excretory, digestive, respiratory, muscular and nervous system.
- Scientists and engineers are guided by habits of mind such as intellectual, honesty, tolerance of ambiguity, skepticism, and openness to new ideas.
- Sense receptors respond to different inputs (electromagnetic, mechanical, chemical).
- Sense receptors transmit responses as signals that travel along nerve cells to the brain.
- Signals are then processed in the brain.
- Brain processing results in immediate behaviors or memories.
- Cause-and-effect relationships may be used to predict response to stimuli in natural systems.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- What are tissues and organs?
- What constitutes a system?
- What is the evidence that a body is actually a system of interacting subsystems composed of groups of interacting cells?
- How do organisms receive and respond to information from their environment?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Centur y Skills	
	Global Awareness	**E,T,A**	**Critical Thinking & Problem Solving**
	Environmental Literacy		**Creativity and Innovation**
X	**Health Literacy**	**E,T,A**	**Collaboration, Teamwork and Leadership**
	Civic Literacy	**E,T,A**	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and		**Communication and Media Fluency**

	Entrepreneurial Literacy		Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

Indicate whether these skills are ***E****-Encouraged,* ***T****-Taught, or* ***A****-Assessed in this unit by marking* ***E, T, A*** *on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
E,T,A	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E,T,A	**CRP4. Communicate clearly and effectively with reason**
E,T,A	**CRP5. Consider the environmental, social and economic impacts of decisions**
	CRP6. Demonstrate creativity and innovation
E,T,A	**CRP7. Employ valid and reliable research strategies**
E,T,A	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
	CRP9. Model integrity, ethical leadership and effective management
	CRP10. Plan education and career paths aligned to personal goals
	CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	*Students will be able to (do)…*
• In multicellular organisms, the body is a system of multiple, interacting subsystems. • Cells form tissues, tissues form organs and organs form body systems. • Tissues and organs are specialized for particular body functions. • Systems may interact with other systems. • Body systems include the circulatory, excretory, digestive, respiratory, muscular and nervous system. • Sense receptors respond to different inputs (electromagnetic, mechanical, chemical). • Sense receptors transmit responses as signals that travel along nerve cells to the brain. • Signals are then processed in the brain. • Brain processing results in immediate behaviors or memories.	• Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells. MS-LS1-3 (Clarification Statement: Emphasis is on the conceptual understanding that cells form tissues and tissues form organs specialized for particular body functions. Examples could include the interaction of subsystems within a system and the normal functioning of those systems. .Assessment Boundary: Assessment does not include the mechanism of one body system independent of others. Assessment is limited to the circulatory, excretory, digestive, respiratory, muscular, and nervous systems.) • Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories. MS-LS1-8 (Clarification Statement: none, Assessment Boundary: Assessment does not include mechanisms for the transmission of this information.)
Assessment Evidence:	
Formative Tasks: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Explore human anatomy and body systems on-line and explain how they interact • Hypothesis and test how sensory receptors respond to stimuli • Diagram essential components of body systems: circulatory, digestive, respiratory, etc.	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Unit test • Multimedia presentation of a body system

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** ☐ Interactive notebook with flipables, vocabulary and illustrations ☐ Guided notes and lab sheets to make sure students are on track with the content ☐ Essential questions and answers ☐ Classroom discussions of labs and activities to ensure understanding ☐ Do Now answers to review material as well as to aide in making connections to their lives Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ☐ Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). ☐ Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). ☐ Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). ☐ Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. ☐ Use project-based science learning to connect science with observable phenomena. ☐ Structure the learning around explaining or solving a social or community-based issue. ☐ Provide ELL students with multiple literacy strategies. ☐ Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources	
Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI) ***Individualized Education Plans (IEPs):*** ⇒ Exemplars of varied performance levels ⇒ Multi-media presentations Consultation with ESL teachers ⇒ Manipulatives ⇒ Tiered/Scaffolded Lessons ⇒ Mnemonic devices ⇒ Visual aids ⇒ Modeling ⇒ Guided note-taking ⇒ Study Guides ⇒ Modified homework ⇒ Differentiated pre-typed class notes and example problems ***Advanced/Gifted Students:*** ⇒ Open-ended responses ⇒ Curriculum Compacting ⇒ Advanced problems to extend the critical thinking skills of advanced learner ⇒ Supplemental reading material for independent study ⇒ Flexible grouping ⇒ Tiered assignments Topic selection by interest • SEPUP Body Works Activities • NOVA body + brain Website • Animal Communications Website • No Ordinary Coronary (http://ngss.nsta.org/Resource.aspx?ResourceID=268) • Textbook	
Suggested Time Frame:	30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Life Science - Growth, Development and Reproduction of Organisms	Grade(s) 6th
Unit Plan Title:	Unit 3 - Growth, Development and Reproduction of Organisms	

Overview/Rationale

Students use data and conceptual models to understand how the environment and genetic factors determine the growth of an individual organism. They connect this idea to the role of animal behaviors in animal reproduction and to the dependence of some plants on animal behaviors for their reproduction. Students provide evidence to support their understanding of the structures and behaviors that increase the likelihood of successful reproduction by organisms. The crosscutting concepts of cause and effect and structure and function provide a framework for understanding the disciplinary core ideas. Students demonstrate grade-appropriate proficiency in analyzing and interpreting data, using models, conducting investigations, and communicating information. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-LS1-4 and MS-LS1-5

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms

- Animals engage in characteristic behaviors that increase the odds of reproduction. (MS-LS1-4)
- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction. (MS-LS1-4)
- Genetic factors as well as local conditions affect the growth of the adult plant. (MS-LS1-5)
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary to MS-LS3-2)*

Science and Engineering Practices

SEP-6: Constructing Explanations and Designing Solutions

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-LS1-5)

SEP-7: Engaging in Argument from Evidence

- Use an oral and written argument supported byempirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS1-4)

SEP-8: Obtaining, Evaluating, and Communicating Information

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)

Cross-Cutting Concepts

CCC-2: Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2)
- Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability.(MS-LS1-4), (MS-LS1-5), (MS-LS4-5)

CCC-6: Structure and Function

- Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)

Technology Standard(s)

8.1.8.A.3- Use and/or develop a simulation that provides an environment to solve a real world problem or theory
8.1.8.D.4- Assess the credibility and accuracy of digital content

Interdisciplinary Standard(s)

ELA/Literacy

- **RI.6.8** - Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not. (MS-LS1-4)
- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4), (MS-LS1-5), (MS-LS3-1), (MS-LS3-2), (MS-LS4-5)
- **RST.6-8.2** - Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-5)
- **RST.6-8.4** - 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 6–8 texts and topics. (MS-LS3-1), (MS-LS3-2)
- **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually

(e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2)

- **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1), (MS-LS3-2)
- **WHST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4)
- **WHST.6-8.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-LS1-5)
- **WHST.6-8.8** - Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5)
- **WHST.6-8.9** - Draw evidence from informational texts to support analysis reflection, and research. (MS-LS1-5)

Mathematics

- **6.SP.A.2** - Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. (MS-LS1-4), (MS-LS1-5)
- **6.SP.B.5** - Summarize numerical data sets in relation to their context. (MS-LS3-2)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features of reproduction.
- Specialized structures for plants affect their probability of successful reproduction.
- Some characteristic animal behaviors affect the probability of successful reproduction in plants.
- Animals engage in characteristic behaviors that affect the probability of successful reproduction.
- There are a variety of characteristic animal behaviors that affect their probability of successful reproduction.
- There are a variety of animal behaviors that attract a mate.
- Successful reproduction of animals and plants may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.
- Genetic factors as well as local conditions affect the growth of an organism.
- Genetic factors affect the growth of organisms.
- The factors that influence the growth of organisms may have more than one cause.
- Some cause-and-effect relationships in plant and animal systems can only be described using probability.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- What characteristics do all plants share and what do they need to live successfully on land?
- How do the characteristics of nonvascular and vascular plants differ?
- How do the structure and function of the roots, stems, leaves and flowers compare?
- What are the stages of a plant life cycle and how do they reproduce?
- What are the characteristics that all animals have in common?
- What are the two ways that animals reproduce? How do they differ?
- How do adaptations allow animals to survive and reproduce on Earth?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply.

21st Centur y Themes

	Global Awareness
X	**Environmental Literacy**
	Health Literacy
	Civic Literacy
	Financial, Economic, Business and Entrepreneurial Literacy

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

21st Centur y Skills

E,T,A	**Critical Thinking & Problem Solving**
E,T,A	**Creativity and Innovation**
E,T,A	**Collaboration, Teamwork and Leadership**
E,T,A	**Cross-Cultural and Interpersonal Communication**
	Communication and Media Fluency
	Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
E,T,A	**CRP2. Apply appropriate academic and technical skills**

	CRP3. Attend to personal health and financial well-being
E,T,A	CRP4. Communicate clearly and effectively with reason
E,T,A	CRP5. Consider the environmental, social and economic impacts of decisions
E,T,A	CRP6. Demonstrate creativity and innovation
	CRP7. Employ valid and reliable research strategies
E,T,A	CRP8. Utilize critical thinking to make sense of problems and persevere in solving them
E,T,A	CRP9. Model integrity, ethical leadership and effective management
	CRP10. Plan education and career paths aligned to personal goals
	CRP11. Use technology to enhance productivity
E,T,A	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
• There are vascular and nonvascular plants. • All plants have specific organelles, chloroplasts, cell wall, chlorophyll, vacuole, etc. to aid in its survival. • Plants reproduce in a variety of ways. • There are invertebrates and vertebrates. • Animals reproduce sexually or asexually. • Some animals go through metamorphosis: incomplete or complete. • Fertilization can occur externally or internally. • Behavioral and physical adaptations allow an animal to survive and be able to reproduce. • Environmental factors can affect the growth and development of organisms.	• Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. MS-LS1-4 (**Clarification Statement:** Examples of behaviors that affect the probability of animal reproduction could include nest building to protect young from cold, herding of animals to protect young from predators, and vocalization of animals and colorful plumage to attract mates for breeding. Examples of animal behaviors that affect the probability of plant reproduction could include transferring pollen or seeds, and creating conditions for seed germination and growth. Examples of plant structures could include bright flowers attracting butterflies that transfer

	pollen, flower nectar and odors that attract insects that transfer pollen and hard shells on nuts that squirrels bury. **Assessment Boundary:** none) • Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. MS-LS1-5 (**Clarification Statement:** Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds. **Assessment Boundary:** Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.)
Assessment Evidence:	
Formative *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Conduct an experiment exploring the structures of plants • Compare and contrast vascular and nonvascular plants • Observe and explain animal growth and development, such as in the metamorphosis of a butterfly • Observe and explain how animals can transfer pollen or seeds • Analyze a graph for deer population and explain the likelihood of the population to reproduce at given years • Model different animal adaptations in order to survive given conditions	**Summative Assessment Measures*****:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Unit Assessment • Quizzes • Adaptation Olympics

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** - Interactive notebook with essential questions, vocabulary and guided notes in flipables - Classroom discussion of labs and activities to ensure understanding - Simulations of environmental conditions affecting growth of organisms and analysis of data - Animal adaptation activities - Do Now questions and written answers - Answers to LEQ and "AHAs" (interactive notebook) Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* - Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. - Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). - Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). - Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). - Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. - Use project-based science learning to connect science with observable phenomena. - Structure the learning around explaining or solving a social or community-based issue. - Provide ELL students with multiple literacy strategies. - Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

- ⇒ Exemplars of varied performance levels
- ⇒ Multi-media presentations Consultation with ESL teachers
- ⇒ Manipulatives
- ⇒ Tiered/Scaffolded Lessons
- ⇒ Mnemonic devices
- ⇒ Visual aids
- ⇒ Modeling
- ⇒ Guided note-taking
- ⇒ Study Guides
- ⇒ Modified homework
- ⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

- ⇒ Open-ended responses
- ⇒ Curriculum Compacting
- ⇒ Advanced problems to extend the critical thinking skills of advanced learner
- ⇒ Supplemental reading material for independent study
- ⇒ Flexible grouping
- ⇒ Tiered assignments

Topic selection by interest

- Investigating Reproductive Strategies (http://ngss.nsta.org/Resource.aspx?ResourceID=20)
- Plants and Animals, Partners in Pollination (http://ngss.nsta.org/Resource.aspx?ResourceID=137)
- Reproduction (http://ngss.nsta.org/Resource.aspx?ResourceID=149)
- Effect of Environment on Plant Growth (http://ngss.nsta.org/Resource.aspx?ResourceID=206)
- Concord Consortium: Virtual Simulations (http://concord.org)
- Phet: Interactive Simulations (https://phet.colorado.edu/)
- Textbook

Suggested Time Frame:	35 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	**Life Science - Matter and Energy Flow in Organisms and Ecosystems**	**Grade(s) 6th**
Unit Plan Title:	**Unit 4- Ecology**	

Overview/Rationale

Students analyze and interpret data, develop models, construct arguments and demonstrate a deeper understanding of the cycling of matter, the flow of energy and resources in ecosystems. They are able to study patterns of interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on populations. They also understand that the limits of resources influence the growth of organisms and populations, which may result in competition for those limited resources. The crosscutting concepts of matter and energy, systems and system models, patterns and cause and effect provide a framework for understanding the disciplinary core ideas. Students demonstrate grade-appropriate proficiency in analyzing and interpreting data, developing models and constructing arguments. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS1-6, MS-LS1-7

Disciplinary Core Ideas

PS3.D: Energy in Chemical Processes and Everyday Life

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. *(secondary to MS-LS1-6)*
- Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary to MS-LS1-7)*

LS1.C: Organization for Matter and Energy Flow in Organisms

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. (MS-LS2-1)
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. (MS-LS2-1)
- Growth of organisms and population increases are limited by access to resources. (MS-LS2-1)
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in

these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared. (MS-LS2-2)

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

Science and Engineering Practices

SEP-2: Developing and Using Models

- Develop a model to describe phenomena. **(MS-LS2-3)**
- Develop a model to describe unobservable mechanisms. (MS-LS1-7)

SEP-4: Analyzing and Interpreting Data

- Analyze and interpret data to provide evidence for phenomena. **(MS-LS2-1)**

SEP-6: Constructing Explanations and Designing Solutions

- Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **(MS-LS1-6)**
- Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. (MS-LS2-2)

SEP-7: Engaging in Argument from Evidence

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. **(MS-LS2-4)**

Connections to Nature of Science

- Science knowledge is based upon logical connections between evidence and explanations. **(MS-LS1-6)**
- Science disciplines share common rules of obtaining and evaluating empirical evidence.(MS-LS2-4)

Cross-Cutting Concepts

CCC-2: Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-LS2-1)

CCC-5: Energy and Matter

- Matter is conserved because atoms are conserved in physical and chemical processes.(MS-LS1-7)
- Within a natural system, the transfer of energy drives the motion and/or cycling of matter. (MS-LS1-6)
- The transfer of energy can be tracked as energy flows through a natural system. (MS-LS2-3)

CCC-1: Patterns

- Patterns can be used to identify cause-and-effect relationships. (MS-LS2-2)

CCC-7: Stability and Change

- Small changes in one part of a system might cause large changes in another part. (MS-LS2-4)

Technology Standard(s)

8.1.8.A.3- Use and/or develop a simulation that provides an environment to solve a real world problem or theory
8.2.8.C.1- Explain how different teams/groups can contribute to the overall design of a product.
8.2.8.C.2- Explain the need for optimization in a design process
8.2.8.C.5- Explain the interdependence of a subsystem the operates as part of a system

Interdisciplinary Standard(s)

ELA/Literacy

- **RI.8.8** - Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced. (MS-LS2-4)
- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6), (MS-LS2-1), (MS-LS2-4)
- **RST.6-8.2** - Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-LS1-6)
- **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS2-1)
- **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-7), (MS-LS2-3)

- **WHST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-4)
- **WHST.6-8.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-LS1-6)
- **WHST.6-8.9** - Draw evidence from informational texts to support analysis reflection, and research. (MS-LS1-6)

Mathematics

- **6.EE.C.9** - Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-6), (MS-LS2-3)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Organisms and populations of organisms are dependent on their environmental interactions with other living things.
- Organisms and populations of organisms are dependent on their environmental interactions with nonliving factors.
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with other limited resources.
- Access to food, water, oxygen, or other resources constrain organisms' growth and reproduction.
- Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms.
- Mutually beneficial interactions may become so interdependent that each organism requires the other to survive.
- The patterns of interactions of organisms with their environment, both its living and nonliving components, are shared.
- Interactions within ecosystems have patterns that can be used to identify cause-and-effect relationships.
- Patterns of interactions among organisms across multiple ecosystems can be predicted.
- Patterns of interactions can be used to make predictions about the relationships among and between organisms and abiotic components of ecosystems.
- Photosynthesis has a role in the cycling of matter and flow of energy into and out of organisms.
- The flow of energy and cycling of matter can be traced.
- Plants, algae and many microorganisms use the energy from light to make sugars (food) from carbon dioxide in the atmosphere and water through the process of photosynthesis, which also releases oxygen.
- Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy.

- Food webs are models that demonstrate how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem.
- Transfers of matter into and out of the physical environment occur at every level.
- Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments.
- The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- What does an organism get from its environment?
- How are organisms organized within an ecosystem?
- What causes populations to change in size?
- What relationships do organisms develop amongst each other and why?
- How do animals obtain their energy?
- How do plants obtain their energy?
- How is matter and energy transferred/ transformed in living things?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
	Global Awareness	**E,T,A**	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**		**Creativity and Innovation**
	Health Literacy	**E,T,A**	**Collaboration, Teamwork and Leadership**
	Civic Literacy	**E,T,A**	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy	**E,T,A**	**Communication and Media Fluency**
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:	
*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*	
E,T,A	**CRP1. Act as a responsible and contributing citizen and employee**
E,T,A	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E,T,A	**CRP4. Communicate clearly and effectively with reason**
E,T,A	**CRP5. Consider the environmental, social and economic impacts of decisions**
	CRP6. Demonstrate creativity and innovation
	CRP7. Employ valid and reliable research strategies
E,T,A	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
E,T,A	**CRP9. Model integrity, ethical leadership and effective management**
	CRP10. Plan education and career paths aligned to personal goals
	CRP11. Use technology to enhance productivity
E,T,A	**CRP12. Work productively in teams while using cultural global competence**

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)	
Students will know….	***Students will be able to (do)…***
• Organisms and populations of organisms are dependent on their environmental interactions with both nonliving factors and other living organisms. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with other limited resources. • Access to food, water, oxygen, or other resources constrain organisms' growth and reproduction.	• Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. MS-LS1-6 (Clarification Statement: Emphasis is on tracing movement of matter and flow of energy. Assessment Boundary: Assessment does not include the biochemical mechanisms of photosynthesis.)

• Predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. • Mutually beneficial interactions may become so interdependent that each organism requires the other to survive. • Interactions within ecosystems have patterns that can be used to identify cause-and-effect relationships. • Patterns of interactions among organisms across multiple ecosystems can be predicted. • Patterns of interactions can be used to make predictions about the relationships among and between organisms and abiotic components of ecosystems. • Photosynthesis has a role in the cycling of matter and flow of energy into and out of organisms. • The flow of energy and cycling of matter can be traced. • Plants, algae and many microorganisms use the energy from light to make sugars (food) from carbon dioxide in the atmosphere and water through the process of photosynthesis, which also releases oxygen. • Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy. • Food webs are models that demonstrate how matter and energy are transferred among producers, consumers, and decomposers as the three groups interact within an ecosystem. • Transfers of matter into and out of the physical environment occur at every level. • Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments. • The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts.	• Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism. MS-LS1-7 (Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released. Assessment Boundary: Assessment does not include details of the chemical reactions for photosynthesis or respiration.) • Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem. MS-LS2-1 (Clarification Statement: Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources. Assessment Boundary: none) • Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem. MS-LS2-3 (Clarification Statement: Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system. Assessment Boundary: Assessment does not include the use of chemical reactions to describe the processes.) • Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems. MS-LS2-2 (Clarification Statement: Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial. Assessment Boundary: none)

Assessment Evidence:	
Formative *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Conduct a lab/simulation to model limiting factors and the effects on a population • Distinguish between living and nonliving things • Examine and analyze graphs of a population's growth, the birth rate and death rate • Model, play and explain a game to show relationships among living organisms to show competition, predation, symbiosis, mutualism, etc. • Examine and compare/contrast the processes of photosynthesis and cellular respiration • Role play organisms in a food web and food chain • Observe and hypothesize the energy the transfer and transformations in an energy pyramid	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?) ******Attach all Benchmarks*** • Unit Test • Quizzes • Ecosystem Diorama • Labs

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** ☐ Interactive notebook with essential questions, vocabulary and guided notes in flipables ☐ Classroom discussion of labs and activities to ensure understanding ☐ Discussion of simulations modeling how limiting factors affect populations ☐ Role playing of organisms within an ecosystem and discussion of the food web ☐ Do Now questions and written answers • Answers to LEQ and "AHAs" (interactive notebook) Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests,

	social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework

⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments
Topic selection by interest

Resources

Interactive Interdependence (http://www.nsta.org/publications/news/story.aspx?id=53165)

- Flow of Matter and Energy in Ecosystems (http://ngss.nsta.org/Resource.aspx?ResourceID=173)
- Investigating Photosynthesis (http://ngss.nsta.org/Resource.aspx?ResourceID=170)
- Exploring the "systems" in Ecoystems (http://ngss.nsta.org/Resource.aspx?ResourceID=172)
- The Simple Story of Photosynthesis and Food (http://ngss.nsta.org/Resource.aspx?ResourceID=174)
- Habitable Planet Population Simulator (http://www.learner.org/courses/envsci/interactives/ecology/)
- Food Webs Lab (http://www.nsta.org/publications/press/extras/adi-lifescience.aspx)
- Chesapeake Bay Food Web (http://www.amnh.org/explore/curriculum-collections/ecology-disrupted/chesapeake-bay)
- Textbook

Suggested Time Frame:	35 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	**Life Science - Interdependent Relationships in Ecosystems**	**Grade(s) 6th**
Unit Plan Title:	**Unit 5- Biodiversity and Humans**	

Overview/Rationale

Students build on their understandings of the transfer of matter and energy as they study patterns of interactions among organisms within an ecosystem. They consider biotic and abiotic factors in an ecosystem and the effects these factors have on population. They construct explanations for the interactions in ecosystems and the scientific, economic, political and social justifications used in making decisions about maintaining biodiversity in ecosystems. The crosscutting concept of stability and change provide a framework for understanding the disciplinary core ideas.

This unit includes a two-stage engineering design process. Students first evaluate different engineering ideas that have been proposed using a systematic method, such as a tradeoff matrix, to determine which solutions are most promising. They then test different solutions, and combine the best ideas into a new solution that may be better than any of the preliminary ideas. Students demonstrate grade appropriate proficiency in asking questions, designing solutions, engaging in argument from evidence, developing and using models, and designing solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-LS2-4, MS-LS2-5, MS-ESS3-3, MS-ETS1-1, MS-ETS1-3

Disciplinary Core Ideas

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4)
- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5)

LS4.D: Biodiversity and Humans

- Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on— for example, water purification and recycling. *(secondary to MS-LS2-5)*

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.(MS-ESS3-

3)

ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary to MS-LS2-5)*

Science and Engineering Practices

SEP- 7: Engaging in Argument from Evidence

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4)
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)

Connections to Nature of Science

- Science disciplines share common rules of obtaining and evaluating empirical evidence.(MS-LS2-4)

Cross-Cutting Concepts

CCC-7: Stability and Change

- Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)

Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5)

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

Technology Standard(s)

8.2.8.C.1- Explain how different teams/groups can contributed to the overall design of a product
8.2.8.C.2- Explain the need for optimization in a design process
8.2.8.C.3- Evaluate the function, value and aesthetics of a technological product or system, from the perspective of the user and the producer
8.2.8.C.4- Identify the steps in the design process that would be used to solve a designated problem
8.2.8.C.5- Explain the interdependence of a subsystem that operates as part of a system
8.2.8.C.8- Develop a proposal for a chosen solution that include models (physical, graphical or mathematical) to communicate the solution to peers

Interdisciplinary Standard(s)

ELA/Literacy

- **RI.8.8** - Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced. (MS-LS2-5)
- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-2)
- **RST.6-8.8** - Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)
- **SL.8.1** - Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS2-2)
- **SL.8.4** - Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS2-2)
- **WHST.6-8.2** - Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (MS-LS2-2)
- **WHST.6-8.9** - Draw evidence from informational texts to support analysis reflection, and research. (MS-LS2-2)

Mathematics

- **6.RP.A.3** - Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (MS-LS2-5)
- **6.SP.B.5** - Summarize numerical data sets in relation to their context. (MS-LS2-2)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Ecosystems are dynamic in nature.
- The characteristics of ecosystems can vary over time.
- Disruptions to any physical or biological component of an ecosystem can lead to shifts in all the ecosystem's populations.
- Small changes in one part of an ecosystem might cause large changes in another part.
- Patterns in data about ecosystems can be recognized and used to make warranted inferences about changes in populations.
- Evaluating empirical evidence can be used to support arguments about changes to ecosystems.
- Biodiversity describes the variety of species found in Earth's terrestrial and oceanic systems.
- The completeness, or integrity, of an ecosystem's biodiversity is often used as a measure of its health.

- Changes in biodiversity can influence humans' resources, such as food, energy and medicine.
- Changes in biodiversity can influence ecosystem services that humans rely on.
- There are systematic processes for evaluation solutions with respect to how well they meet the criteria and constraints of a problem.
- A solution needs to be tested and modified on the basis of the test results, in order to improve it.
- Models of all kinds are important for testing solutions.
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.
- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- What is biodiversity?
- Why is biodiversity important?
- What is the status of biodiversity?
- How can a single change to an ecosystem disrupt the whole system?
- What are the main types of environmental issues?
- How can we protect biodiversity?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply.	**21st Centur y Themes**	*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*	**21st Centur y Skills**
x	**Global Awareness**	E,T,A	**Critical Thinking & Problem Solving**
x	**Environmental Literacy**	E,T,A	**Creativity and Innovation**
	Health Literacy	E,T,A	**Collaboration, Teamwork and Leadership**
	Civic Literacy	E,T,A	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy	E,T,A	**Communication and Media Fluency**
		E,T,A	**Accountability, Productivity and Ethics**

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

E,T,A	**CRP1. Act as a responsible and contributing citizen and employee**
E,T,A	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E,T,A	**CRP4. Communicate clearly and effectively with reason**
E,T,A	**CRP5. Consider the environmental, social and economic impacts of decisions**
E,T,A	**CRP6. Demonstrate creativity and innovation**
E,T,A	**CRP7. Employ valid and reliable research strategies**
E,T,A	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
E,T,A	**CRP9. Model integrity, ethical leadership and effective management**
	CRP10. Plan education and career paths aligned to personal goals
E,T,A	**CRP11. Use technology to enhance productivity**
E,T,A	**CRP12. Work productively in teams while using cultural global competence**

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
• Ecosystems are constantly changing. • Disruptions to any component of an ecosystem can lead to shifts in all the ecosystem's populations. • Small changes in one part of an ecosystem might cause large changes in another part. • Patterns in data about ecosystems can be rnoticed and used to make warranted inferences about changes in	• Evaluate competing design solutions for maintaining biodiversity and ecosystem services. MS-LS2-5 (Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations. Assessment Boundary: none)

populations. • Evaluating empirical evidence can be used to support arguments about changes to ecosystems. • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic systems. • The completeness, or integrity, of an ecosystem's biodiversity is often used as a measure of its health. • Changes in biodiversity can influence humans' resources, such as food, energy and medicine. • Changes in biodiversity can influence ecosystem services that humans rely on. • A solution needs to be tested and modified on the basis of the test results, in order to improve it.	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. MS-LS2-4 (Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems. Assessment Boundary: none) Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-1 (Clarification Statement: none Assessment Boundary: none) Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-3 (Clarification Statement: none Assessment Boundary: none)
Assessment Evidence:	
Formative: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Define biodiversity, discuss facts and issues related to New Jersey biodiversity and why biodiversity is important • Use a classification flow chart to classify organisms • Name the major kingdoms of organisms • Construct bar graphs that compare the number of species, both worldwide and statewide in different groups of organisms • Design and carry out a biological inventory of a local area (plants and animals living there) • Compare several poems that relate to theme of biodiversity	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Unit quizzes • Unit test • Research on a NJ endangered species • Multimedia project on ecosystem service, such as water purification, nutrient recycling and prevention of soil or beach erosion

over time and write poetry to convey personal reflections on biodiversity • Explain personal beliefs and values about protecting biodiversity. List several reasons why people believe it is important to protect biodiversity • Describe factors that affect the relationship between habitat fragmentation and biodiversity loss. Create a graph that demonstrates the relationship between biodiversity and the size of a habitat. • Describe how habitat loss, introduced species, pollution, population growth and over-consumption are threatening a species of animal and biodiversity in general. • Express personal values by creating a personal vision for the future, especially as it relates to biodiversity • Discuss human impacts and develop a method to elevate some of the negative impact on the animals/plants in our state	• Project on endangered species in NJ

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** ☐ Interactive notebook with flipables, vocabulary and illustrations ☐ Guided notes and lab sheets to make sure students are on track with the content ☐ Essential questions and answers ☐ Classroom discussions of labs and activities to ensure understanding ☐ Do Now answers to review material as well as to aide in making connections to their lives Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ☐ Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables,

	multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modification & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Resources

Topic selection by interest

- Exploring the Environment (http://ete.cet.edu/modules/modules.html)
- Exploring the "Systems" in Ecosystems (http://www.pbslearningmedia.org/resource/lsps07.sci.life.eco.lpexpecosystems/exploring-the-systems-in-ecosystems/)
- National Wildlife Federation (http://www.nwf.org/Kids.aspx)
- Conserve Wildlife Foundation of New Jersey (http://www.conservewildlifenj.org/species/threats/)
- National Invasive Species Information Center (NISIC) (http://www.invasivespeciesinfo.gov)
- Textbook

Suggested Time Frame:	30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Physical Science - Waves and Electromagnetic Radiation	Grade(s) 6th
Unit Plan Title:	Unit 6 - Waves and the Electromagnetic Spectrum	

Overview/Rationale

In this unit of study, students develop and use models, use mathematical thinking, and obtain, evaluate, and communicate information in order to describe and predict characteristic properties and behaviors of waves. Students also apply their understanding of waves as a means of sending digital information. The crosscutting concepts of patterns and structure and function are used as organizing concepts for these interdisciplinary core ideas.

Science Standards (Established Goals)

MS-PS4-1, MS-PS4-2, MS-PS4-3

Disciplinary Core Ideas

PS4.A: Wave Properties

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.(MS-PS4-1)
- A sound wave needs a medium through which it is transmitted. (MS-PS4-2)

PS4.B: Electromagnetic Radiation

- When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2)
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends.(MS-PS4-2)
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)
- However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)

PS4.C: Information Technologies and Instrumentation

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)

Science and Engineering Practices

SEP- 2: Developing and Using Models

- Develop a model to describe phenomena. **(MS-PS4-2)**

SEP-5: Using Mathematics and Computational Thinking

- Use mathematical representations to describe and/or support scientific conclusions and design solutions. **(MS-PS4-1)**

SEP-8: Obtaining, Evaluating, and Communicating Information

- Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3)

Science Knowledge Is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)

Cross-Cutting Concepts

CCC-1: Patterns

- Graphs and charts can be used to identify patterns in data. (MS-PS4-1)

CCC-6: Structure and Function

- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. **(MS-PS4-2)**
- Structures can be designed to serve particular functions. (MS-PS4-3)

Influence of Science, Engineering, and Technology on Society and the Natural World

- Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)

Science Is a Human Endeavor

- Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

Technology Standard(s)

8.2.8.A.1- Research a product that was designed for a specific demand and identify how the product has changed to meet new demands
8.2.8.A.2- Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system
8.2.8.C.3- Evaluate the function, value and aesthetics of a technological product or system, from the perspective of the used and the producer

Interdisciplinary Standard(s)

ELA/Literacy

- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-3)
- **RST.6-8.2** - Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. (MS-PS4-3)
- **RST.6-8.9** - Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained

from reading a text on the same topic. (MS-PS4-3)

- **SL.8.5 -** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1), (MS-PS4-2)
- **WHST.6-8.9** - Draw evidence from informational texts to support analysis reflection, and research. (MS-PS4-3)

Mathematics

- **6.RP.A.1** - Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)
- **6.RP.A.3** - Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (MS-PS4-1)
- **7.RP.A.2** - Recognize and represent proportional relationships between quantities. (MS-PS4-1)
- **MP.2** - Reason abstractly and quantitatively. (MS-PS4-1)
- **MP.4** - Model with mathematics. (MS-PS4-1)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- A simple wave has a repeating pattern with a specific wavelength, frequency and amplitude.
- Describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.
- Graphs and charts can be used to identify patterns in data.
- Waves can be described with both qualitative and quantitative thinking.
- When light shines on an object, it is reflected, absorbed or transmitted through the object, depending on the object's material and frequency (color) of the light.
- The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g. , air and water, air and glass) where the light path bends.
- A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.
- Waves are reflected, absorbed, or transmitted through various materials.
- A sound wave needs a medium through which it is transmitted.
- Because light can travel through space, it cannot be a matter wave, like sound or water waves.
- The structure of a wave can be modified to serve particular functions by taking into account properties of different materials and how materials can be shaped and used.
- Structures can be designed to use properties of waves to serve particular functions.
- Waves can be used for communication purposes.
- Digitized signals (wave pulses) are a more reliable way to encode and transmit information than are analog signals.
- Wave-related technologies extend the measurement, exploration, modeling and computational capacity of scientific investigations.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- What is a wave?
- How do waves behave?
- What are the main groups of waves?
- What are the properties of waves?
- Why do surfers love physicists?
- How do the light and sound systems in the Performing Arts Center work?
- If rotary phones worked for my grandparents, why did they invent cell phones?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
	Global Awareness	**E,T,A**	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**		**Creativity and Innovation**
	Health Literacy	**E,T,A**	**Collaboration, Teamwork and Leadership**
	Civic Literacy	**E,T,A**	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy		**Communication and Media Fluency**
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
E,T,A	**CRP2. Apply appropriate academic and technical skills**

	CRP3. Attend to personal health and financial well-being
E,T,A	CRP4. Communicate clearly and effectively with reason
	CRP5. Consider the environmental, social and economic impacts of decisions
	CRP6. Demonstrate creativity and innovation
	CRP7. Employ valid and reliable research strategies
E,T,A	CRP8. Utilize critical thinking to make sense of problems and persevere in solving them
	CRP9. Model integrity, ethical leadership and effective management
	CRP10. Plan education and career paths aligned to personal goals
	CRP11. Use technology to enhance productivity
E,T,A	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
• A simple wave has a repeating pattern with a specific wavelength, frequency and amplitude. • Describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. • Graphs and charts can be used to identify patterns in data. • When light shines on an object, it is reflected, absorbed or transmitted through the object, depending on the object's material and frequency (color) of the light. • The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g. , air and water, air and glass) where the light path bends. • A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. • Waves are reflected, absorbed, or transmitted through	• Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. MS-PS4-1 (**Clarification Statement:** Emphasis is on describing waves with both qualitative and quantitative thinking. **Assessment Boundary:** Assessment does not include electromagnetic waves and is limited to standard repeating waves.) • Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.MS-PS4-2 (**Clarification Statement:** Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions. **Assessment Boundary:** Assessment is limited to qualitative applications pertaining to light and mechanical waves).

various materials. • A sound wave needs a medium through which it is transmitted. • Because light can travel through space, it cannot be a mechanical wave, like sound or water waves. • The structure of a wave can be modified to serve particular functions by taking into account properties of different materials and how materials can be shaped and used. • Structures can be designed to use properties of waves to serve particular functions. • Waves can be used for communication purposes. • The larger the amplitude, the greater the energy carried by the wave. • The energy carried by a wave increases as the amplitude increases. • Waves travel through different materials at different speeds. • Either the frequency or wavelength of a light determines the color of the light. • Either the wavelength or frequency determines the pitch of a sound wave. • Radio waves have the longest wavelengths and they carry the least amount of energy. • Television signals, as well as AM and FM radio signals, are all types of radio waves. • Infrared waves are heat that is emitted by every object. • Visible light is electromagnetic waves that you can detect with your eyes. • What you see as different colors are electromagnetic waves of different • wavelengths.	• Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. MS-PS4-3 (**Clarification Statement:** Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen. **Assessment Boundary:** Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.)
Assessment Evidence:	
Formative: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Hypothesize and investigate wave properties, by examining water waves in a lab • Model waves using a slinky and explain the wave behaviors	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?) *****Attach all Benchmarks***

• Analyze graphs to identify patterns in waves • Hypothesize and examine what happens when light hits different sources • Illustrate reflection and refraction of light waves and diffraction of sound waves • Observe infrared wavelengths in a night vision video clip • Use a model of the electromagnetic spectrum to make connections between the brightness and color of light and the frequency • Hypothesize and observe how sound waves travel through different mediums	• Unit quizzes • Unit test • Labs/ discussions • Do Nows and answers • Homework illustrations

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** ☐ Interactive notebook with flipables, vocabulary and illustrations ☐ Guided notes and lab sheets to make sure students are on track with the content ☐ Essential questions and answers ☐ Classroom discussions of labs and activities to ensure understanding ☐ Do Now answers to review material as well as to aide in making connections to their lives Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. ☐ Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). ☐ Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). ☐ Provide multiple grouping opportunities for students to share their ideas and to encourage

	work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study

⇒ Flexible grouping ⇒ Tiered assignments Topic selection by interest • Waves on a String (https://phet.colorado.edu/en/simulation/wave-on-a-string) • Sound Waves (https://phet.colorado.edu/en/simulation/sound) • Electromagnetic Waves for Kids (http://www.ducksters.com/science/physics/types_of_electromagnetic_waves.php) • Electromagnetic Math (https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Electromagnetic_Math.html) • Light and Color (http://www.physicsclassroom.com/class/light) • Light and Color Video (http://www.pbslearningmedia.org/resource/lsps07.sci.phys.energy.lightcolor/light-and-color/) • Mixing Primary Colors Online (http://www.omsi.edu/tech/colormix.php) • Textbook	
Suggested Time Frame:	30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Earth and Space Sciences				
MS-ESS1 Earth's Place in the Universe				
MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.			X
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.			X
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.			X
MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.		X	
MS-ESS2 Earth's Systems				
MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.		X	
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.		X	
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.		X	
MS-ESS2-4	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.			X
MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.			X
MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.			X
MS-ESS3 Earth and Human Activity				
MS-ESS3-1	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.			X
MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.			X
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	X		X
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.			X
MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Life Science				
MS-LS1 From Molecules to Organisms: Structures and Processes				
MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	X		X
MS-LS1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	X		X
MS-LS1-3	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	X		X
MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.	X		
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	X		
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	X		
MS-LS1-7	Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as the matter moves through organism.	X		
MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	X		X
MS-LS2 Ecosystems: Interactions, Energy, and Dynamics				
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	X		
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	X		
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	X		
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	X		
MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	X		
MS-LS3 Heredity: Inheritance and Variation of Traits				
MS-LS3-1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.			X
MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Life Science				
MS-LS4 Biological Evolution: Unity and Diversity				
MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.		X	
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.		X	
MS-LS4-3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.		X	
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.			X
MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.			X
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Physical Science				
MS-PS1 Matter and Its Interactions				
MS-PS1-1	Develop models to describe atomic composition of simple molecules and extended structures.			X
MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.			X
MS-PS1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.			X
MS-PS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.			X
MS-PS1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.			X
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.			X
MS-PS2 Motion and Stability: Forces and Interactions				
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.		X	
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.		X	
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.		X	
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.		X	X
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.		X	
MS-PS3 Energy				
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.		X	
MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.		X	
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer		X	
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.		X	
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.		X	

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Physical Science				
MS-PS4 Waves and Their Applications in Technologies for Information Transfer				
MS-PS4-1	**Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.**	**X**		
MS-PS4-2	**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.**	**X**		
MS-PS4-3	**Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.**	**X**		

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Engineering Design				
MS – ETS1 Engineering Design				
MS-ETS1-1	**Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**	**X**	**X**	**X**
MS-ETS1-2	**Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**		**X**	**X**
MS-ETS1-3	**Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**	**X**	**X**	**X**
MS-ETS1-4	**Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**		**X**	

7th Grade Science Curriculum

Middle Township Public Schools
216 S. Main Street
Cape May Court House, NJ 08210

Board of Education Approval: August 18, 2016

Table of Contents

Middle School Science Curriculum Work Committee

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Introduction

This document serves to meet all requirements for curriculum as per the Middle Township Board of Education and the New Jersey Department of Education and will serve as a guide for lesson planning. Units within the curricular framework for science are designed to be taught in the order in which they are presented. Within the units, the teachers have flexibility of what order to present the standards. Suggested Science and Engineering Practice Standards and Cross-Cutting Concepts are listed in each unit to be imbedded regularly in daily science instruction.

Course Description

Middle School science in Middle Township Public School district is interdisciplinary and covers all four domains of the Next Generation Science Standards: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science. The goal of science education curriculum is to produce students who have gained sufficient knowledge of the practices, crosscutting concepts, and core ideas of science and engineering to engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and to continue to learn about science throughout their lives. They should come to appreciate that science and the current scientific understanding of the world are the result of many hundreds of years of creative human endeavor. It is especially important to note that the above goals are for all students, not just those who pursue careers in science, engineering, or technology or those who continue on to higher education (p. 9, NRC, 2012).
Given this goal, an integrated science curriculum model should drive the formation of middle school science curriculum because:

- The nature of science is complex and multidisciplinary.
- Learning theory research in science shows expert knowledge base develops better through interdisciplinary connections and not through isolated content.
- Effective research-based practices for curriculum and instruction in science and engineering are supported through this approach.

Nature of Science

The nature of science is complex and multidisciplinary. From research about how scientists work, we know that scientists do not work in isolation in their own house of physics, or biology or chemistry but they reach out and create networks of scientists within and across disciplines who can contribute understanding, share ideas, and critique evidence and explanations. As we see in the science of global climate change, scientists work across the fields of geology, physics, and biology to provide evidence, plan investigations, and develop models to represent new ways to think about Earth systems. Important practices like engaging in argument from

evidence, modeling, and communicating information do not occur in isolation but rely on feedback from within and across scientific communities and disciplines. Basing the middle school model curriculum in an integrated model where the students are engaged with a variety of topics at each grade, focused on the connection of ideas across the domains, enhances the interdisciplinary nature of science.

Learning Theory

In the elementary years, students build their understandings of core concepts across all three domains of science: physical, life and Earth and space. Continuing this model in grades 6-8 better supports student learning in that there will not be a large gap of time in which a student does not engage in a specific discipline. This model takes advantage of current research which recognizes that there is variation across children at a given age and that thinking does not develop along a preset roadmap for each student. It allows middle school students to build on what they know and think they understand from their elementary years with the goal in middle school of helping students to revise their knowledge and understanding about those core ideas. Learning theory research shows expert knowledge base develops better through interdisciplinary real-world connections then through isolated content. This is especially important in middle school where motivation is critical to learning. An integrated and better articulated middle school model science curriculum that reflects what we know currently about how children learn science and how their mastery develops over time promotes deeper learning in science. As we know and understand about how students develop understanding while learning content, it informs teachers' practice; if teachers understand where their students are in their understanding of core ideas,and anticipate what students' misconceptions and struggles may be, they are better able to differentiate instruction and provide scaffolding that allows students to develop an integrated and deeper understanding of the science.

Research Based Science Instruction and Curriculum

Effective science instruction can take many forms but includes similar components. According to the Center on Instruction's 2010 report, *Effective Science Instruction: What does the Research Tell Us?*, research-based effective practices of curriculum and instruction important to science learning are: Motivation, Eliciting Students' Prior Knowledge, Intellectual Engagement; Use of Evidence to Critique Claims, and Sense-Making. The integrated model may be better able to support some of these instructional practices especially if it frames curriculum around engaging, relevant, and real-world interdisciplinary questions that will increase student motivation, intellectual engagement and sense-making. Effective science instruction helps middle school students build their understandings and practices, makes connections among and between core concepts and practices, and links to their prior knowledge. Students in grades 6-8 come to understand the natural world in a more scientifically accurate way and understand the nature of science.

Conclusion

Science curriculum should be thematic with a focus on connections among and between core concepts and practices. This approach reinforces the interdisciplinary nature of science and allows for a sequential progression of skills and concepts. This supports developmentally appropriate teaching and assessments. Each grade level has its own specific standards from each science domain that are seen as stepping stones in the progression of learning about a core idea and that meet a specific level of understanding. The idea is to embed technology and engineering in this interdisciplinary progression which would also be coordinated with the New Jersey Student Learning Standards.

Three Dimensions of the Next Generation Science Standards

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like “skills” to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC’s intent is to better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they

provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

Pacing Guide

UNIT TITLE	ENDURING UNDERSTANDINGS	NGSS	TIMEFRAME
1 – The Results of Forces Interacting on an Object	• Animate and inanimate objects exert forces on objects at all time. • Forces cannot always be seen and that inertia is directly related to mass, not weight or speed. • The interaction of forces cause an object to either remain at a constant velocity or accelerate. • Friction may only come into play when objects are in motion.	**MS-PS2-1 MS-PS2-2 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4**	**30 days**
2 – Transfer and Transformation of Energy	• Kinetic energy is related to the mass of an object and to the speed of an object. • Kinetic energy has a relationship to mass separate from its relationship to speed. • Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of the object's speed. • Proportional relationships among different types of quantities provide information about the magnitude of properties and processes.	**MS-PS3-1 MS-PS3-2 MS-PS3-5**	**30 days**

3- Thermal Energy	• Temperature is a measure of the average kinetic energy of particles of matter. • Thermal energy is the total amount of kinetic energy in an object. • The relationship between the temperature and the total energy	**MS-PS3-3 MS-PS3-4 MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4**	**30 days**

	of a system depends on the types, states, and amounts of matter present. • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. • The transfer of energy can be tracked as energy flows through a designed or natural system. • What we feel as hot and cold are actually the change in flow of thermal energy. • Heat is thermal energy that is being transferred, objects cannot have heat. • As objects gain thermal energy the particles become more active, get further away from each other and the object expands. • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. • Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. • A solution needs to be tested and then modified on the basis of the test results in order to improve it. • There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.		
4 - Forces That Work at a Distance (Gravity and Electromagnetic Energy)	• Fields exist between objects that exert forces on each other even though the objects are not in contact. • The interactions of magnets, electrically charged strips of tape, and electrically charged pith balls are examples of fields that exist between objects exerting forces on each other, even though the objects are not in contact.	**MS-PS2-3 MS-PS2-4 MS-PS2-5**	**35 days**

	• Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object or a ball, respectively). • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems. • Factors affect the strength of electric and magnetic forces. • Devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. • Electric and magnetic (electromagnetic) forces can be attractive or repulsive. • The size of an electric or magnetic (electromagnetic) force depends on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • Cause-and-effect relationships may be used to predict the factors that affect the strength of electrical and magnetic forces in natural or designed systems • Gravitational interactions are always attractive and depend on the masses of interacting objects. • There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass. • Evidence supporting the claim that gravitational interactions are attractive and depend on the masses of interacting objects could include data generated from simulations or digital tools and charts displaying mass, strength of interaction, distance from the sun, and orbital periods of objects within the solar system.		

5 – How Earth Changes: Plate Tectonics and Its Results	• The geologic time scale is used to organize Earth's 4.6-billion- year-old history. • Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. • The geologic time scale interpreted from rock strata provides a way to organize Earth's history. • Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. • Energy drives the process that results in the cycling of Earth's materials. • The processes of melting, crystallization, weathering, deformation, and sedimentation act together to form minerals and rocks through the cycling of Earth's materials. • All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. • Energy flowing and matter cycling within and among the planet's systems derive from the sun and Earth's hot interior. • Energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. • Explanations of stability and change in Earth's natural systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. • Geoscience processes have changed Earth's surface at varying time and spatial scales. • Processes change Earth's surface at time and spatial	**MS-ESS1-4 MS-ESS2-1 MS-ESS2-2 MS-ESS2-3**	**35 days**

	scales that can be large or small; many geoscience processes usually behave gradually but are punctuated by catastrophic events. • Geoscience processes shape local geographic features such as		

	the Pocono Mountains • The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. • Interactions among Earth's systems have shaped Earth's history and will determine its future. • Water's movements—both on the land and underground— cause weathering and erosion, which change the land's surface features and create underground formations. • Time, space, and energy phenomena within Earth's systems can be observed at various scales using models to study systems that are too large or too small.		
6 – Earth's 4.6 Billion Year History	• Evolution is a very slow process • Evolution does not mean an organism changes automatically from one to another • Evolution is not "Survival of the Fittest" • Evolution does not happen because an organism needs to change	**MS-LS4-1 MS-LS4-2 MS-LS4-3**	**20 days**

Content Area:	**Physical Science - Motion and Stability: Forces and Interactions**	**Grade(s) 7th**
Unit Plan Title:	**Unit 1 - The Result of Forces Interacting on an Object**	

Overview/Rationale

Students use system and system models and stability and change to understanding ideas related to why some objects will keep moving and why objects fall to the ground. Students apply Newton's third law of motion to related forces to explain the motion of objects.
Students also apply an engineering practice and concept to solve a problem caused when objects collide. The crosscutting concepts of system and system models and stability and change provide a framework for understanding the disciplinary core ideas. Students demonstrate proficiency in asking questions, planning and carrying out investigations, designing solutions, engaging in argument from evidence, developing and using models, and constructing explanations and designing solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

This unit is based on MS-PS2-1, MS-PS2-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4.

Disciplinary Core Ideas

PS2.A: Forces and Motion

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1)
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2) ETS1.A:

Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely
  to limit possible solutions. (MS-ETS1-1) ETS1.B: Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2)
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1- 3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4) ETS1.C:

Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of a larger change in motion. (MS- PS2-2)
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2) ETS1.A:

Defining and Delimiting Engineering Problems

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) ETS1.B:

Developing Possible Solutions

- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2)
- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1- 3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4) ETS1.C: Optimizing the Design Solution
- Although one design may not perform the best across all tests, identifying the characteristics of

Science and Engineering Practices
SEP-1: Asking Questions and Defining Problems • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (SEP-1) **SEP-2: Developing and Using Models** • Develop a model that predicts or describes phenomena such as balls rolling, bouncing, coming to a stop, or falling. Use this information to predict what happens to a skydiver or an object in the international space station. (SEP-2) **SEP-3: Planning and Carrying Out Investigations** • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (SEP-3) **SEP-4: Analyze and Interpret Data** • In combination with Unit 7.2, analyze data pertaining to the motion of a marble (roller coaster car) on a foam tubing track. (SEP-4) **SEP-6: Constructing Explanations and Designing Solutions** • Apply scientific ideas or principles to design an object, tool, process or system. (SEP-6) **SEP-7: Engage in Argument from Evidence** • Argue the results of a ball lab, skydiver videos, and space station videos (SEP-7)
Cross-Cutting Concepts
CCC-2: Cause and Effect • May be used to predict phenomena is nature or designed systems (CCC-2) **CCC-3: Scale, Proportion, and Quantity** • The distance at which forces such as gravity occur has a proportional affect motion. The sum of forces affect the motion of an object (CCC-3) **CCC-4: Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (CCC-4) **CCC-5: Energy and Matter**

- Both matter and energy are conserved. Transfer of energy can be tracked through systems (CCC-5)

CCC-7: Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (CCC-7)

Technology Standard(s)

- **8.1.8.A.2** Create a document using one or more digital applications
- **8.1.8.A.3** Use a simulation that provides an environment to solve a real world problem
- **8.1.8.A.4** Graph and calculate data and present a summary of the results

Interdisciplinary Standard(s)

English Language Arts

- Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS2-1),(MS-ETS1-1),(MS-ETS1-2) RST.6-8.1
- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS- PS2-1),(MS-PS2-2) RST.6-8.3
- Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1) WHST.6-8.8
- Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2) WHST.6-8.9
- Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2),(MS-ETS1-3) RST.6-8.9
- Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2) WHST.6-8.7

Math

- Reason abstractly and quantitatively. (MS-PS2-1),(MS-PS2-2),(MS-PS2-3),(MS-ETS1-1),(MS-ETS1-2) MP.2
- Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use

positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS- PS2-1) 6.NS.C.5

- Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1),(MS-PS2-2) 6.EE.A.2
- Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1),(MS-PS2-2) 7.EE.B.3
- Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-PS2-1),(MS-PS2-2) 7.EE.B.4
- Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically.
- Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1),(MS-ETS1-2) 7.EE.3

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Animate and inanimate objects exert forces on objects at all time.
- Forces cannot always be seen and that inertia is directly related to mass, not weight or speed.
- The interaction of forces cause an object to either remain at a constant velocity or accelerate.
- Friction may only come into play when objects are in motion.

Common misunderstandings:

Students tend to think of force as a property of an object ("an object has force," or "force is within an object") rather than as a relation between objects. In addition, students tend to distinguish between active objects and objects that support or block or otherwise act passively. Students tend to call the active actions "force" but do not consider passive actions as "forces". Teaching students to integrate the concept of passive support into the broader concept of force is a challenging task even at the high-school level.

Students believe constant speed needs some cause to sustain it. In addition, students believe that the amount of motion is proportional to the amount of force; that if a body is not moving, there is no force acting on it; and that if a body is moving there is a force acting on it in the direction of the motion. Students also believe that objects resist acceleration from the state of rest because of friction -- that is, they confound inertia with friction. Students also have a difficult time understanding that inertia is related to mass and does not change unless mass changes (assume that inertia increases as speed increases). Students tend to hold on to these ideas even after instruction in high-school or college physics. Specially designed instruction does help high-school students change their ideas.

Research has shown less success in changing middle-school students' ideas about force and motion. Nevertheless, some research indicates that middle-school students can start understanding the effect of constant forces to speed up, slow down, or change the direction of motion of an object. This research also suggests it is possible to change middle-school students' belief that a force always acts in the direction of motion. Students have difficulty appreciating that all interactions involve equal forces acting in opposite directions on the separate, interacting bodies. Instead they believe that "active" objects (like hands) can exert forces whereas "passive" objects (like tables) cannot. Alternatively, students may believe that the object with more of some obvious property will exert a greater force (NSDL, 2015).

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

How do forces control the behavior of everyone’s favorite boardwalk ride, a roller coaster?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T-**Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
X	**Global Awareness**	E,T,A	**Critical Thinking & Problem Solving**
	Environmental Literacy	E,T,A	**Creativity and Innovation**
	Health Literacy	E,T,A	**Collaboration, Teamwork and Leadership**
	Civic Literacy	E,T,A	**Cross-Cultural and Interpersonal Communication**

X	Financial, Economic, Business and Entrepreneurial Literacy		E,T	Communication and Media Fluency
			E,T,A	Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T-**Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

X	**CRP1. Act as a responsible and contributing citizen and employee**
X	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
X	**CRP4. Communicate clearly and effectively with reason**
	CRP5. Consider the environmental, social and economic impacts of decisions
X	**CRP6. Demonstrate creativity and**
X	**innovation CRP7. Employ valid and reliable**
X	**research strategies**
X	**CRP8. Utilize critical thinking to make sense of problems and persevere in**
	solving them CRP9. Model integrity, ethical leadership and effective
	management
X	**CRP10. Plan education and career paths aligned to personal**
	goals CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	*Students will be able to (do)…*
• Newton's Laws of Motion • Inertia	• Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * [Clarification

 - Momentum and Conservation of Momentum - Balanced vs Unbalanced Forces - Net Forces	Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.] (MS-PS2-1) • Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.] (MS-PS2- 2) • Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1) • Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2) • Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3) • Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an

	optimal design can be achieved. (MS-ETS1-4)
Assessment Evidence:	
Formative • Components of a Culminating roller coaster project with formal lab report (incorporates this and energy unit) • Mini project cartoon strip on Newton's laws Both graded with a rubric	**Summative Assessment Measures*:*** quizzes, tests, academic prompts, observations, homework, writing assignments ☐ Create a roller coaster that shows the interaction of forces ☐ Analyze their design and make appropriate modifications ☐ Create a cartoon strip that analyzes the three laws of motion, inertia and kinetic vs potential energy ☐ Write a formal lab paper complete with data table that ties information from 7.1 and 7.2 together.

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	Consider how will the design will engage in the following activities: Explain the action of various objects due to forces acting on them (ball bouncing, marbles rolling, etc) Explain the Laws of Motion as they pertain to balloons travelling along a string Student collisions on skateboards for momentum Explain how inertia explains a bodies actions before, during, after an accident Use spring scales to explore 3rd Law Use spring scales and various masses and rates of acceleration to study 2nd law Culminating roller coaster project with formal lab report (incorporates this and energy unit) Mini project cartoon strip on Newton's laws Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g.

	multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about- udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignment

Topic selection by interest

- MDougall/Littell "Forces and Motion"
- YouTube videos of astronauts in the ISS
- YouTube videos of "The Physics of Skydiving"
- Hawking video "Time Travel" which also explains relative motion

Suggested Time Frame:	30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Physical Science - Relationships Between Forms of Energy	Grade(s) 7
Unit Plan Title:	**Unit 2 -The Transfer and Transformation of Energy**	

Overview/Rationale

In this unit, students use the practices of analyzing and interpreting data, developing and using models, and engaging in argument from evidence to make sense of relationship between energy and forces. Students develop their understanding of important qualitative ideas about the conservation of energy. Students understand that objects that are moving have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions. Students also understand the difference between energy and temperature, and the relationship between forces and energy. The crosscutting concepts of scale, proportion, and quantity, systems and system models, and energy and matter are called out as organizing concepts for these disciplinary core ideas. Students use the practices of analyzing and interpreting data, developing and using models, and engaging in argument from evidence. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

This unit is based on MS-PS3-1, MS-PS3-2, and MS-PS3-5.

Disciplinary Core Ideas

PS3.A: Definitions of Energy
* Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)
* A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)

PS3.B: Conservation of Energy and Energy Transfer
* When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)

PS3.C: Relationship Between Energy and Forces
* When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS- PS3-2)

Science and Engineering Practices
SEP-1: Ask Questions and Define Problem • Determine how best to build a roller coaster using foam tubing and a marble (SEP-1) **SEP-2: Developing and Using Models** • Develop a model to describe unobservable mechanisms. (SEP-2) **SEP-3: Planning and Carrying Out Investigation** • Coaster build (SEP-3) **SEP-4: Analyzing and Interpreting Data** • Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (SEP-4) **SEP-5: Using Mathematics and Computational Thinking** • Construct a data table for kinetic and potential energy levels assuming no friction is present (SEP-5) **SEP-6: Construct Explanations and Design Solutions** • Explain scientific processes taking place from this unit and 7.1 (SEP-6) **SEP-7: Engaging in Argument from Evidence** • Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (SEP-7) **SEP-8: Obtaining, Evaluating, and Communicating Information** • Prepare a formal lab report on their project (SEP-8)
Cross-Cutting Concepts
CCC-1: Patterns • Graphs and tables can be used to identify patterns in data (CCC-1) **CCC-3: Scale, Proportion, and Quantity** • Energy levels may depend on height, mass, speed, and gravitational acceleration (CCC-3) **CCC-4: Systems and System Models** • A model, such as a roller coaster, can be used to represent interactions of forces and energy levels/types (CCC-4) **CCC-5: Energy and Matter** • Energy may take different forms and can be tracked through systems (CCC-5)

CCC-6: Structure and Function

- The shape and properties of materials can be manipulated for various results (CCC-6)

Technology Standard(s)

- 8.1.8.A.3 Use a simulation to provide an environment to solve a real world problem
- 8.1.8.A.4 Graph and calculate data and present a summary

Interdisciplinary Standard(s)

English Language Arts-

RST.6.8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. *(MS-PS3-1),(MS-PS3-5)*

RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)

WHST.6-8.1 Write arguments focused on discipline content. *(MS-PS3-5)*

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-PS3-2)*

Mathematics-

MP.2 Reason abstractly and quantitatively. (MS-PS3-1),(MS-PS3-4),(MS-PS3-5)

6.RP.A.1 Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3- 1),*(MS-PS3-5)*

6.RP.A.2 Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. *(MS-PS3-1)*

Recognize and represent proportional relationships between quantities. (MS-PS3-1),*(MS-PS3-5)*

8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)

8.EE.A.2 Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. *(MS- PS3-1)*

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Kinetic energy is related to the mass of an object and to the speed of an object.
- Kinetic energy has a relationship to mass separate from its relationship to speed.
- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of the object's speed.
- Proportional relationships among different types of quantities provide information about the magnitude of properties and processes.

Common misunderstandings…

- Students tend to think that energy transformations involve only one form of energy at a time. Although they develop some skill in identifying different forms of energy, in most cases their descriptions of energy-change focus only on forms which have perceivable effects. Finally, it may not be clear to students that some forms of energy, such as light, sound, and chemical energy, can be used to make things happen.
- The idea of energy conservation seems counterintuitive to middle- school students who hold on to the everyday use of the term energy. Even after instruction, however, students do not seem to appreciate that energy conservation is a useful way to explain phenomena. A key difficulty students have in understanding conservation appears to derive from not considering the appropriate system and environment. In addition, middle students tend to use their conceptualizations of energy to interpret energy conservation ideas. For example, some students interpret the idea that "energy is not created or destroyed" to mean that energy is stored up in the system and can even be released again in its original form. Or, students may believe that no energy remains at the end of a process, but may say that "energy is not lost" because an effect was caused during the process (for example, a weight was lifted) (NSDL, 2015)
- A deeper understanding of conservation of energy comes during the next unit "thermal energy" since they can then understand that kinetic energy can be at the atomic level. When a ball bounces off the floor the floor gains thermal energy, the air around the ball gains thermal energy, the sound is a form of kinetic energy that moves particles.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

How can you ride a skateboard down a ramp, ride a roller coaster, or play a game of soccer yet the energy before you started is the same as when you end?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Century Themes		*Indicate whether these skills are* ***E****-Encouraged,* ***T-****Taught, or* ***A****-Assessed in this unit by marking* ***E, T, A*** *on the line before the appropriate skill.* 21st Century Skills	
X	**Global Awareness**	E,T,A	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**	E,T,A	**Creativity and Innovation**
	Health Literacy	E,T,A	**Collaboration, Teamwork and Leadership**
	Civic Literacy	E,T,A	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy	E,T,A	**Communication and Media Fluency**
		E,T,A	**Accountability, Productivity and Ethics**

In this unit plan, the following Career Ready Practices are addressed:

Indicate whether these skills are ***E****-Encouraged,* ***T-****Taught, or* ***A****-Assessed in this unit by marking* ***E, T, A*** *on the line before the appropriate skill.*

E,T,A	**CRP1. Act as a responsible and contributing citizen and**
E,T,A	**employee CRP2. Apply appropriate academic and technical**
	skills
E,T,A	**CRP3. Attend to personal health and financial well-**
	being CRP4. Communicate clearly and effectively
E,T,A	**with reason**

	CRP5. Consider the environmental, social and economic impacts of decisions **CRP6. Demonstrate creativity and innovation**

	E,T,A	CRP7. Employ valid and reliable research strategies
	E,T,A	CRP8. Utilize critical thinking to make sense of problems and persevere in solving them CRP9. Model integrity, ethical leadership and effective management
	E,T,A	CRP10. Plan education and career paths aligned to personal goals CRP11. Use technology to enhance productivity
		CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
Kinetic energy is related to the mass of an object and to the speed of an object. Kinetic energy has a relationship to mass separate from its relationship to speed. • Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of the object's speed. Proportional relationships among different types of quantities provide information about the magnitude of properties and processes.	• Design and create a roller coaster that shows how potential energy transforms into kinetic energy. • Test different heights to determine that the optimal height for stopping their coaster car is the minimal allowable height. • Create a table that shows the relationship between kinetic and potential energy assuming no frictions. • Elaborate on why a coaster cannot have a hill higher than it started.

Assessment Evidence:

Formative : *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)*	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the*

- Build an online skate park using PHET website - Build and explore pendulums - Build a roller coaster using pipe insulation as a culminating project for this and Newton's Laws Unit - Prepare a formal lab report detailing what they have learned from the roller coaster project	*desired results? How will students reflect upon and self-assess their learning?)* ******Attach all Benchmarks*** - Develop a model to describe what happens to the amount of potential energy stored in the system when the arrangement of objects interacting at a distance changes - Use models to represent systems and their interactions, such as inputs, processes, and outputs, and energy and matter flows within systems. Models could include representations, diagrams, pictures, and written descriptions. - Unit test
Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** - Student learning map with an explanation of the unit - Hook with a video of X Game vert skate boarders - Guided notes for new vocabulary - Pendulum lab with guided questions in lab report format ○ Higher level students will perform calculations including gpe, E_k, and possibly calculations of acceleration due to g. - Build on line skate parks using PHET web site - Construct a roller coaster and complete a formal lab report using word processing, complete with a table for gpe and kinetic energy. Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* - Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community.

	• Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about- udl.html#.VXmoXcfD_UA)

Modifications & Resources

<u>Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)</u>

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

- ⇒ Open-ended responses
- ⇒ Curriculum Compacting
- ⇒ Advanced problems to extend the critical thinking skills of advanced learner
- ⇒ Supplemental reading material for independent study
- ⇒ Flexible grouping
- ⇒ Tiered assignments
- ⇒

Topic selection by interest

- McDougall/Littell "Forces and Motion"
- PHET skatepark
- PHET pendulum
- Youtube video "X Games Big Vert Skateboard Competition"

Suggested Time Frame:	30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Physical Science - Thermal Energy	Grade(s) 7
Unit Plan Title:	Unit 3 - Thermal Energy	

Overview/Rationale

In this unit, students ask questions, plan and carry out investigations, engage in argument from evidence, analyze and interpret data, construct explanations, define problems and design solutions as they make sense of the difference between energy, heat, and temperature. They use the practices to make sense of how the total change of energy in any system is always equal to the total energy transferred into or out of the system. The crosscutting concepts of energy and matter, scale, proportion, and quantity, and influence of science, engineering, and technology on society and the natural world are the organizing concepts for these disciplinary core ideas.
Students ask questions, plan and carry out investigations, engage in argument from evidence, analyze and interpret data, construct explanations, define problems and design solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-PS3-3, MS-PS3-4, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4.

Disciplinary Core Ideas

PS3.A: Definitions of Energy

- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

ETS1.A: Defining and Delimiting Engineering Problems

- The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1)

ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3)
- Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1- 3)
- Models of all kinds are important for testing solutions. (MS-ETS1-4)

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)

Science and Engineering Practices

SEP-1: Asking Questions and Defining Problems

- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. Using bolts of various mass to explore the difference between temperature and thermal energy (SEP-1)

SEP-2: Developing and Using Models

- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (SEP-2

SEP-3: Planning and Carrying Out Investigations

- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (SEP-3)

SEP-4: Analyzing and Interpreting Data

- Analyze and interpret data to determine similarities and differences in findings. Will determine the relationship between mass and thermal energy levels (SEP-4)

SEP-5: Using Mathematics and Computational Thinking

- Determine the mass of bolts and that mass's relationship to thermal energy held by an object (SEP-5)

SEP-6: Constructing Explanations and Designing Solutions

- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (SEP-6)

SEP-7: Engaging in Argument from Evidence

- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (SEP-7)

SEP-8: Obtaining, Evaluating, and Communicating Information

- Complete a lab report with a written explanation of various energy levels relating it to the particle model (SEP-8)

Cross-Cutting Concepts

CCC-1: Patterns

- For objects of similar compositions (bolts made of the same material) more mass has the ability to hold more thermal energy at the same temperature (CCC-1)

CCC-2: Cause and Effect

- The transfer of thermal energy results in a change in kinetic energy (CCC-2)

CCC-3: Scale, Proportion, and Quantity

- Proportional relationships (e.g. mass of an object to the thermal energy it has). (CCC-3)

CCC-5: Energy and Matter

- The thermal energy an object has is a property it has due to kinetic energy of the atoms moving in an excited state. The conservation of energy from EME to thermal energy in the water to thermal energy in the bolt. (CCC-5)

CCC-6: Structure and Function

- The structure of an object has the ability to make it a good conductor or insulator (CCC-6)

Technology Standard(s)

- **8.1.8.A.4** Graph and calculate data within a spreadsheet and present a summary of the results

Interdisciplinary Standard(s)

English Language Arts

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-PS3-5),MS-ETS1-1),(MS-ETS1-2),(MS-ETS1- 3)

- **RST.6-8.3** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3),(MS-PS3-4)
- **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-3),(MS-PS3-4),(MS-ETS1-3)
- **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, videos, or multimedia sources with that gained from reading a text on the same topic. (MS-ETS1-2),(MS-ETS1-3)
- **WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2)
- **WHST.6-8.8** Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-ETS1-1)
- **WHST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-ETS1-2)
- **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ETS1-4)

Mathematics

- **MP.2** Reason abstractly and quantitatively. (MS-PS3-4),(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4)
- **6.SP.B.5** Summarize numerical data sets in relation to their context. (MS-PS3-4)
- **7.EE.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)
- **7.SP** Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (MS-ETS1-4)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)
Students will understand that…   • Temperature is a measure of the average kinetic energy of particles of matter. • Thermal energy is the total amount of kinetic energy in an object. • The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. • The transfer of energy can be tracked as energy flows through a designed or natural system. • What we feel as hot and cold are actually the change in flow of thermal energy. • Heat is thermal energy that is being transferred, objects cannot have heat. • As objects gain thermal energy the particles become more active, get further away from each other and the object expands. • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. • Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. • A solution needs to be tested and then modified on the basis of the test results in order to improve it. • There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.
Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)
Why does room a temperature object feel warm to one person and cool to another? Why does a 60 degree towel feel warm while a 60 degree piece of metal feels cold? Which has more thermal energy, an iceberg or a hot paper clip? How does a cooler work? How do ice cubes cool a drink? He SR71 Blackbird was the world's fastest jet. While sitting on a runway it leaked fuel-when flying it did not. Why?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes		Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill. 21st Centur y Skills	
	Global Awareness	**E,T,A**	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**	**E,T,A**	**Creativity and Innovation**
	Health Literacy	**E,T,A**	**Collaboration, Teamwork and Leadership**
	Civic Literacy	**E,T,A**	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy		**Communication and Media Fluency**
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and
E,T,A	**employee CRP2. Apply appropriate academic and technical**
	skills
E,T,A	**CRP3. Attend to personal health and financial well-**
	being CRP4. Communicate clearly and effectively
E,T,A	**with reason**
E,T,A	**CRP5. Consider the environmental, social and economic impacts of**
E,T,A	**decisions CRP6. Demonstrate creativity and innovation**
	CRP7. Employ valid and reliable research strategies
	CRP8. Utilize critical thinking to make sense of problems and persevere in

		solving them CRP9. Model integrity, ethical leadership and effective management CRP10. Plan education and career paths aligned to personal goals

	CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
• Temperature is a measure of the average kinetic energy of particles of matter. • Thermal energy is the total amount of kinetic energy in an object. • The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. • The transfer of energy can be tracked as energy flows through a designed or natural system. • What we feel as hot and cold are actually the change in flow of thermal energy. • Heat is thermal energy that is being transferred, objects cannot have heat. • As objects gain thermal energy the particles become more active, get further away from each other and the object expands.	• Predict which material/s/ will hold and transfer more thermal energy • Create a model that shows how local thermal energy absorption causes shore and ocean breezes. • Apply scientific ideas or principles to design, construct, and test a design of a device that either minimizes or maximizes thermal energy transfer. • Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] (MS-PS3-3) • Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different

	masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] (MS-PS3-4) • Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1) • Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2) • Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3) • Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MS-ETS1-4)
Assessment Evidence:	
Formative: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Explanation of thermal expansion of objects they see • Hypothesis and testing of similar objects with different masses and the amount of thermal energy they can hold • Hypothesis and testing of objects with similar masses but different materials and thermal energy they can hold.	**Summative Assessment Measures*****:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Unit Test • Large bolt vs small bolt lab

• Hypothesis and testing of various forms of convections such as lava lamp, paper spirals rotating over a hot plate.	

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** • Student learning map with concepts and order we will be learning • Guided notes and lab sheets to make sure they are on track • Questions listed above that pertain to their lives • Classroom discussions of labs and activities to ensure understanding • Do Now writing assignments to review material • Anonymous Paper Toss to evaluate student understanding • Complete a lab that relates the relationship between thermal energy and kinetic energy • Complete a lab that relates how the flow of thermal energy is always from a high level to a lower level • Using the particle model, explain how a ball heated by a torch does not fit through a metal ring that it previously did • Conduct labs that lead to an understanding of conduction using candles to heat different types of metal rods and a glass rod. • Conduct convection labs with paper spirals over a hot plate, dust particles in front of a projector, and lava lamps. Labs will be followed with written explanations of how the density of an object changes as it gains thermal energy thereby causing a buoyant force. Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* • Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables,

	multimedia, modeling).

	• Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about- udl.html#.VXmoXcfD_UA)
Modifications	

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students: ⇒ Open-ended responses ⇒ Curriculum Compacting ⇒ Advanced problems to extend the critical thinking skills of advanced learner ⇒ Supplemental reading material for independent study ⇒ Flexible grouping ⇒ Tiered assignments Topic selection by interest

Suggested Time Frame:	30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	**Physical Science - Types of Interactions**	**Grade(s) 7**
Unit Plan Title:	**Unit 4 - Forces That Work at a Distance (Gravity and Electromagnetic Energy)**	

Overview/Rationale

Students have a general idea of objects being made of small particles but assume that these particles actually touch. For example a ball bouncing of the floor touches the ground. This unit will help students understand that EME actually keeps the particles from touching. Students use cause and effect; system and system models; and stability and change to understand ideas that explain why some materials are attracted to each other while others are not. Students apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while others repel. In particular, students develop understandings that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative. Students also develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields. Students are expected to consider the influence of science, engineering, and technology on society and the natural world. Students are expected to demonstrate proficiency in asking questions, planning and carrying out investigations, designing solutions, and engaging in argument. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-PS2-3, MS-PS2-4, MS-PS2-5

Disciplinary Core Ideas

PS2.B: Types of Interactions

- Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5)
- Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3)
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)

Science and Engineering Practices
SEP-1: Asking Questions and Defining Problems - Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (SEP-1) **SEP-3: Planning and Carrying Out Investigations** - Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (SEP-3) - Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (SEP-3) **SEP-4: Analyze and Interpret Data** - Data related to the construction of DC motors, electro magnets, and activities involving static electricity (SEP-4) **SEP-6: Constructing Explanations and Designing Solutions** - Apply scientific ideas or principles to design an object, tool, process or system. (SEP-6) **SEP-7: Engaging in Argument from Evidence** - Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (SEP-7) **SEP-8: Obtaining, Evaluating, and Communicating Information** - Written explanations based on scientific observations (SEP-8)

Cross-Cutting Concepts
CCC-1: Patterns - The distance objects are affects their EME interaction (CCC-1) **CCC-2: Cause and Effect** - Cause and effect relationships may be used to predict phenomena in natural or designed systems. (CCC-2) **CCC-3: Scale, Proportion and Quantity** - Similar relationship between distance and interaction (CCC-3)

CCC-4: Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (CCC-4)

CCC-5: Energy and Matter

- EME is a quality due to the interaction of particles and is conserved (the energy that makes a light bulb glow is energy generated from other forms) (CCC-5)

CCC-6: Structure and Function

- Not all objects can conduct EME (insulators) due to their physical properties (CCC-6)

CCC-4: Stability and Change

- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (CCC-4)

Technology Standard(s)

- **8.1.8.A.4** Graph and calculate data in a spreadsheet
- **8.1.8.A.3** Use simulation that provides an environment for solving a real life problem

Interdisciplinary Standard(s)

ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. *(MS-PS2-1),(MS-PS2-3)*

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
(MS-PS2-1),(MS-PS2-2),(MS-PS2-5)

WHST.6-8.1 Write arguments focused on *discipline-specific content*. (MS-PS2-4)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. *(MS-PS2-1)*,(MS-PS2-2),*(MS-PS2-5)*

Mathematics –

MP2 - Reason abstractly and quantitatively. (MS-PS2-1),(MS-PS2-2),(MS-PS2-3)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)
• Fields exist between objects that exert forces on each other even though the objects are not in contact. • The interactions of magnets, electrically charged strips of tape, and electrically charged pith balls are examples of fields that exist between objects exerting forces on each other, even though the objects are not in contact. • Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object or a ball, respectively). • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems. • Factors affect the strength of electric and magnetic forces. • Devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. • Electric and magnetic (electromagnetic) forces can be attractive or repulsive. • The size of an electric or magnetic (electromagnetic) force depends on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • Cause-and-effect relationships may be used to predict the factors that affect the strength of electrical and magnetic forces in natural or designed systems • Gravitational interactions are always attractive and depend on the masses of interacting objects. • There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass. • Evidence supporting the claim that gravitational interactions are attractive and depend on the masses of interacting objects could include data generated from simulations or digital tools and charts displaying mass, strength of interaction, distance from the sun, and orbital periods of objects within the solar system.
Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)
Why do astronauts on the International Space Station appear to be weightless? Why does a feather fall to the ground lower than a hammer? When a strong gust of wind blows against a sky scraper the building sways back and forth. What keeps it from falling? How does the electricity in our room work? Where does it come from?

In this unit plan, the following 21st Century themes and skills are addressed:				
Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**		
X	Global Awareness	E,T,A	Critical Thinking & Problem Solving	
X	Environmental Literacy	E,T,A	Creativity and Innovation	
	Health Literacy	E,T,A	Collaboration, Teamwork and Leadership	
	Civic Literacy	E,T,A	Cross-Cultural and Interpersonal Communication	
	Financial, Economic, Business and Entrepreneurial Literacy		Communication and Media Fluency	
		E,T,A	Accountability, Productivity and Ethics	

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and
	employee CRP2. Apply appropriate academic and technical
	skills
E,T,A	CRP3. Attend to personal health and financial well-
	being CRP4. Communicate clearly and effectively
E,T,A	with reason
E,T,A	CRP5. Consider the environmental, social and economic impacts of
E,T,A	decisions CRP6. Demonstrate creativity and innovation
	CRP7. Employ valid and reliable research strategies
	CRP8. Utilize critical thinking to make sense of problems and persevere in

		solving them CRP9. Model integrity, ethical leadership and effective management **CRP10. Plan education and career paths aligned to personal goals**

	CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
- Gravitational interactions are always attractive and depend on the masses of interacting objects. - There is a gravitational force between any two masses; it is very small except when one or both of the objects have large mass. - Factors affect the strength of electric and magnetic forces. - Devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. - Electric and magnetic (electromagnetic) forces can be attractive or repulsive. - The size of an electric or magnetic (electromagnetic) force depends on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects.	• Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. [Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.] (MS-PS2-5) • Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. [Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]

	(MS-PS2-3)

	• Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. [Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment may include Newton's Law of Gravitation or Kepler's Laws.] (MS-PS2-4)
Assessment Evidence:	
Formative: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • Drop objects with various masses and shapes to determine the affect of gravity • Create a model to show how the ISS is actually falling around Earth as is everything in it. • Model electrical attraction with hair, balloons, tape, Styrofoam, paper, dust particles. • Build a working motor to determine how magnetism and electricity are two parts of a similar force.	**Summative Assessment Measures*****:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Unit Test • Lab Assessments (final product)

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** - Provide a learning map for all students - Provide numerous hands on activities and phenomenon they cannot yet explain (ISS actually has essentially the same acceleration due to gravity as Earth, neodymium magnet falling through a copper pipe) - Numerous labs with a written component that will be revised as time goes by - Ask questions that may show fallacies in their thought process necessitating revised thoughts - Students will generate some labs on their own based on interest - Higher level math students may be introduced to Keppler's Law and math behind computing (g). - Activities include circuit building, electric motor building, study of EME from Styrofoam, tape, water, and balloons. Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)* - Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. - Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). - Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). - Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). - Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. - Use project-based science learning to connect science with observable phenomena. - Structure the learning around explaining or solving a social or community-based issue.

	• Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about- udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Topic selection by interest • McDougall/Littell "Electricity and Magnetism" • Carolina Scientific Electricity and Magnetism Kit • Phet Circuit building • Phet balloon electricity	
Suggested Time Frame:	35 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	**Earth and Space Science - Earth Systems**	**Grade(s)7**
Unit Plan Title:	**Unit 5 - How Earth Changes: Plate Tectonics and its Results**	

Overview/Rationale

Students examine geoscience data in order to understand processes and events in Earth's history. Important crosscutting concepts in this unit are scale, proportion, and quantity, stability and change, and patterns in relation to the different ways geologic processes operate over geologic time. An important aspect of the history of Earth is that geologic events and conditions have affected the evolution of life, but different life forms have also played important roles in altering Earth's systems. Students understand how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. Students investigate the controlling properties of important materials and construct explanations based on the analysis of real geoscience data. Students are expected to demonstrate proficiency in analyzing and interpreting data and constructing explanations. They are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-ESS1-4, MS-ESS2-1 MS-ESS2-2, MS-ESS2-3

Disciplinary Core Ideas

ESS1.C: The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. (MS-ESS1-4)

ESS2.A: Earth's Materials and Systems

- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. (MS-ESS2-1)
- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. (MS-ESS2-2)

ESS2.B: Plate Tectonics and Large-Scale System Interactions

- Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart. (MS-ESS2-3)

Science and Engineering Practices
SEP-2: Developing and Using Models • Develop and use a model to describe phenomena. (MS-ESS2-1) **SEP-4: Analyzing and Interpreting Data** • Analyze and interpret data to provide evidence for phenomena. (MS-ESS2-3) **SEP-6: Constructing Explanations and Designing Solutions** • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future. (MS-ESS1-4),(MS-ESS2-2)
Cross-Cutting Concepts
CCC-1: Patterns • Patterns in rates of change and other numerical relationships can provide information about natural systems. (CCC-1) **CCC-2: Cause and Effect** • Explore the relationship between convection in the asthenosphere and tectonic movement and the relationship between tectonic movement and Earth's features and the carbon cycle (CCC-2) **CCC-3: Scale Proportion and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (CCC-3) **CCC-5: Energy and Matter** • Energy conservation is maintained as the energy from radioactive isotopes create an atmosphere for convection and tectonic movement (CCC-5) **CCC-7: Stability and Change** • Earth is constantly changing, however the forces that change it are stable (CCC-7)
Technology Standard(s)
• **8.1.8.A.3** Use a simulation that provides an environment to solve a real world theory

Interdisciplinary Standard(s)
English Language Arts **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-4),(MS-ESS2-2) **WHST.6-8.2** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS1-4)**,**(MS-ESS2-2) **RST.6-8.7** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS2-3) **RST.6-8.9** Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-ESS2-3) **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS2- 1),(MS-ESS2-2) ***Mathematics*** **7.EE.B.4** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS2-2),(MS-ESS2-3) **6.EE.B.6** Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-4),(MS-ESS2-2),(MS-ESS2-3) **7.EE.B.6** Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-4) **MP.2**Reason abstractly and quantitatively. (MS-ESS2-2),(MS-ESS2-3)
Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)
Students will understand that… • The geologic time scale is used to organize Earth's 4.6-billion-year-old history. • Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. • The geologic time scale interpreted from rock strata provides a way to organize Earth's history. • Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too

small.

- Energy drives the process that results in the cycling of Earth's materials.
- The processes of melting, crystallization, weathering, deformation, and sedimentation act together to form minerals and rocks through the cycling of Earth's materials.
- All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems.
- Energy flowing and matter cycling within and among the planet's systems derive from the sun and Earth's hot interior.
- Energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.
- Explanations of stability and change in Earth's natural systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.
- Geoscience processes have changed Earth's surface at varying time and spatial scales.
- Processes change Earth's surface at time and spatial scales that can be large or small; many geoscience processes usually behave gradually but are punctuated by catastrophic events.
- Geoscience processes shape local geographic features such as the Pocono Mountains
- The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years.
- Interactions among Earth's systems have shaped Earth's history and will determine its future.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
- Time, space, and energy phenomena within Earth's systems can be observed at various scales using models to study systems that are too large or too small.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- How do we know how old Earth is?
- How are mountain formed?
- How do tectonic plates move?
- How do earthquakes cause tsunamis like the 2011 Japanese tsunami?
- How did Earth form?
- How did Earth's moon form?
- Do you think there is life on other planets? Why or why not?

- Assuming there is life on other planets, what would that type of life be like?
- How do all of the resources on Earth continue to be re-used?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Centur y Skills	
X	**Global Awareness**	E,T,A	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**	E,T,A	**Creativity and Innovation**
	Health Literacy	E,T,A	**Collaboration, Teamwork and Leadership**
	Civic Literacy	E,T,A	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy		**Communication and Media Fluency**
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and
E,T,A	**employee CRP2. Apply appropriate academic and technical**
	skills
E,T,A	**CRP3. Attend to personal health and financial well-**
E,T,A	**being CRP4. Communicate clearly and effectively**
E,T,A	**with reason**
E,T,A	**CRP5. Consider the environmental, social and economic impacts of**

		decisions CRP6. Demonstrate creativity and innovation CRP7. Employ valid and reliable research strategies

	E,T,A	CRP8. Utilize critical thinking to make sense of problems and persevere in
		solving them CRP9. Model integrity, ethical leadership and effective
		management
		CRP10. Plan education and career paths aligned to personal
	E,T	goals CRP11. Use technology to enhance productivity
		CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	*Students will be able to (do)…*
Part A: • The geologic time scale is used to organize Earth's 4.6- billion-year-old history. • Rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. • The geologic time scale interpreted from rock strata provides a way to organize Earth's history. • Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **Part B:** • Energy drives the process that results in the cycling of Earth's materials. • The processes of melting, crystallization, weathering, deformation, and sedimentation act together to form minerals and rocks through the cycling of Earth's materials.	• **Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.** [Clarification Statement: Emphasis is on how analyses of rock formations and the fossils they contain are used to establish relative ages of major events in Earth's history. Examples of Earth's major events could range from being very recent (such as the last Ice Age or the earliest fossils of homo sapiens) to very old (such as the formation of Earth or the earliest evidence of life). Examples can include the formation of mountain chains and ocean basins, the evolution or extinction of particular living organisms, or significant volcanic eruptions.] [Assessment Boundary: Assessment does not include recalling the names of specific periods or epochs and events within them.] (MS-ESS1-4) • **Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process**. [Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the

• All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. • Energy flowing and matter cycling within and among the planet's systems derive from the sun and Earth's hot interior. • Energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. • Explanations of stability and change in Earth's natural systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. • Geoscience processes have changed Earth's surface at varying time and spatial scales. • Processes change Earth's surface at time and spatial scales that can be large or small; many geoscience processes usually behave gradually but are punctuated by catastrophic events. • Geoscience processes shape local geographic features. • The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. • Interactions among Earth's systems have shaped Earth's history and will determine its future. • Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. • Time, space, and energy phenomena within Earth's systems can be observed at various scales using models to study systems that are too large or too	cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.] (MS-ESS2-1) • **Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales**. [Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.] (MS-ESS2-2) • **Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.** [Clarification Statement: Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).] [Assessment Boundary: Paleomagnetic anomalies in oceanic and continental crust are not assessed but will be discussed (MS-ESS2-3)

small.	

Assessment Evidence:	
Formative: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • In pairs, create a Geologic Time Line and present it to the class • Create replicas of fossils and explain how fossils are formed and the difference between cast, mold, and trace fossils. Include this fossil with an index fossil and various sedimentary layers. • Create a map of various student generated land masses. The land masses will show a distribution of fossils to support the theory of plate tectonics. Land masses will also show mountains of various heights and physical attributes and explain why the mountains appear differently (new vs. old, coastal vs. continental- continental).	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Unit Test • Performance tasks listed to the left • Daily writing prompts • Handling actual marine fossils found in the Pocono Mts. and explaining how they got to be 1,000 feet above sea level. • Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** • Student learning maps with guided notes • Quick videos to bring concepts to light • Student centered activities that involve creativity and sharing with the class • Manipulation and handling of actual fossils • Daily writing prompts that are revised as their understanding progresses • Some projects have the lea way to allow students to organize it around their interests Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All*

	Standards, All Students/Case Studies for vignettes and explanations of the modifications.)

	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about- udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking

⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Topic selection by interest

McDougall/Littell: "Our Changing Earth" NOVA: "Our Amazing Planet"
History Channel: "The Ring of Fire"
Interactive website on the formation and breaking apart of Pangea

Suggested Time Frame:	35 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Life Science - Evidence of a Common Ancestry	Grade(s) 7
Unit Plan Title:	Unit 6 - Earth's 4.6 Billion Year History	

Overview/Rationale

In this unit of study, students analyze graphical displays and gather evidence from multiple sources in order to develop an understanding of how fossil records and anatomical similarities of the relationships among organisms and species describe biological evolution.
Students search for patterns in the evidence to support their understanding of the fossil record and how those patterns show relationships between modern organisms and their common ancestors. The crosscutting concepts of cause and effect, patterns, and structure and function are called out as organizing concepts for these disciplinary core ideas.
Students use the practices of analyzing graphical displays and gathering, reading, and communicating information.
Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-LS4-1, MS-LS4-2, MS-LS4-3

Disciplinary Core Ideas

LS4.A: Evidence of Common Ancestry and Diversity

- The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)
- Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent. (MS-LS4-2)
- Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)

Science and Engineering Practices
SEP-4: Analyzing and Interpreting Data • Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3) • Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1) **SEP-6: Constructing Explanations and Designing Solutions** • Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2) **Connections to Nature of Science** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1)
Cross-Cutting Concepts
CCC-1: Patterns • Patterns can be used to identify cause and effect relationships. (CCC-1) **CCC-2: Cause and Effect** • Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (CCC-2) **CCC-3: Scale, Proportion and Quantity** • Understanding the vast scale of 4.6 billion years and the quantity of organisms that have existed vs. those presently existing (CCC-3)
Technology Standard(s)
• **8.1.12.A.2** Produce and edit a multi-page digital document for a commercial audience and present it to peers
Interdisciplinary Standard(s)
English Language Arts **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations

or descriptions. (MS-LS4-1),(MS-LS4-2),(MS-LS4-3)
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS4-1),(MS-LS4-3)
RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. (MS-LS4-3)
WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS4-2)
WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-2)
SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-2)
SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-2)

Mathematics

6.EE.B.6 Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-LS4-1),(MS-LS4- 2)

Enduring Understandings: (What are the big ideas? What specific understandings about them are desired? What misunderstandings are predictable?)

Students will understand that…

- Evolution is a very slow process
- Evolution does not mean an organism changes automatically from one to another
- Evolution is not “Survival of the Fittest”
- Evolution does not happen because an organism needs to change

Common Misconceptions…

- Students often hold onto ideas that they have learned from common day language such as “only the strong survive” or “survival of the fittest.” Because of this they may think that evolution is a competition with an immediate result.
- Because of the difficulty we have in conceptualizing that Earth is 4.6 billion years old, it makes it even more difficult to understand that evolution takes an extremely long time to cause an extremely small amount of change.
- Students may feel that primate evolution is a race from “monkey-ness” to “human-ness” with humans being the ultimate end result.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

- How do we know that dinosaurs are more closely related to birds than lizards?
- On the shelf in our room there is a horseshoe crab molt. How is it that the horseshoe crab species has existed for about 300 million years yet some organisms existed for much less time?
- Sherpas live at altitudes that would kill us. How?
- What evidence do we have that supports the theory that our species (Homo) has been evolving for several million years?
- How does fossil evidence support evolutionary theory?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Centur y Skills	
X	**Global Awareness**	E,T,A	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**	E,T,A	**Creativity and Innovation**
	Health Literacy	E,T,A	**Collaboration, Teamwork and Leadership**
X	**Civic Literacy**	E,T,A	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and	E,T	**Communication and Media Fluency**

		Entrepreneurial Literacy	E,T,A	Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

E,T,A	CRP1. Act as a responsible and contributing citizen and employee
E,T,A	CRP2. Apply appropriate academic and technical skills
	CRP3. Attend to personal health and financial well-being
E,T,A	CRP4. Communicate clearly and effectively with reason
E,T,A	CRP5. Consider the environmental, social and economic impacts of decisions
E,T,A	CRP6. Demonstrate creativity and
E,T,A	innovation CRP7. Employ valid and reliable
E,T,A	research strategies
E,T,A	CRP8. Utilize critical thinking to make sense of problems and persevere in
E	solving them CRP9. Model integrity, ethical leadership and effective
E, T	management CRP10. Plan education and career paths aligned to personal
E, T	goals CRP11. Use technology to enhance productivity CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives: (What key knowledge and skills will students acquire as a result of this unit? What should they eventually be able to do as a result of such knowledge and skill?)

Students will know….	***Students will be able to (do)…***
• The fossil record documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. • The collection of fossils and their placement in chronological order as identified through the location of	• Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

sedimentary layers in which they are found or through radioactive dating is known as the fossil record. • Relative fossil dating is achieved by examining the fossil's relative position in sedimentary rock layers. • Objects and events in the fossil record occur in consistent patterns that are understandable through measurement and observation. • Patterns exist in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in rock layers. • Patterns can occur within one species of organism or across many species. • Similarities and differences exist in the gross anatomical structures of modern organisms. • There are anatomical similarities and differences among modern organisms and between modern organisms and fossil organisms. • Similarities and differences exist in the gross anatomical structures of modern organisms and their fossil relatives. • Similarities and differences in the gross anatomical structures of modern organisms enable the reconstruction of evolutionary history and the inference of lines of evolutionary decent. • Patterns and anatomical similarities in the fossil record can be used to identify cause-and-effect relationships. • Science assumes that objects and events in evolutionary history occur in consistent patterns that are understandable through measurement and observation.	[Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.] (MS-LS4-1) • Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships. Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.] (MS-LS4-2) • Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy. [Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.] (MS-LS4-3)

Assessment Evidence:	
FormativeTasks: *(Through what authentic performance tasks will students demonstrate the desired understandings? By what criteria will performances of understanding be judged?)* • *Student learning map to organize unit* • *Guided notes to organize thoughts* • *Content related short videos to break up info* • *Web based activities for exploration* • *Written group responses that will be revised as the unit progresses*	**Summative Assessment Measures*:*** *(Through what other evidence (E.g. quizzes, tests, academic prompts, observations, homework, journals, etc.) will students demonstrate achievement of the desired results? How will students reflect upon and self- assess their learning?)* ******Attach all Benchmarks*** • Apply scientific ideas to construct explanations for evolutionary relationships. • Apply the patterns in gross anatomical structures among modern organisms and between modern organisms and fossil organisms to construct explanations of evolutionary relationships. • Apply scientific ideas about evolutionary history to construct an explanation for evolutionary relationships evidenced by similarities or differences in the gross appearance of anatomical structures.

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities *D*	***Consider how will the design will:*** • Student learning map to organize unit • Guided notes to organize thoughts • Content related short videos to break up info • Web based activities for exploration • Written group responses that will be revised as the unit progresses Additional Differentiation/Modification Options: *(Note: Teachers identify the modifications that they will use in the unit. See NGSS Appendix D: All Standards, All Students/Case Studies for vignettes and explanations of the modifications.)*

	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. Restructure lesson using UDL principals (http://www.cast.org/our-work/about- udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides

⇒ Modified homework ⇒ Differentiated pre-typed class notes and example problems ***Advanced/Gifted Students:*** ⇒ Open-ended responses ⇒ Curriculum Compacting ⇒ Advanced problems to extend the critical thinking skills of advanced learner ⇒ Supplemental reading material for independent study ⇒ Flexible grouping ⇒ Tiered assignments ⇒ Topic selection by interest McDougall/Littell: “Our Changing Earth” History Channel: “Birth of the Earth” Zumal: web quest	
Suggested Time Frame:	20 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Earth and Space Sciences				
MS-ESS1 Earth's Place in the Universe				
MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.			X
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.			X
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.			X
MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.		X	
MS-ESS2 Earth's Systems				
MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.		X	
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.		X	
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.		X	
MS-ESS2-4	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.			X
MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.			X
MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.			X
MS-ESS3 Earth and Human Activity				
MS-ESS3-1	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.			X

MS-ESS3-2	**Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.**			**X**
MS-ESS3-3	**Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.**	**X**		**X**
MS-ESS3-4	**Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.**			**X**
MS-ESS3-5	**Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.**			**X**

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Life Science				
MS-LS1 From Molecules to Organisms: Structures and Processes				
MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	X		X
MS-LS1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	X		X
MS-LS1-3	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	X		X
MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.	X		
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	X		
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	X		
MS-LS1-7	Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as the matter moves through organism.	X		
MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	X		X
MS-LS2 Ecosystems: Interactions, Energy, and Dynamics				
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	X		
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	X		
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	X		

MS-LS2-4	**Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.**	**X**		
MS-LS2-5	**Evaluate competing design solutions for maintaining biodiversity and ecosystem services.**	**X**		
MS-LS3 Heredity: Inheritance and Variation of Traits				
MS-LS3-1	**Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.**			**X**
MS-LS3-2	**Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.**			**X**

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Life Science				
MS-LS4 Biological Evolution: Unity and Diversity				
MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.		X	
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.		X	
MS-LS4-3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.		X	
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.			X
MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.			X
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Physical Science				
MS-PS1 Matter and Its Interactions				
MS-PS1-1	Develop models to describe atomic composition of simple molecules and extended structures.			X
MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.			X
MS-PS1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.			X
MS-PS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.			X
MS-PS1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.			X
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.			X
MS-PS2 Motion and Stability: Forces and Interactions				
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.		X	
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.		X	
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.		X	
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.		X	X
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.		X	
MS-PS3 Energy				

MS-PS3-1	**Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.**		**X**	
MS-PS3-2	**Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.**		**X**	
MS-PS3-3	**Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer**		**X**	
MS-PS3-4	**Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.**		**X**	
MS-PS3-5	**Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.**		**X**	

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Physical Science				
MS-PS4 Waves and Their Applications in Technologies for Information Transfer				
MS-PS4-1	**Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.**	**X**		
MS-PS4-2	**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.**	**X**		
MS-PS4-3	**Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.**	**X**		

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Engineering Design				
MS – ETS1 Engineering Design				
MS-ETS1-1	**Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**	**X**	**X**	**X**
MS-ETS1-2	**Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**		**X**	**X**
MS-ETS1-3	**Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**	**X**	**X**	**X**
MS-ETS1-4	**Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**		**X**	

8th Grade Science Curriculum

Middle Township Public Schools
216 S. Main Street
Cape May Court House, NJ 08210

Board of Education Approval: August 18, 2016

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Middle School Science Curriculum Work Committee

Shannon Hunsicker

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Introduction

This document serves to meet all requirements for curriculum as per the Middle Township Board of Education and the New Jersey Department of Education and will serve as a guide for lesson planning. Units within the curricular framework for science are designed to be taught in the order in which they are presented. Within the units, the teachers have flexibility of what order to present the standards. Suggested Science and Engineering Practice Standards and Cross-Cutting Concepts are listed in each unit to be imbedded regularly in daily science instruction.

Course Description

Middle School science in Middle Township Public School district is interdisciplinary and covers all four domains of the Next Generation Science Standards: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science. The goal of science education curriculum is to produce students who have gained sufficient knowledge of the practices, crosscutting concepts, and core ideas of science and engineering to engage in public discussions on science-related issues, to be critical consumers of scientific information related to their everyday lives, and to continue to learn about science throughout their lives. They should come to appreciate that science and the current scientific understanding of the world are the result of many hundreds of years of creative human endeavor. It is especially important to note that the above goals are for all students, not just those who pursue careers in science, engineering, or technology or those who continue on to higher education (p. 9, NRC, 2012).
Given this goal, an integrated science curriculum model should drive the formation of middle school science curriculum because:

- The nature of science is complex and multidisciplinary.
- Learning theory research in science shows expert knowledge base develops better through interdisciplinary connections and not through isolated content.
- Effective research-based practices for curriculum and instruction in science and engineering are supported through this approach.

Nature of Science

The nature of science is complex and multidisciplinary. From research about how scientists work, we know that scientists do not work in isolation in their own house of physics, or biology or chemistry but they reach out and create networks of scientists within and across disciplines who can contribute understanding, share ideas, and critique evidence and explanations. As we see in the science of global climate change, scientists work across the fields of geology, physics, and biology to provide evidence, plan investigations, and develop models to represent new ways to think about Earth systems. Important practices like engaging in argument from

evidence, modeling, and communicating information do not occur in isolation but rely on feedback from within and across scientific communities and disciplines. Basing the middle school model curriculum in an integrated model where the students are engaged with a variety of topics at each grade, focused on the connection of ideas across the domains, enhances the interdisciplinary nature of science.

Learning Theory

In the elementary years, students build their understandings of core concepts across all three domains of science: physical, life and Earth and space. Continuing this model in grades 6-8 better supports student learning in that there will not be a large gap of time in which a student does not engage in a specific discipline. This model takes advantage of current research which recognizes that there is variation across children at a given age and that thinking does not develop along a preset roadmap for each student. It allows middle school students to build on what they know and think they understand from their elementary years with the goal in middle school of helping students to revise their knowledge and understanding about those core ideas. Learning theory research shows expert knowledge base develops better through interdisciplinary real-world connections then through isolated content. This is especially important in middle school where motivation is critical to learning. An integrated and better articulated middle school model science curriculum that reflects what we know currently about how children learn science and how their mastery develops over time promotes deeper learning in science. As we know and understand about how students develop understanding while learning content, it informs teachers' practice; if teachers understand where their students are in their understanding of core ideas, and anticipate what students' misconceptions and struggles may be, they are better able to differentiate instruction and provide scaffolding that allows students to develop an integrated and deeper understanding of the science.

Research Based Science Instruction and Curriculum

Effective science instruction can take many forms but includes similar components. According to the Center on Instruction's 2010 report, *Effective Science Instruction: What does the Research Tell Us?*, research-based effective practices of curriculum and instruction important to science learning are: Motivation, Eliciting Students' Prior Knowledge, Intellectual Engagement; Use of Evidence to Critique Claims, and Sense-Making. The integrated model may be better able to support some of these instructional practices especially if it frames curriculum around engaging, relevant, and real-world interdisciplinary questions that will increase student motivation, intellectual engagement and sense-making. Effective science instruction helps middle school students build their understandings and practices, makes connections among and between core concepts and practices, and links to their prior knowledge. Students in grades 6-8 come to understand the natural world in a more scientifically accurate way and understand the nature of science.

Conclusion

Science curriculum should be thematic with a focus on connections among and between core concepts and practices. This approach reinforces the interdisciplinary nature of science and allows for a sequential progression of skills and concepts. This supports developmentally appropriate teaching and assessments. Each grade level has its own specific standards from each science domain that are seen as stepping stones in the progression of learning about a core idea and that meet a specific level of understanding. The idea is to embed technology and engineering in this interdisciplinary progression which would also be coordinated with the New Jersey Student Learning Standards.

Three Dimensions of the Next Generation Science Standards

The National Research Council's (NRC) *Framework* describes a vision of what it means to be proficient in science; it rests on a view of science as both a body of knowledge and an evidence-based, model and theory building enterprise that continually extends, refines, and revises knowledge. It presents three dimensions that will be combined to form each standard:

Dimension 1: Practices

The practices describe behaviors that scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use as they design and build models and systems. The NRC uses the term practices instead of a term like “skills” to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice. Part of the NRC’s intent is to better explain and extend what is meant by “inquiry” in science and the range of cognitive, social, and physical practices that it requires.

Although engineering design is similar to scientific inquiry, there are significant differences. For example, scientific inquiry involves the formulation of a question that can be answered through investigation, while engineering design involves the formulation of a problem that can be solved through design. Strengthening the engineering aspects of the Next Generation Science Standards will clarify for students the relevance of science, technology, engineering and mathematics (the four STEM fields) to everyday life.

Dimension 2: Crosscutting Concepts

Crosscutting concepts have application across all domains of science. As such, they are a way of linking the different domains of science. They include: Patterns, similarity, and diversity; Cause and effect; Scale, proportion and quantity; Systems and system models; Energy and matter; Structure and function; Stability and change. The Framework emphasizes that these concepts need to be made explicit for students because they

provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.

Dimension 3: Disciplinary Core Ideas

Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science. To be considered core, the ideas should meet at least two of the following criteria and ideally all four:

- Have **broad importance** across multiple sciences or engineering disciplines or be a **key organizing concept** of a single discipline;
- Provide a **key tool** for understanding or investigating more complex ideas and solving problems;
- Relate to the **interests and life experiences of students** or be connected to **societal or personal concerns** that require scientific or technological knowledge;
- Be **teachable** and **learnable** over multiple grades at increasing levels of depth and sophistication.

Disciplinary ideas are grouped in four domains: the physical sciences; the life sciences; the earth and space sciences; and engineering, technology and applications of science.

Pacing Guide

UNIT TITLE	ENDURING UNDERSTANDINGS	NGSS	TIMEFRAME
1 - Astronomy	• Patterns in the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • The Earth and solar system model of the solar system can explain eclipses of the sun and the moon. • Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. • The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. • Patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky. • Science assumes that objects and events in the solar system systems occur in consistent patterns that are understandable through measurement and observation. • Gravity plays a role in the motions within galaxies and the solar system. • Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. • Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system. • Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observation. • Objects in the solar system have scale properties. • Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large. • Engineering advances have led to important discoveries in space science, and	**MS – ESS1-1** **MS – ESS1-2** **MS – ESS1-3**	**14 – 20 days**

	scientific discoveries have led to the development of entire industries and engineered systems. • Objects in the solar system have scale properties. • Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large. • Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.		
2 - Weather and Climate	• Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity. • The cycling of water through Earth's systems is driven by energy from the sun and the force of gravity. • Within Earth's systems, the transfer of energy drives the motion and/or cycling of water. • The motions and complex interactions of air masses result in changes in weather conditions. • The complex patterns of the changes in and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. • Examples of data that can be used to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions include weather maps, diagrams, and visualizations; other examples can be obtained through laboratory experiments. • Air masses flow from regions of high pressure to regions of low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time. • Because patterns of the changes and the movement of water in the atmosphere are so complex, weather can only be predicted probabilistically. Sudden changes in weather can result when different air masses collide. Weather can be predicted	**MS-ESS2-5** **MS-ESS2-6** **MS-ESS3-5**	**14 – 20 days**

	within probabilistic ranges. • Cause-and effect-relationships may be used to predict changes in weather. • Unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. • Patterns of atmospheric and oceanic circulation that determine regional climates vary by latitude, altitude, and geographic land distribution. • Atmospheric circulation that, in part, determines regional climates is the result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds. • Ocean circulation that, in part, determines regional climates is the result of the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. • Models that can be used to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates can be diagrams, maps and globes, or digital representations.		
3 - Structure and Properties of Matter	• Substances are made from different types of atoms. • Atoms are the basic units of matter. • Substances combine with one another in various ways. • Molecules are two or more atoms joined together. • Atoms form molecules that range in size from two to thousands of atoms. • Molecules can be simple or very complex. • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. • Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules; these new substances have different properties from those of the reactants. • The analysis of data on the properties of products and reactants can be used to determine whether a chemical process has occurred. • Density, melting point, boiling point, solubility, flammability, and odor are characteristic properties that can be used to identify a pure substance. • Macroscopic patterns are related to the nature of the atomic-level structure of a substance	**MS-PS1-1** **MS-PS1-3** **MS-PS1-4**	**14 – 20 days**

4 - Interactions of Matter	• Changes in particle motion, temperature, and state of a pure substance occur when thermal energy is added or removed. • Qualitative molecular-level models of solids, liquids, and gases can be used to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs. • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. • In a liquid, the molecules are constantly in contact with others. • In a gas, the molecules are widely spaced except when they happen to collide. • In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. • The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter. • Each pure substance has characteristic physical and chemical properties that can be used to identify it. • Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules. • New substances that result from chemical processes have different properties from those of the reactants. • Natural resources can undergo a chemical process to form synthetic material. • Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped.	**MS-PS2-4**	**14 days**
5 - Chemical Reactions	• Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules. • New substances created in a chemical process have different properties from those of the reactants. • The total number of each type of atom in a chemical process is conserved, and thus the mass does not change (the law of conservation of matter). • Matter is conserved because atoms are conserved in physical and chemical processes. • The law of conservation of mass is a mathematical description of natural phenomena. • Some chemical reactions release energy, while others store energy.	**MS-PS1-2** **MS-PS1-5** **MS-PS1-6**	**16 days**

	• The transfer of thermal energy can be tracked as energy flows through a designed or natural system. • Models of all kinds are important for testing solutions. • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. • A solution needs to be tested and then modified on the basis of the test results in order to for it to be improved. • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process. * Some of the characteristics identified as having the best performance may be incorporated into the new design.		
6- Inheritance and Variation of Traits	• Complex and microscopic structures and systems, such as genes located on chromosomes, can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among the parts of the system; therefore, complex natural structures/systems can be analyzed to determine how they function. • Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. • Each distinct gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual. • In addition to variations that arise from sexual reproduction, genetic information can be altered due to mutations. • Some changes to genetic material are beneficial, others harmful, and some neutral to the organism. • Changes in genetic material may result in the production of different proteins. • Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. • Structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism • Though rare, mutations may result in changes to the structure and function of proteins. • Organisms reproduce either sexually or asexually and transfer their genetic information to their offspring.	**MS-LS3-1** **MS-LS3-2**	**14 days**

	- Asexual reproduction results in offspring with identical genetic information. - Sexual reproduction results in offspring with genetic variation. - Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. - In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. - Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. - Punnett squares, diagrams, and simulations can be used to describe the cause-and-effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.		
7- Selection and Adaptation	- Genetic variations of traits in a population increase or decrease some individuals' probability of surviving and reproducing in a specific environment. - Natural selection leads to the predominance of certain traits in a population and the suppression of others. - Natural selection may have more than one cause, and some cause-and-effect relationships within natural selection can only be described using probability. - Natural selection, which over generations leads to adaptations, is one important process through which species change over time in response to changes in environmental conditions. - The distribution of traits in a population changes. - Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. - Natural selection may have more than one cause, and some cause-and-effect relationships in natural selection can only be described using probability. - Mathematical representations can be used to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. - In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. - In artificial selection, humans choose desirable, genetically determined traits in to pass on to offspring. - Phenomena, such as genetic outcomes in artificial selection, may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.	**MS-LS4-4** **MS-LS4-5** **MS-LS4-6**	**14 – 20 days**

	• Technologies have changed the way humans influence the inheritance of desired traits in organisms. • Engineering advances have led to important discoveries in the field of selective breeding. • Engineering advances in the field of selective breeding have led to the development of entire industries and engineered systems. • Scientific discoveries have led to the development of entire industries and engineered systems.		
8- Stability and Change on Earth	• Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. • All human activities draw on Earth's land, ocean, atmosphere, and biosphere resources and have both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. • Minerals, fresh water, and biosphere resources are distributed unevenly around the planet as a result of past geologic processes. • Cause-and-effect relationships may be used to explain how uneven distributions of Earth's mineral, energy, and groundwater resources have resulted from past and current geosciences processes. • Resources that are unevenly distributed as a result of past processes include but are not limited to petroleum, metal ores, and soil. • Mineral, fresh water, ocean, biosphere, and atmosphere resources are limited, and many are not renewable or replaceable over human lifetimes. • The distribution of some of Earth's land, ocean, atmosphere, and biosphere resources are changing significantly due to removal by humans. • Natural hazards can be the result of interior processes, surface processes, or severe weather events. • Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. • Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces, can help forecast the locations and likelihoods of future events. • Data on natural hazards can be used to forecast future catastrophic events and inform the development of technologies to mitigate their effects. • Data on natural hazards can include the locations, magnitudes, and frequencies of the natural hazards. • Graphs, charts, and images can be used to identify patterns of natural hazards in a region.	**MS-ESS3-1** **MS-ESS3-2** **MS-ESS3-4** **MS-ESS3-5**	**21 – 30 days**

	• Graphs, charts, and images can be used to understand patterns of geologic forces that can help forecast the locations and likelihoods of future events. • Technologies that can be used to mitigate the effects of natural hazards can be global or local. • Technologies used to mitigate the effects of natural hazards vary from region to region and over time. • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. • Increases in human population and per-capita consumption of natural resources impact Earth's systems. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. • Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems. • The consequences of increases in human populations and consumption of natural resources are described by science • Science does not make the decisions for the actions society takes. • Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes. • Increases in human population and per-capita consumption of natural resources impact Earth's systems. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. • Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems • The consequences of increases in human populations and consumption of natural resources are described by science. • Science does not make the decisions for the actions society takes. • Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes. • Stability in Earth's surface temperature might be disturbed either by sudden events or gradual changes that accumulate over time. • Human activities and natural processes are examples of factors that have caused the rise in global temperatures over the past century.		

	• Human activities play a major role in causing the rise in global temperatures. • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). • Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, and on applying that knowledge wisely in decisions and activities. • Evidence that some factors have caused the rise in global temperature over the last century can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities		
9- Human Impact	• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. • Changes to Earth's environments can have different impacts (negative and positive) for different living things. • Typically as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise. • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	**MS-ESS3-3** **MS-EST1-1** **MS-ETS1-2** **MS-ETS1-3**	**16 – 25 days**

Content Area:	Earth and Space Science - Space Systems	Grade(s) 8
Unit Plan Title:	Unit 1 - Astronomy	

Overview/Rationale

This unit is broken down into three sub-ideas: the universe and its stars, Earth and the solar system, and the history of planet Earth. Students examine the Earth's place in relation to the solar system, the Milky Way galaxy, and the universe. There is a strong emphasis on a systems approach and using models of the solar system to explain the cyclical patterns of eclipses, tides, and seasons. There is also a strong connection to engineering through the instruments and technologies that have allowed us to explore the objects in our solar system and obtain the data that support the theories explaining the formation and evolution of the universe. Students examine geosciences data in order to understand the processes and events in Earth's history. The crosscutting concepts of patterns, scale, proportion, and quantity and systems and systems models provide a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in developing and using models and analyzing and interpreting data. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

- MS-ESS1-1 Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
- MS-ESS1-2 Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.
- MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.

Disciplinary Core Ideas

ESS1.A: The Universe and Its Stars

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1)
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. (MS-ESS1-2)

ESS1.B: Earth and the Solar System

- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.(MS-ESS1-2), (MS-ESS1-3)
- This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. (MS-ESS1-1)
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.(MS-ESS1-2)

Science and Engineering Practices

SEP-2: Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS1-1), (MS-ESS1-2)

SEP-4: Analyzing and Interpreting Data
Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)

Cross-Cutting Concepts

CCC-1: Patterns

- Patterns can be used to identify cause-and-effect relationships. (MS-ESS1-1)

CCC-3: Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-ESS1-3)

CCC-4: Systems and System Models

- Models can be used to represent systems and their interactions. (MS-ESS1-2)

Connections to Engineering, Technology, and Applications of Science
Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-ESS1-3)

Connections to Nature of Science
Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-ESS1-1), (MS-ESS1-2)

Technology Standard(s)

8.2.8.A.1 Research a product that was designed for a specific demand and identify how the product has changed to meet new demands (i.e.

telephone for communication - smart phone for mobility needs).
8.2.8.A.2 Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system.
8.2.8.A.3 Investigate a malfunction in any part of a system and identify its impacts. The relationships among technologies and the connections between technology and other fields of study.
8.2.8.A.4 Redesign an existing product that impacts the environment to lessen its impact(s) on the environment.

Interdisciplinary Standard(s)

ELA/Literacy

- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS1-3)
- **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS1-3)
- **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-ESS1-1)

Mathematics

- **6.EE.B.6** - Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS1-2)
- **6.RP.A.1** - Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)
- **7.EE.B.4** - Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS1-2)
- **7.RP.A.2** - Recognize and represent proportional relationships between quantities. (MS-ESS1-1), (MS-ESS1-2), (MS-ESS1-3)
- **MP.2** - Reason abstractly and quantitatively. (MS-ESS1-3)
- **MP.4** - Model with mathematics. (MS-ESS1-1), (MS-ESS1-2)

Enduring Understandings:

- Patterns in the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models.
- The Earth and solar system model of the solar system can explain eclipses of the sun and the moon.
- Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun.
- The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.
- Patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky.
- Science assumes that objects and events in the solar system systems occur in consistent patterns that are understandable through measurement and observation.
- Gravity plays a role in the motions within galaxies and the solar system.

- Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them.
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.
- Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system.
- Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observation.
- Objects in the solar system have scale properties.
- Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects.
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
- Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large.
- Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.
- Objects in the solar system have scale properties.
- Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects.
- The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.
- Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large.
- Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.

Essential Question(s) :

Unit Essential Question:
What pattern in the Earth–sun–moon system can be used to explain lunar phases, eclipses of the sun and moon, and seasons?

Lesson Essential Questions:
What is the role of gravity in the motions within galaxies and the solar system?
What are the scale properties of objects in the solar system?

In this unit plan, the following 21st Century themes and skills are addressed:					
Check all that apply. **21st Centur y Themes**			*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**		
	X	Global Awareness		E,T,A	Critical Thinking & Problem Solving
	X	Environmental Literacy		E	Creativity and Innovation
		Health Literacy		E,T	Collaboration, Teamwork and Leadership
		Civic Literacy			Cross-Cultural and Interpersonal Communication
		Financial, Economic, Business and Entrepreneurial Literacy		E	Communication and Media Fluency
					Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:		
*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*		
	E	CRP1. Act as a responsible and contributing citizen and employee
	A	CRP2. Apply appropriate academic and technical skills
		CRP3. Attend to personal health and financial well-being
	E	CRP4. Communicate clearly and effectively with reason
	E	CRP5. Consider the environmental, social and economic impacts of decisions
	E	CRP6. Demonstrate creativity and innovation
	T	CRP7. Employ valid and reliable research strategies
		CRP8. Utilize critical thinking to make sense of problems and persevere in solving them

		CRP9. Model integrity, ethical leadership and effective management
	T	CRP10. Plan education and career paths aligned to personal goals
		CRP11. Use technology to enhance productivity
		CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:

Students will know….	***Students will be able to (do)…***
• Patterns in the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • The Earth and solar system model of the solar system can explain eclipses of the sun and the moon. • Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. • The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. • Patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky. • Science assumes that objects and events in the solar system systems occur in consistent patterns that are understandable through measurement and observation. • Gravity plays a role in the motions within galaxies and the solar system. • Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. • The solar system consists of the sun and a collection of objects,	• Generate and analyze evidence (through simulations or long term investigations) to explain why the Sun's apparent motion across the sky changes over the course of a year. (ESS1.B) *[Clarification Statement: This SLO is based on a disciplinary core idea found in the Framework. It is included as a scaffold to the following SLO.]* • Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. *[Clarification Statement: Examples of models can be physical, graphical, or conceptual.]* (MS-ESS1-1) • Develop and use a model that shows how gravity causes smaller objects to orbit around larger objects at increasing scales, including the gravitational force of the sun causes the planets and other bodies to orbit around it holding together the solar system. (ESS1.A; ESS1.B) *[Clarification Statement: This SLO is based on disciplinary core ideas found in the Framework. It is included as a scaffold to the following SLO.]* • Analyze and interpret data to determine scale properties of objects in the solar system. *[Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.]* (MS-ESS1-3)

including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them. • The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. • Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system. • Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observation. • Objects in the solar system have scale properties. • Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large. • Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems. • Objects in the solar system have scale properties. • Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit	• Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. *[Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).]* (MS-ESS1-2)

around the sun by its gravitational pull on them. - Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large. - Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.	
Assessment Evidence:	
Formative Tasks: ***Web assessments:*** • Solar System Trading Cards • Sizes of Stars • Space Activities for Science Class Lab Rubrics Reference Scale	**Summative Assessment Measures*:*** • Students will develop and use a physical, graphical, or conceptual model to describe patterns in the apparent motion of the sun, moon, and stars in the sky. • Students develop and use models to explain the relationship between the tilt of Earth's axis and seasons. • Analyze and interpret data to determine similarities and differences among objects in the solar system. • Prezi presentation on models of solar system and present • Homework • Classwork • Quizzes • Tests • Labs

Teaching and Learning Actions: (What learning experiences and instruction will enable students to achieve the desired results?	
Instructional Strategies and Activities/ Modifications *D*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, • graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their • understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides

⇒ Modified homework

⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses

⇒ Curriculum Compacting

⇒ Advanced problems to extend the critical thinking skills of advanced learner

⇒ Supplemental reading material for independent study

⇒ Flexible grouping

⇒ Tiered assignments

NASA Solar System Exploration: This link will connect you to NASA's Solar system Exploration website. The website offers a wide variety of student activities.

Seasons Interactive provides students with the opportunity to investigate how Earth's angle of inclination affects three factors: the angle of incoming sunlight, average daily temperatures and the Sun's ecliptic path. Three preset values for the angle of inclination are available (corresponding to the values of Earth, Venus and Uranus). Additionally, users may select an angle value from a sliding scale. Users can control the speed of the simulation or may pause it when needed. Students are able to compare the heights of the ecliptic paths during the course of the year by checking the "Trace Sun's Path" box. From this information, students will be able to construct an explanation for the occurrence of seasons. Exercises with solutions are included, as well as a self-assessment located below the simulation. Teachers should be aware of several weaknesses in the simulation. First, the model allows students to reverse the motion of the Earth around the Sun which could lead to

misconceptions. Secondly, the model overemphasizes the elliptical path of the Earth which often leads to the misconception that seasons are caused by distance
from the Sun. Lastly, while the Sun is shown moving across the sky during the day (from Earth's view), the stars are left static during the night.

In Eclipse Interactive, students investigate both lunar and solar eclipses by manipulating up to three independent variables: Moon's tilt from orbit, Earth-Moon distance and size of the Moon. By viewing the effects of changes to these variables, students will be able to construct explanations for solar and lunar eclipses. The model includes both top and side views of the Earth-Moon system during the Moon's revolution. In addition, students can toggle to show outlines of the Earth and Moon. Teachers should note that the simulation has been designed as a single screen model that automatically moves between solar and lunar eclipses without any indication of time. As a result, younger students may become confused and will need to be reminded about the duration of lunar months. The simulation includes bare-bones introductory content, how-to instructions, the interactive model itself, related exercises, and solutions to the exercises. One minor inconvenience is the lack of a reset button.

The Pull of the Planets is part of a thematic series of lessons highlighting the Juno mission to Jupiter. It is a traditional hands-on activity that models how gravitational forces can keep planets and asteroids in orbit within the Solar System. Using a stretchable fabric held in place with an embroidery hoop, students work with spheres of various materials to explore how mass and sizes affect the strength of gravitational forces. Background materials, including a materials sheet, aid teachers in organizing this activity.

List of textbooks but not limited to:

Earth's Atmosphere – McDougall Littell Science
Astronomy – Prentice Hall Science Explorer

Suggested Time Frame:	14-20 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	**Earth and Space Science**	**Grade(s) 8**
Unit Plan Title:	**Unit 2 - Weather and Climate**	

Overview/Rationale

This unit is broken down into three sub-ideas: Earth's large-scale systems interactions, the roles of water in Earth's surface processes, and weather and climate. Students make sense of how Earth's geosystems operate by modeling the flow of energy and cycling of matter within and among different systems. A systems approach is also important here, examining the feedbacks between systems as energy from the Sun is transferred between systems and circulates though the ocean and atmosphere. The crosscutting concepts of cause and effect, systems and system models, and energy and matter are called out as frameworks for understanding the disciplinary core ideas. In this unit, students are expected to demonstrate proficiency in developing and using models and planning and carrying out investigations as they make sense of the disciplinary core ideas. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

- MS-ESS2-5 Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.
- MS-ESS2-6 Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Disciplinary Core Ideas

ESS2.C: The Roles of Water in Earth's Surface Processes

- The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)
- Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5)
- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.(MS-ESS3-5)

Science and Engineering Practices

SEP-1: Asking Questions and Defining Problems
Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables and clarifying arguments and models.

- Ask questions to identify and clarify evidence of an argument. (MS-ESS3-5)

SEP-2: Developing and Using Models
Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. (MS-ESS2-6)

SEP-3: Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Collect data about the performance of a proposed object, tool, process, or system under a range of conditions. (MS-ESS2-5)

Cross-Cutting Concepts

CCC-2: Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)

CCC-4: Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)

CCC- 7: Stability and Change

- Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

Technology Standard(s)

8.1.8.E.1 Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem.
8.2.8.D.1 Design and create a product that addresses a real world problem using a design process under specific constraints.
8.2.8.D.2 Identify the design constraints and trade-offs involved in designing a prototype (e.g., how the prototype might fail and how it might be improved) by completing a design problem and reporting results in a multimedia presentation, design portfolio or engineering notebook.
8.2.8.D.3 Build a prototype that meets a STEM-based design challenge using science

Interdisciplinary Standard(s)

ELA/Literacy

- **RI.3.1** - Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers. (3-ESS2-2), (3-ESS3-1)
- **RI.3.9** - Compare and contrast the most important points and key details presented in two texts on the same topic. (3-ESS2-2)
- **W.3.1** - Write opinion pieces on topics or texts, supporting a point of view with reasons. (3-ESS3-1)
- **W.3.7** - Conduct short research projects that build knowledge about a topic.(3-ESS3-1)
- **W.3.8** - Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories. (3-ESS2-2)

Mathematics

- **3.MD.A.2** - Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem. (3-ESS2-1)
- **3.MD.B.3** - Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. (3-ESS2-1)
- **MP.2** - Reason abstractly and quantitatively. (3-ESS2-1), (3-ESS2-2), (3-ESS3-1)
- **MP.4** - Model with mathematics. (3-ESS2-1), (3-ESS2-2), (3-ESS3-1)
- **MP.5** - Use appropriate tools strategically. (3-ESS2-1)

Enduring Understandings:

- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- The cycling of water through Earth's systems is driven by energy from the sun and the force of gravity.
- Within Earth's systems, the transfer of energy drives the motion and/or cycling of water.

- The motions and complex interactions of air masses result in changes in weather conditions.
- The complex patterns of the changes in and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns.
- Examples of data that can be used to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions include weather maps, diagrams, and visualizations; other examples can be obtained through laboratory experiments.
- Air masses flow from regions of high pressure to regions of low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time.
- Because patterns of the changes and the movement of water in the atmosphere are so complex, weather can only be predicted probabilistically. Sudden changes in weather can result when different air masses collide. Weather can be predicted within probabilistic ranges.
- Cause-and effect-relationships may be used to predict changes in weather.
- Unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
- Patterns of atmospheric and oceanic circulation that determine regional climates vary by latitude, altitude, and geographic land distribution.
- Atmospheric circulation that, in part, determines regional climates is the result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds.
- Ocean circulation that, in part, determines regional climates is the result of the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents.
- Models that can be used to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates can be diagrams, maps and globes, or digital representations.

Essential Question(s) :

***Unit Essential Question*:**
What factors interact and influence weather and climate?

***Lesson Essential Questions*:**
What are the processes involved in the cycling of water through Earth's systems?
What is the relationship between the complex interactions of air masses and changes in weather conditions?
What are the major factors that determine regional climates?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
X	**Global Awareness**	E	**Critical Thinking & Problem Solving**

X	Environmental Literacy	E	Creativity and Innovation
X	Health Literacy	E,T	Collaboration, Teamwork and Leadership
	Civic Literacy		Cross-Cultural and Interpersonal Communication
	Financial, Economic, Business and Entrepreneurial Literacy	E,A	Communication and Media Fluency
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
E	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E	**CRP4. Communicate clearly and effectively with reason**
T	**CRP5. Consider the environmental, social and economic impacts of decisions**
	CRP6. Demonstrate creativity and innovation
	CRP7. Employ valid and reliable research strategies
E	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
	CRP9. Model integrity, ethical leadership and effective management
E	**CRP10. Plan education and career paths aligned to personal goals**
	CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:	
Students will know… • Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity. • The cycling of water through Earth's systems is driven by energy from the sun and the force of gravity. • Within Earth's systems, the transfer of energy drives the motion and/or cycling of water. • The motions and complex interactions of air masses result in changes in weather conditions. • The complex patterns of the changes in and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. • Examples of data that can be used to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions include weather maps, diagrams, and visualizations; other examples can be obtained through laboratory experiments. • Air masses flow from regions of high pressure to regions of low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time. • Because patterns of the changes and the movement of water in the atmosphere are so complex, weather can only be predicted probabilistically. Sudden changes in weather can result when different air masses collide. Weather can be predicted within probabilistic ranges. • Cause-and effect-relationships may be used to predict changes in weather.	***Students will be able to (do)…*** • Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. *[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]* (MS-ESS2-4) • Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. *[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]* (MS-ESS2-5) • Explain how variations in density result from variations in temperature and salinity drive a global pattern of interconnected ocean currents. *[Note: This SLO is based on a disciplinary core idea found in the Framework. It is included as a scaffold to the following SLO.]* (ESS2.C) • Use a model to explain the mechanisms that cause varying daily temperature ranges in a coastal community and in a community located in the interior of the country. *[Note: This SLO is based disciplinary core ideas found in the Framework. It is included as a scaffold to the following SLO.]* (ESS2.C; ESS2.D)

• Unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. • Patterns of atmospheric and oceanic circulation that determine regional climates vary by latitude, altitude, and geographic land distribution. • Atmospheric circulation that, in part, determines regional climates is the result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds. • Ocean circulation that, in part, determines regional climates is the result of the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. • Models that can be used to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates can be diagrams, maps and globes, or digital representations.	• Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]* (MS-ESS2-6)
Assessment Evidence:	
Formative Tasks: ***Web resources:*** • Making Drops of Rain • River Erosion • Demonstrating That Air Has Mass • Slowing Evaporation • Comparing the Weather • Modeling Climates • Weather Activities for Science Class • www.teachervision.com Various rubrics Formative/summative assessments	**Summative Assessment Measures*:*** • Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. • Model the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. • Collect data to serve as the basis for evidence for how the motions and complex interactions of air masses result in changes in weather conditions. • Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. • Classwork

Reference Scale	• Homework • Quizzes • Tests • Labs
Teaching and Learning Actions:	
Instructional Strategies and Activities *D - Modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)
Modifications & Resources	

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids

- ⇒ Modeling
- ⇒ Guided note-taking
- ⇒ Study Guides
- ⇒ Modified homework
- ⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

- ⇒ Open-ended responses
- ⇒ Curriculum Compacting
- ⇒ Advanced problems to extend the critical thinking skills of advanced learner
- ⇒ Supplemental reading material for independent study
- ⇒ Flexible grouping
- ⇒ Tiered assignments

Air Masses of a set of Level 1 activities designed by the Science Center for Teaching, Outreach, and Research on Meteorology (STORM) Project. The authors suggest that previous activities in the unit be completed before Activity 12: Air Masses, including those that address pressure systems and dew point temperature. In Activity 12, the students learn about the four main types of air masses that affect weather in the United States, their characteristic temperatures, and humidity levels as it relates to dew point temperatures. The lesson plan follows the 5E format. Initially, students discuss local weather and then examine surface temperature and dew point data on maps to determine patterns and possible locations of air masses. They learn about the source regions of air masses and compare their maps to a forecast weather map with fronts and pressure systems drawn in. During the Extension phase, students access current maps with surface and dew point temperatures at http://www.uni.edu/storm/activities/level1 and try to identify locations of air masses. They sketch in fronts and compare their results to the fronts map. Evaluation consists of collection of student papers.

Ocean Currents and Sea Surface Temperature allows students to gather data using My NASA Data microsets to investigate how differential heating of Earth results in circulation patterns in the oceans and the atmosphere that globally distribute the heat. They examine the relationship between the rotation of Earth and the circular motions of ocean currents and air. Students also make predictions based on the data to concerns about global climate change. They begin by examining the temperature of ocean's surface currents and ocean surface winds. These currents, driven by the wind, mark the movement of surface heating as monitored by satellites. Students explore the link between 1) ocean temperatures and currents, 2) uneven heating and rotation of Earth, 3) resulting climate and weather patterns, and 4) projected impacts of climate change (global warming). Using the Live Access Server, students can select data sets for various elements for different regions of the globe, at different times of the year, and for multiple years. The information is provided in maps or graphs which can be saved for future reference. Some of the data sets accessed for this lesson include Sea Surface Temperature, Cloud Coverage, and Sea Level Height for this lesson. The lesson provides directions for accessing the data as well as questions to guide discussion and learning. The estimated time for completing the activity is 50 minutes. Inclusion of the Extension activities could broaden the scope of the lesson to several days in length. Links to informative maps and text such as the deep ocean conveyor belt, upwelling, and coastal fog as needed to answer questions in the extension activities are included.

Adopt a Drifter: Do Ocean Surface Currents Influence Climate? Students construct climagraphs showing both precipitation and temperature for 3 coastal cities and describe how ocean surface currents affect climate on nearby land. They are provided with the research question, "Do ocean currents influence climate?" and are asked to construct a hypothesis. The students are asked to read an introductory paragraph explaining the relationship between the temperature of the ocean current and temperature and precipitation on adjacent land and examine a map of major ocean currents. They construct 3 climographs using data provided. The labels on the graphs are not directly on the lines, so the teacher would need to instruct students on the placement of their data points. Conclusion and analysis questions are provided asking students to examine the direction of flow of ocean currents, temperature of the water, source regions of the current, and impact on both temperature and precipitation on coastal regions. Extension activities include researching additional information on vegetation, culture and physical geography of the 3 cities studied, plus comparing data for 2 additional cities. The activity should take 2 class periods.

List of textbooks but not limited to:

Earth's Atmosphere – McDougall Littell Science

Astronomy – Prentice Hall Science Explorer

Suggested Time Frame:	14-21 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	**Physical Science**	**Grade(s) 8**
Unit Plan Title:	**Unit 3 - Structure and Properties of Matter**	

Overview/Rationale

Students build understandings of what occurs at the atomic and molecular scale. Students apply their understanding that pure substances have characteristic properties and are made from a single type of atom or molecule. They also provide a molecular level accounts to explain states of matter and changes between states. The crosscutting concepts of cause and effect, scale, proportion and quantity, structure and function, interdependence of science, engineering, and technology, and the influence of science, engineering and technology on society and the natural world provide a framework for understanding the disciplinary core ideas. Students demonstrate grade appropriate proficiency in developing and using models, and obtaining, evaluating, and communicating information. Students are also expected to use the scientific and engineering practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

- MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.
- MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.
- MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1)
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)*
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4)
- In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.(MS-PS1-4)
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1)
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4)

PS1.B: Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3) *(Note: This Disciplinary Core*

Idea is also addressed by MS-PS1-2.)

PS3.A: Definitions of Energy

- The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. *(secondary to MS-PS1-4)*
- The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system’s material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. *(secondary to MS-PS1-4)*

Science and Engineering Practices

SEP-2: Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to predict and/or describe phenomena. (MS-PS1-1), (MS-PS1-4)

SEP-8: Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 experiences and progresses to evaluating the merit and validity of ideas and methods.

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3)

Cross-Cutting Concepts

CCC-2: Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4)

CCC-3: Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1)

CCC-6: Structure and Function

- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3)

Connections to Engineering, Technology, and Applications of Science
Influence of Science, Engineering, and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)

Technology Standard(s)

8.1.8.A.4 Graph and calculate data within a spreadsheet and present a summary of the results
8.1.8.E.1 Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem.

Interdisciplinary Standard(s)

ELA/Literacy

- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS1-3)
- **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1), (MS-PS1-4)
- **WHST.6-8.8** - Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-PS1-3)

Mathematics

- **6.NS.C.5** - Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS1-4)
- **6.RP.A.3** - Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (MS-PS1-1)
- **8.EE.A.3** - Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)
- **MP.2** - Reason abstractly and quantitatively. (MS-PS1-1)
- **MP.4** - Model with mathematics. (MS-PS1-1)

Enduring Understandings:

- Substances are made from different types of atoms.
- Atoms are the basic units of matter.
- Substances combine with one another in various ways.
- Molecules are two or more atoms joined together.
- Atoms form molecules that range in size from two to thousands of atoms.
- Molecules can be simple or very complex.
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules; these new substances have different properties from those of the reactants.
- The analysis of data on the properties of products and reactants can be used to determine whether a chemical process has occurred.
- Density, melting point, boiling point, solubility, flammability, and odor are characteristic properties that can be used to identify a pure substance.
- Macroscopic patterns are related to the nature of the atomic-level structure of a substance

Essential Question(s) :

Unit Essential Question:
How is it that everything is made of star dust?

Lesson Essential Questions:
If the universe is not made of Legos®, then what is it made of?
Is it possible to tell if two substances mixed or if they reacted with each other?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
	Global Awareness	**E,T**	**Critical Thinking & Problem Solving**

X	Environmental Literacy	E	Creativity and Innovation
	Health Literacy	E,T,A	Collaboration, Teamwork and Leadership
	Civic Literacy	E	Cross-Cultural and Interpersonal Communication
	Financial, Economic, Business and Entrepreneurial Literacy		Communication and Media Fluency
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

Indicate whether these skills are ***E****-Encouraged,* ***T****-Taught, or* ***A****-Assessed in this unit by marking* ***E, T, A*** *on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
A	CRP2. Apply appropriate academic and technical skills
	CRP3. Attend to personal health and financial well-being
E	CRP4. Communicate clearly and effectively with reason
	CRP5. Consider the environmental, social and economic impacts of decisions
E	CRP6. Demonstrate creativity and innovation
	CRP7. Employ valid and reliable research strategies
	CRP8. Utilize critical thinking to make sense of problems and persevere in solving them
	CRP9. Model integrity, ethical leadership and effective management
T	CRP10. Plan education and career paths aligned to personal goals
E	CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:	
Students will know…	***Students will be able to (do)…***
- Substances are made from different types of atoms. - Atoms are the basic units of matter. - Substances combine with one another in various ways. - Molecules are two or more atoms joined together. - Atoms form molecules that range in size from two to thousands of atoms. - Molecules can be simple or very complex. - Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). - Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. - Substances react chemically in characteristic ways. - In a chemical process, the atoms that make up the original substances are regrouped into different molecules; these new substances have different properties from those of the reactants. - The analysis of data on the properties of products and reactants can be used to determine whether a chemical process has occurred. - Density, melting point, boiling point, solubility, flammability, and odor are characteristic properties that can be used to identify a pure substance. - Macroscopic patterns are related to the nature of the atomic-level structure of a substance.	- Develop models to describe the atomic composition of simple molecules and extended structures. *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms. The substructure of atoms and the periodic table are learned in high school chemistry.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]* (MS-PS1-1) - Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.*[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]* (MS-PS1-2)

Assessment Evidence:	
Formative Tasks: • Use the model of the simple molecule to describe its atomic composition. • Develop a model of an extended structure. • Use the model of the extended structure to describe its repeating subunits. • Analyze and interpret data to determine similarities and differences from results of chemical reactions between substances before and after they undergo a chemical process. • Analyze and interpret data on the properties of substances before and after they undergo a chemical process. • Identify and describe possible correlation and causation relationships evidenced in chemical reactions. • Make logical and conceptual connections between evidence that chemical reactions have occurred and explanations of the properties of substances before and after they undergo a chemical process. ***Web Resources:*** • A Matter of Fact • Balloon Graph • Teachervision.com Various Rubrics Reference scale Formative/summative assessments	**Summative Assessment Measures*:*** • Develop a model of a simple molecule. • Homework • Classwork • Quizzes • Tests • Labs

Teaching and Learning Actions:	
Instructional Strategies and Activities *D- modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Middle school Chemistry, Chapter 1: Solids, Liquids, and Gases Students are introduced to the idea that matter is composed of atoms and molecules that are attracted to each other and in constant motion. Students explore the attractions and motion of atoms and molecules as they experiment with and observe the heating and cooling of a solid, liquid, and gas.

Middle school Chemistry, Chapter 2: Changes of State Students help design experiments to test whether the temperature of water affects the rate of evaporation and whether the temperature of water vapor affects the rate of condensation. Students also look in more detail at the water molecule to help explain the state changes of water. (all activities/lessons)

States of Matter: Use interactive computer models to trace an atom's trajectory at a certain physical stage, and investigate how molecular behavior is responsible for the substance's state.

Molecular View of a Solid: Explore the structure of a solid at the molecular level. Molecules are always in motion, though molecules in a solid move slowly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.

Molecular View of a Liquid: Explore the structure of a liquid at the molecular level. Molecules are always in motion. Molecules in a liquid move moderately. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.

Molecular View of a Gas: Explore the structure of a gas at the molecular level. Molecules are always in motion. Molecules in a gas move quickly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts. ***Textbooks used:*** Chemical Interactions – McDougall Littell Science	
Suggested Time Frame:	14-21 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Physical Science - Forces and Interactions	Grade(s) 8
Unit Plan Title:	Unit 4 - Interactions of Matter	

Overview/Rationale

Students build understandings of what occurs at the atomic and molecular scale. Students apply their understanding that pure substances have characteristic properties and are made from a single type of atom or molecule. They also provide a molecular level accounts to explain states of matter and changes between states. The crosscutting concepts of cause and effect, scale, proportion and quantity, structure and function, interdependence of science, engineering, and technology, and the influence of science, engineering and technology on society and the natural world provide a framework for understanding the disciplinary core ideas.

Students demonstrate grade appropriate proficiency in developing and using models, and obtaining, evaluating, and communicating information. Students are also expected to use the scientific and engineering practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-PS2-4 Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Disciplinary Core Ideas

Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4)

Science and Engineering Practices

SEP 7 - Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4)

Connections to Nature of Science
Science Knowledge Is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2), (MS-PS2-4)

Cross-Cutting Concepts

CCC 4- Systems and System Models

- Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1), (MS-PS2-4)

Technology Standard(s)

8.1.8.A.2 Create a document (e.g. newsletter, reports, personalized learning plan, business letters or flyers) using one or more digital applications to be critiqued by professionals for usability.
8.1.8.B.1 Synthesize and publish information about a local or global issue or event (ex. tele collaborative project, blog, school web).

Interdisciplinary Standard(s)

ELA/Literacy

- **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS2-1), (MS-PS2-3)
- **RST.6-8.3** - Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS2-1), (MS-PS2-2), (MS-PS2-5)
- **WHST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS2-2)
- **WHST.6-8.7** - Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-1), (MS-PS2-5)

Mathematics

- **6.EE.A.2** - Write, read, and evaluate expressions in which letters stand for numbers. (MS-PS2-1), (MS-PS2-2)
- **6.NS.C.5** - Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (MS-PS2-1)
- **7.EE.B.3** - Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. (MS-PS2-1), (MS-PS2-2)
- **7.EE.B.4** - Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-PS2-1), (MS-PS2-2)
- **MP.2** - Reason abstractly and quantitatively. (MS-PS2-1), (MS-PS2-2), (MS-PS2-3)

Enduring Understandings:

- Changes in particle motion, temperature, and state of a pure substance occur when thermal energy is added or removed.
- Qualitative molecular-level models of solids, liquids, and gases can be used to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs.
- Gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
- In a liquid, the molecules are constantly in contact with others.
- In a gas, the molecules are widely spaced except when they happen to collide.
- In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
- The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter.
- Each pure substance has characteristic physical and chemical properties that can be used to identify it.
- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules.
- New substances that result from chemical processes have different properties from those of the reactants.
- Natural resources can undergo a chemical process to form synthetic material.
- Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped.

Essential Question(s) :

Unit Essential Question:
How can we trace synthetic materials back to natural ingredients?

Lesson Essential Questions:
How can you tell what the molecules are doing in a substance?
How can we trace synthetic materials back to natural ingredients?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Centur y Skills	
X	**Global Awareness**	E,T,A	**Critical Thinking & Problem Solving**
	Environmental Literacy	E	**Creativity and Innovation**

	Health Literacy	E,A	Collaboration, Teamwork and Leadership
	Civic Literacy		Cross-Cultural and Interpersonal Communication
	Financial, Economic, Business and Entrepreneurial Literacy	E	Communication and Media Fluency
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
T	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E	**CRP4. Communicate clearly and effectively with reason**
	CRP5. Consider the environmental, social and economic impacts of decisions
E	**CRP6. Demonstrate creativity and innovation**
	CRP7. Employ valid and reliable research strategies
	CRP8. Utilize critical thinking to make sense of problems and persevere in solving them
	CRP9. Model integrity, ethical leadership and effective management
T	**CRP10. Plan education and career paths aligned to personal goals**
E	**CRP11. Use technology to enhance productivity**
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:	
Students will know….	***Students will be able to (do)…***
• Changes in particle motion, temperature, and state of a pure substance occur when thermal energy is added or removed. • Qualitative molecular-level models of solids, liquids, and gases can be used to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs. • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. • In a liquid, the molecules are constantly in contact with others. • In a gas, the molecules are widely spaced except when they happen to collide. • In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. • The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter. • Each pure substance has characteristic physical and chemical properties that can be used to identify it. • Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules. • New substances that result from chemical processes have different properties from those of the reactants. • Natural resources can undergo a chemical process to form synthetic material.	• Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. *[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]* (MS-PS1-3) • Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.*[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]* (MS-PS1-4)

• Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped.	
Assessment Evidence:	
Formative Tasks: • Use cause-and-effect relationships to predict changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural or designed systems. • Obtain, evaluate, and communicate information to show that synthetic materials come from natural resources and affect society. • Gather, read, and synthesize information about how synthetic materials formed from natural resources affect society. • Assess the credibility, accuracy, and possible bias of each publication and methods used within the publication. Describe how information about how synthetic materials formed from natural resources ***Web resources:*** ***Energy and Matter*** https://www.teachervision.com/energy-and-matter/printable/57624.html Properties of Matter Activity Reference Scale	**Summative Assessment Measures*:*** • Develop a model that predicts and describes changes in particle motion that could include molecules or inert atoms or pure substances. • Homework • Classwork • Quizzes/Tests • Labs

Rubrics Formative and Summative Assessments	

Teaching and Learning Actions:	
Instructional Strategies and Activities *D*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources:

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Refer to links from "Structure and Properties of Matter"

Textbooks used:
Chemical Interactions – McDougall Littell Science

Suggested Time Frame:	14 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Physical Science	Grade(s) 8
Unit Plan Title:	Unit 5 - Chemical Reactions	

Overview/Rationale

Students provide molecular-level accounts of states of matters and changes between states, of how chemical reactions involve regrouping of atoms to form new substances, and of how atoms rearrange during chemical reactions. Students also apply their understanding of optimization design and process in engineering to chemical reaction systems. The crosscutting concept of energy and matter provides a framework for understanding the disciplinary core ideas. Students are expected to demonstrate proficiency in developing and using models, analyzing and interpreting data, designing solutions, and obtaining, evaluating, and communicating information. Students are also expected to use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Science Standards (Established Goals)

- MS-PS1-2 Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- MS-PS1-5 Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
- MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Disciplinary Core Ideas

PS1.A: Structure and Properties of Matter

- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)*

PS1.B: Chemical Reactions

- Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2), (MS-PS1-5) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)*
- The total number of each type of atom is conserved, and thus the mass does not change.(MS-PS1-5)
- Some chemical reactions release energy, others store energy. (MS-PS1-6)

ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it. *(secondary to MS-PS1-6)*

ETS1.C: Optimizing the Design Solution

- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design. *(secondary to MS-PS1-6)*
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary to MS-PS1-6)*

Science and Engineering Practices

SEP-2: Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to describe unobservable mechanisms. (MS-PS1-5)

SEP-: Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)

SEP-6: Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6)

Connections to Nature of Science

Science Knowledge Is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

- Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)

Cross-Cutting Concepts
CCC-1: Patterns • Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) **CCC-5: Energy and Matter** • Matter is conserved because atoms are conserved in physical and chemical processes.(MS-PS1-5) • The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)
Technology Standard(s)
8.1.8.B.1 Synthesize and publish information about a local or global issue or event (ex. telecollaborative project, blog, school web). **8.1.8.A.2** Create a document (e.g. newsletter, reports, personalized learning plan, business letters or flyers) using one or more digital applications to be critiqued by professionals for usability. **8.2.8.D.3** Build a prototype that meets a STEM-based design challenge using science
Interdisciplinary Standard(s)
ELA/Literacy • **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-PS1-2) • **RST.6-8.3** - Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6) • **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-2), (MS-PS1-5) • **WHST.6-8.7** - Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS1-6) **Mathematics** • **6.RP.A.3** - Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (MS-PS1-2), (MS-PS1-5) • **6.SP.B.4** - Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-PS1-2) • **6.SP.B.5** - Summarize numerical data sets in relation to their context. (MS-PS1-2) • **MP.2** - Reason abstractly and quantitatively. (MS-PS1-2), (MS-PS1-5) • **MP.4** - Model with mathematics. (MS-PS1-5)

Enduring Understandings:

- Substances react chemically in characteristic ways.
- In a chemical process, the atoms that make up the original substances are regrouped into different molecules.
- New substances created in a chemical process have different properties from those of the reactants.
- The total number of each type of atom in a chemical process is conserved, and thus the mass does not change (the law of conservation of matter).
- Matter is conserved because atoms are conserved in physical and chemical processes.
- The law of conservation of mass is a mathematical description of natural phenomena.
- Some chemical reactions release energy, while others store energy.
- The transfer of thermal energy can be tracked as energy flows through a designed or natural system.
- Models of all kinds are important for testing solutions.
- There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.
- The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.
- A solution needs to be tested and then modified on the basis of the test results in order to for it to be improved.
- Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process. * Some of the characteristics identified as having the best performance may be incorporated into the new design.

Essential Question(s) :

Unit Essential Question:
How do substances combine or change (react) to make new substances?

Lesson Essential Question:
What happens to the atoms when I bake a cake?
How can a device be designed, constructed, tested, and modified that either releases or absorbs thermal energy by chemical processes?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
X	Global Awareness	E,T	Critical Thinking & Problem Solving

	Environmental Literacy	E	Creativity and Innovation
X	Health Literacy	E,T,A	Collaboration, Teamwork and Leadership
	Civic Literacy		Cross-Cultural and Interpersonal Communication
	Financial, Economic, Business and Entrepreneurial Literacy	E	Communication and Media Fluency
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
T	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E	**CRP4. Communicate clearly and effectively with reason**
	CRP5. Consider the environmental, social and economic impacts of decisions
E	**CRP6. Demonstrate creativity and innovation**
	CRP7. Employ valid and reliable research strategies
T	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
	CRP9. Model integrity, ethical leadership and effective management
A	**CRP10. Plan education and career paths aligned to personal goals**
	CRP11. Use technology to enhance productivity
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:	
Students will know….	***Students will be able to (do)…***
• Substantces react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules. • New substances created in a chemical process have different properties from those of the reactants. • The total number of each type of atom in a chemical process is conserved, and thus the mass does not change (the law of conservation of matter). • Matter is conserved because atoms are conserved in physical and chemical processes. • The law of conservation of mass is a mathematical description of natural phenomena. • Some chemical reactions release energy, while others store energy. • The transfer of thermal energy can be tracked as energy flows through a designed or natural system. • Models of all kinds are important for testing solutions. • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. • A solution needs to be tested and then modified on the basis of the test results in order to for it to be improved.	• Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. *[Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.] (MS-PS1-5)* • Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* *[Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.] (MS-PS1-6)* • Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)

• Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process. * Some of the characteristics identified as having the best performance may be incorporated into the new design.	
Assessment Evidence:	
Formative Tasks: Web ***resources:*** *Which metal corrodes the fastest?* Salt or Sugar: Which Dissolves Faster in Different Liquids? Chemical Reactions • Can You Copperplate? • This lesson plan introduces students to the process of plating one metallic object with another metal and the importance of this process in engineering applications. With parameters, students design strategies to copperplate other metal objects using… • Balancing Chemical Equations • In this interactive simulation, users adjust the coefficients in an equation while the molecules are depicted in a box above the equation. This allows the users to visualize what the symbols in the chemical equation actually mean. They can count t… • Energy Changes in Chemical Reactions • This is a 5E laboratory lesson plan about endothermic and exothermic reactions. Teaching resources include activity sheets for assessment, answer sheets, a variety of video clips and animations to support the students' learning of the concepts, backg…	**Summative Assessment Measures*:*** ☐ Use physical models or drawings, including digital forms, to represent atoms in a chemical process. ☐ Use mathematical descriptions to show that the number of atoms before and after a chemical process is the same. ☐ Undertake a design project, engaging in the design cycle, to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. ☐ Specific criteria are limited to amount, time, and temperature of a substance. ☐ Analyze and interpret data for the amount, time, and temperature of a substance in testing a device that either releases or absorbs thermal energy by chemical processes to determine similarities and differences in findings. ☐ Develop a model to generate data for testing a device that either releases or absorbs thermal energy by chemical processes, including those representing inputs and outputs of thermal energy. ☐ Homework ☐ Classwork ☐ Quizzes ☐ Tests ☐ Labs

☐ Baggie Chemistry • Students begin the activity by brainstorming observable changes that indicate a chemical change has occurred. They then mix calcium chloride with water and measure the temperature change during the reaction. Next, they add baking soda to the solut… ☐ Design and Build a Biosuit • The overarching unit has students learn about, design, and build biosuits - suits designed to protect people in potentially dangerous conditions while allowing for complex tasks to still be completed. This review focuses on lessons 3 and 4 of that… ☐ Reference Scales ☐ Rubrics	

Teaching and Learning Actions:	
Instructional Strategies and Activities *D- modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

Middle School Chemistry, Chapter 4: Periodic Table and Bonding: (Lesson 1 and 2 only) Students look deeply into the structure of the atom and play a game to better understand the relationship between protons, neutrons, electrons, and energy levels in atoms and their location in the periodic table. Predict how elements will react to each other based on their location in the periodic table. Lesson 1: Students are constructing an explanation of why charges attract or repel.

Middle School Chemistry, Chapter 5: The Water Molecule and Dissolving: Students investigate the polarity of the water molecule and design tests to compare water to less polar liquids for evaporation rate, surface tension, and ability to dissolve certain substances. Students also discover that dissolving applies to solids, liquids, and gases.

Middle School Chemistry, Chapter 6: Chemical Change: Students explore the concept that chemical reactions involve the breaking of certain bonds between atoms in the reactants, and the rearrangement and rebonding of these atoms to make the products. Students also design tests to investigate how the amount of products and the rate of the reaction can be changed. Students will also explore endothermic and exothermic reactions. Students are using models to match what happens during a chemical change and mass is conserved.

Gumdrop Models: Students will design a model to explain the structure of an atom. This activity will allow for fast pacing for the gifted and talented students. Students will be given Data Cards to develop and modify models of molecules. Content will be differentiated Data Cards will begin with the construction of an atom. As students finish construction, they will draw the atom/molecule as a summative assessment.

Can you Copperplate?
This lesson plan introduces students to the process of plating one metallic object with another metal and the importance of this process in engineering applications. With parameters, students design strategies to copperplate other metal objects using…
Balancing Chemical Equations
Energy Changes in Chemical Reactions
Baggie Link Chemistry

Textbooks Used:

Chemical Interactions – McDougall Littell Science

Suggested Time Frame:	16 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Life Science: Growth, Development and Reproduction of Organisms	Grade(s) 8
Unit Plan Title:	Unit 6 - Inheritance and Variation of Traits	

Overview/Rationale

Students develop and use models to describe how gene mutations and sexual reproduction contribute to genetic variation. Students understand how genetic factors determine the growth of an individual organism. They also demonstrate understanding of the genetic implications of sexual and asexual reproduction. The crosscutting concepts of cause and effect and structure and function provide a framework for understanding how gene structure determines differences in the functioning of organisms. Students are expected to demonstrate proficiency in developing and using models. Students use these science and engineering practices to demonstrate understanding of the disciplinary core ideas.

Science Standards (Established Goals)

- MS-LS3-1 Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.
- MS-LS3-2 Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Disciplinary Core Ideas

LS1.B: Growth and Development of Organisms
- Organisms reproduce, either sexually or asexually, and transfer their genetic information to their offspring. *(secondary to MS-LS3-2)*

LS3.A: Inheritance of Traits
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. Each distinct gene chiefly controls the production of specific proteins, which in turn affects the traits of the individual. Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. (MS-LS3-1)
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. (MS-LS3-2)

LS3.B: Variation of Traits
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. (MS-LS3-2)
- In addition to variations that arise from sexual reproduction, genetic information can be altered because of mutations. Though rare, mutations may result in changes to the structure and function of proteins. Some changes are beneficial, others harmful, and some neutral to the organism. (MS-LS3-1)

Science and Engineering Practices
SEP 2 - Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop and use a model to describe phenomena. (MS-LS3-1), (MS-LS3-2)
Cross-Cutting Concepts
CCC-2: Cause and Effect • Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS3-2) **CCC-6: Structure and Function** • Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts, therefore complex natural structures/systems can be analyzed to determine how they function. (MS-LS3-1)
Technology Standard(s)
8.1.8.E.1 Effectively use a variety of search tools and filters in professional public databases to find information to solve a real world problem. **8.2.8.D.1** Design and create a product that addresses a real world problem using a design process under specific constraints. **8.2.8.D.2** Identify the design constraints and trade-offs involved in designing a prototype (e.g., how the prototype might fail and how it might be improved) by completing a design problem and reporting results in a multimedia presentation, design portfolio or engineering notebook. **8.2.8.D.3** Build a prototype that meets a STEM-based design challenge using science
Interdisciplinary Standard(s)
ELA/Literacy • **RST.6-8.1** - Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-4), (MS-LS1-5), (MS-LS3-1), (MS-LS3-2), (MS-LS4-5) • **RST.6-8.4** - 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 6–8 texts and topics. (MS-LS3-1), (MS-LS3-2) • **RST.6-8.7** - Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-LS3-1), (MS-LS3-2) • **SL.8.5** - Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS3-1), (MS-LS3-2)

Mathematics

- **6.SP.B.5** - Summarize numerical data sets in relation to their context. (MS-LS3-2)
- **MP.4** - Model with mathematics. (MS-LS3-2)

Enduring Understandings:

- Complex and microscopic structures and systems, such as genes located on chromosomes, can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among the parts of the system; therefore, complex natural structures/systems can be analyzed to determine how they function.
- Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes.
- Each distinct gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual.
- In addition to variations that arise from sexual reproduction, genetic information can be altered due to mutations.
- Some changes to genetic material are beneficial, others harmful, and some neutral to the organism.
- Changes in genetic material may result in the production of different proteins.
- Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits.
- Structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism
- Though rare, mutations may result in changes to the structure and function of proteins.
- Organisms reproduce either sexually or asexually and transfer their genetic information to their offspring.
- Asexual reproduction results in offspring with identical genetic information.
- Sexual reproduction results in offspring with genetic variation.
- Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.
- In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring.
- Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other.
- Punnett squares, diagrams, and simulations can be used to describe the cause-and-effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.

Essential Question(s) :

Unit Essential Question:
Why do kids look similar to their parents?

Lesson Essential Questions:
How do structural changes to genes (mutations) located on chromosomes affect proteins or affect the structure and function of an organism?
How do asexual reproduction and sexual reproduction affect the genetic variation of offspring?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
X	**Global Awareness**	**A**	**Critical Thinking & Problem Solving**
X	**Environmental Literacy**	**E**	**Creativity and Innovation**
	Health Literacy	**E**	**Collaboration, Teamwork and Leadership**
	Civic Literacy	**T**	**Cross-Cultural and Interpersonal Communication**
	Financial, Economic, Business and Entrepreneurial Literacy	**E**	**Communication and Media Fluency**
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
T	**CRP2. Apply appropriate academic and technical skills**
	CRP3. Attend to personal health and financial well-being
E	**CRP4. Communicate clearly and effectively with reason**

		CRP5. Consider the environmental, social and economic impacts of decisions
	E	**CRP6. Demonstrate creativity and innovation**
	E	**CRP7. Employ valid and reliable research strategies**
	E	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
		CRP9. Model integrity, ethical leadership and effective management
	E	**CRP10. Plan education and career paths aligned to personal goals**
		CRP11. Use technology to enhance productivity
		CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:

Students will know….	***Students will be able to (do)…***
• Complex and microscopic structures and systems, such as genes located on chromosomes, can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among the parts of the system; therefore, complex natural structures/systems can be analyzed to determine how they function. • Genes are located in the chromosomes of cells, with each chromosome pair containing two variants of each of many distinct genes. • Each distinct gene chiefly controls the production of specific proteins, which in turn affect the traits of the individual. • In addition to variations that arise from sexual reproduction, genetic information can be altered due to mutations. • Some changes to genetic material are beneficial, others harmful, and some neutral to the organism.	• Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. *[Clarification Statement: Emphasis is on conceptual understanding that changes in genetic material may result in making different proteins.] [Assessment Boundary: Assessment does not include specific changes at the molecular level, mechanisms for protein synthesis, or specific types of mutations.] (MS-LS3-1)* • Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation. *[Clarification Statement: Emphasis is on using models such as Punnett squares, diagrams, and simulations to describe the cause and effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.] (MS-LS3-2)*

• Changes in genetic material may result in the production of different proteins. • Changes (mutations) to genes can result in changes to proteins, which can affect the structures and functions of the organism and thereby change traits. • Structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. • Though rare, mutations may result in changes to the structure and function of proteins. • Organisms reproduce either sexually or asexually and transfer their genetic information to their offspring. • Asexual reproduction results in offspring with identical genetic information. • Sexual reproduction results in offspring with genetic variation. • Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited. • In sexually reproducing organisms, each parent contributes half of the genes acquired (at random) by the offspring. • Individuals have two of each chromosome and hence two alleles of each gene, one acquired from each parent. These versions may be identical or may differ from each other. • Punnett squares, diagrams, and simulations can be used to describe the cause-and-effect relationship of gene transmission from parent(s) to offspring and resulting genetic variation.	

Assessment Evidence:	
Formative Tasks: ☐ Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism. ☐ Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information. ☐ Develop and use a model to describe why sexual reproduction results in offspring with genetic variation. ☐ Use models such as Punnett squares, diagrams, and simulations to describe the cause-and effect-relationship of gene transmission from parent(s) to offspring and resulting genetic variation. • Using Blood Types for Identification • Dominant or Recessive? Additional Labs/experiments Rubrics Reference Scale	**Summative Assessment Measures*: (formative assessments)*** ☐ Homework ☐ Quizzes ☐ Tests ☐ Labs
Teaching and Learning Actions:	

Instructional Strategies and Activities *D - modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies).

	• Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

- ⇒ Exemplars of varied performance levels
- ⇒ Multi-media presentations Consultation with ESL teachers
- ⇒ Manipulatives
- ⇒ Tiered/Scaffolded Lessons
- ⇒ Mnemonic devices
- ⇒ Visual aids
- ⇒ Modeling
- ⇒ Guided note-taking
- ⇒ Study Guides
- ⇒ Modified homework
- ⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

- ⇒ Open-ended responses
- ⇒ Curriculum Compacting
- ⇒ Advanced problems to extend the critical thinking skills of advanced learner

⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

- Investigating Reproductive Strategies
- Students work in pairs to compare five aspects of an organism that reproduces sexually, asexually, or both sexually and asexually. The activity comes with a chart for the students to fill out and with information sheets on twelve organisms. As a clas…

- Catch Up on Tomato Technology
- This lesson is a tool to demonstrate how various technological advances have changed the tomato and the tomato industry over the years. The technology includes both selective breeding and genetic engineering.…

- Junior's Family Tree
- The learner will trace the family history of a horse named Junior as they explore why he has the characteristic traits that he does. The lesson includes an interview with a horse breeder and demonstrates how traits are passed from generation to gener…

- Monstrous Mutations Adaptation: Mutations & Variations Activity
- This hands-on activity is a simulation of how mutations can affect survival skills in animals. The objective of this activity is to understand and observe how mutations can be useful, harmful or neutral adaptations. Students will also observe how …

- Plants and Animals, Partners in Pollination
- This online unit explores the theme of the National Zoo's Pollinarium exhibition: how plant and animal partners interact to accomplish pollination. It is a series of three lessons that allow the learner to explore and develop an understanding of the …

- A Recipe for Traits
- Students create and decode DNA for man's best friend to observe how variations in DNA lead to the inheritance of different traits. Strips of paper that represent DNA are randomly selected and used to assemble the dog's DNA. Students read the DNA and …

- Reproduction
- In this activity, the learner explores various ways in which organisms reproduce. The learner discusses the role that reproduction plays in the cycle of life. By watching short videos and participating in follow-up discussion: 1. They observe …

- Genetics of Sesame Street Characters
- The Sesame Street Characters are used to: 1. Create a gene map for a particular Sesame Street character. 2. Move the resulting chromosomes through the steps of meiosis to produce the possible gametes of that individual character. 3. Choose a spous…

- Effect of Environment on Plant Growth
- This activity demonstrates the effect of changes in the environment on the growth of plants. The plants are placed in environments such as high salinity, cold, heat, or drought and observe the different reactions (growth) of the plants to these condi…

- Dragon Genetics – Understanding Inheritance
- **This activity allows students to simulate the processes of meiosis and fertilization as they investigate the inheritance of multiple genes. The simulation also allows the student to see the cause and effect relationship of gene trans…**

Suggested Time Frame:	14 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Life Science: Natural Selection and Adaptations/Growth, Development and Reproduction of Organisms	Grade(s) 8
Unit Plan Title:	Unit 7 - Selection and Adaptation	

Overview/Rationale

Students construct explanations based on evidence to support fundamental understandings of natural selection and evolution. They will use ideas of genetic variation in a population to make sense of how organisms survive and reproduce, thus passing on the traits of the species. The crosscutting concepts of patterns and structure and function are called out as organizing concepts that students use to describe biological evolution. Students use the practices of constructing explanations, obtaining, evaluating, and communicating information, and using mathematical and computational thinking. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-LS4-4 Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.
MS-LS4-5 Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.
MS-LS4-6 Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Disciplinary Core Ideas

LS4.B: Natural Selection
Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)
In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)

LS4.C: Adaptation
Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)

Cross-Cutting Concepts

CCC-2: Cause and Effect
Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4),(MS-LS4-5),(MS-LS4-6)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology
Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5)

Connections to Nature of Science
Science Addresses Questions About the Natural and Material World
Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)

Science and Engineering Practices

SEP 6 - Constructing Explanations and Designing Solutions
Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)

SEP 8 - Obtaining, Evaluating, and Communicating Information
Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)

Using Mathematics and Computational Thinking
Use mathematical representations to support scientific conclusions and design solutions. (MS- LS4-6)

Technology Standard(s)

8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.
8.1.8.A.3 Use and/or develop a simulation that provides an environment to solve a real world problem or theory.

Interdisciplinary Standard(s)

English Language Arts
Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. ***(MS***

*LS4-4),(MS- LS4-5**) RST.6-8.1***
Compare and contrast the information gained from experiments, simulations, videos, or multimedia sources with that gained from reading a text on the same topic. *(MS-LS4-4)* **RST.6-8.9**
Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. *(MS-LS4-4)* **WHST.6-8.2**
Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-LS4-5) **WHST.6-8.8**
Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS4-4) **WHST.6-8.9**
Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (MS-LS4-4) **SL.8.1**
Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. (MS-LS4-4) **SL.8.4**

Mathematics
Model with mathematics. (MS-LS4-6) **MP.4**
Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-LS4-4),(MS-LS4-6) 6.RP.A.1
Summarize numerical data sets in relation to their context. (MS-LS4-4),(MS-LS4-6) **6.SP.B.5**
Recognize and represent proportional relationships between quantities. (MS-LS4-4),(MS-LS4-6) **7.RP.A.2**

Enduring Understandings:

- Genetic variations of traits in a population increase or decrease some individuals' probability of surviving and reproducing in a specific environment.
- Natural selection leads to the predominance of certain traits in a population and the suppression of others.
- Natural selection may have more than one cause, and some cause-and-effect relationships within natural selection can only be described using probability.
- Natural selection, which over generations leads to adaptations, is one important process through which species change over time in response to changes in environmental conditions.
- The distribution of traits in a population changes.
- Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common.
- Natural selection may have more than one cause, and some cause-and-effect relationships in natural selection can only be described using probability.
- Mathematical representations can be used to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.
- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding.
- In artificial selection, humans choose desirable, genetically determined traits in to pass on to offspring.
- Phenomena, such as genetic outcomes in artificial selection, may have more than one cause, and some cause-and-effect relationships in systems

can only be described using probability.

- Technologies have changed the way humans influence the inheritance of desired traits in organisms.
- Engineering advances have led to important discoveries in the field of selective breeding.
- Engineering advances in the field of selective breeding have led to the development of entire industries and engineered systems.
- Scientific discoveries have led to the development of entire industries and engineered systems.

Essential Question(s) :

Unit Essential Question:
Are Genetically Modified Organisms (GMO) safe to eat?

Lesson Essential Question:
How can changes to the genetic code increase or decrease an individual's chances of survival?
How can the environment effect natural selection?
Are Genetically Modified Organisms (GMO) safe to eat?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes			*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Centur y Skills		
	X	**Global Awareness**		E	**Critical Thinking & Problem Solving**
	X	**Environmental Literacy**		E	**Creativity and Innovation**
	X	**Health Literacy**		E	**Collaboration, Teamwork and Leadership**
	X	**Civic Literacy**			**Cross-Cultural and Interpersonal Communication**
	X	**Financial, Economic, Business and Entrepreneurial Literacy**		E	**Communication and Media Fluency**
				E	**Accountability, Productivity and Ethics**

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	E	**CRP1. Act as a responsible and contributing citizen and employee**
	T	**CRP2. Apply appropriate academic and technical skills**
		CRP3. Attend to personal health and financial well-being
	E	**CRP4. Communicate clearly and effectively with reason**
	T	**CRP5. Consider the environmental, social and economic impacts of decisions**
	E	**CRP6. Demonstrate creativity and innovation**
		CRP7. Employ valid and reliable research strategies
	E	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
		CRP9. Model integrity, ethical leadership and effective management
	E	**CRP10. Plan education and career paths aligned to personal goals**
	E	**CRP11. Use technology to enhance productivity**
		CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:

Students will know….	• ***Students will be able to (do)…***
• Genetic variations of traits in a population increase or decrease some individuals' probability of surviving and reproducing in a specific environment. • Natural selection leads to the predominance of certain traits in a population and the suppression of others. • Natural selection may have more than one cause, and some cause-and-effect relationships within natural selection can only be described using probability.	• Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. *[Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations] (MS-LS4-4)* • Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.*[Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on*

- Natural selection, which over generations leads to adaptations, is one important process through which species change over time in response to changes in environmental conditions. - The distribution of traits in a population changes. - Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. - Natural selection may have more than one cause, and some cause-and-effect relationships in natural selection can only be described using probability. - Mathematical representations can be used to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. - In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. - In artificial selection, humans choose desirable, genetically determined traits in to pass on to offspring. - Phenomena, such as genetic outcomes in artificial selection, may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability. - Technologies have changed the way humans influence the inheritance of desired traits in organisms. - Engineering advances have led to important discoveries in the field of selective breeding. - Engineering advances in the field of selective breeding have led to the development of entire industries and engineered systems. - Scientific discoveries have led to the development of entire industries and engineered systems.	*genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.] (MS-LS4-5)* - Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. *[Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.] [Assessment Boundary: Assessment does not include Hardy Weinberg calculations.] (MS-LS4-6)*

• **Assessment Evidence:**	
Formative Tasks: • Construct an explanation that includes probability statements regarding variables and proportional reasoning of how genetic variations of traits in a population increase some individuals' probability surviving and reproducing in a specific environment. • Use probability to describe some cause-and-effect relationships that can be used to explain why some individuals survive and reproduce in a specific environment. • Explain some causes of natural selection and the effect it has on the increase or decrease of specific traits in populations over time. • Use mathematical representations to support conclusions about how natural selection may lead to increases and decreases of genetic traits in populations over time. • Gather, read, and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection) from multiple appropriate sources. • Describe how information from publications about technologies and methods that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection) used are supported or not supported by evidence. Assess the credibility, accuracy, and possible bias of publications and they methods they used when gathering information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection).	**Summative Assessment Measures*:*** • Classwork • Homework • Quizzes • Tests • Labs

Genetics of Sesame Street Characters A Recipe for Traits Monstrous Mutations Adaptation: Mutations & Variations Activity Various rubrics and experiments Reference scale rubrics	

Teaching and Learning Actions:	
Instructional Strategies and Activities *D-modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling

⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

- 99.99% Antibacterial Products and Natural Selection
- This activity is a hands-on simulation using Skittles and mini-marshmallows to show how natural selection can act as a mechanism to increase the presence of antibacterial resistance in a population. Students simulate the effect of hand sanitizer on a…

- An Origin of Species: Pollenpeepers
- This web simulation allows students to explore adaptive radiation of a fictitious group of birds called Pollenpeepers over a period of 5 million years. A hurricane blows some birds to 3 very different island groups and students identify the changes …

- The Day the Mesozoic Died
- This three-act film tells the story of the detective work that solved the mystery of what caused the disappearance of the dinosaurs at the end of the Cretaceous period. Shot on location in Italy, Spain, Texas, Colorado, and North Dakota, the film t…

- Clipbirds
- This variation on the classic bird beak activity demonstrates variation of beak size within a population and shows how the proportion of big-, medium-, and small-beaked birds changes in response to the available types of food. The “birds” with binde…

- Translating the NGSS for Classroom Instruction
- This book was published by NSTA and was written by Rodger Bybee. It gives a brief introduction to the Framework and the Next Generation Science Standards and describes examples of how to translate these into instruction in the classroom in elementa…

- Making Sense of Natural Selection
- This article from The Science Teacher magazine describes a unit of study on natural selection. Students begin by trying to explain the phenomenon of the exponential increase in a population of fish. The activities in the lessons include "Oh Deer" to…

- Bug Hunt
- “Bug Hunt” uses NetLogo software and simulates an insect population that is preyed on by birds. There are six speeds of bugs from slow to fast and the bird tries to catch as many insects as possible in a certain amount of time. Students are able to…

- Habitat Change Assessment Probe
- This is one of 25 assessment probes from the book,” Uncovering Student Ideas in Science, Volume 2: 25 More Formative Assessment Probes”, by Page Keeley and co-authors. All assessment probes in this collection are aligned to a particular science conce…

- The Gene Scene
- This is a three-part activity that introduces the concept of genetic diversity within a population. In Part I students will observe and compare human traits within their classroom population, demonstrating that each individual has a variety o…

- A Guide to Developing Literacy Practices in Science: Supporting Claims with Evidence by Using an Argumentation Card Sort: Fossils
- This activity outlines a strategy to understand and participate in scientific argumentation. Students evaluate evidence for two different claims related to a fossil tooth. They are asked to answer the question, “From what kind of animal did this f…

- Color Variation over Time in Rock Pocket Mouse Populations
- This activity provides an introduction to natural selection and the role of genetic variation by asking students to analyze illustrations of rock pocket mouse populations (dark/light fur) on different color substrates in the Sonoran Desert (light/dar…

- HHMI Data Point: Effects of Natural Selection on Finch Beak Size
- Effects of Natural Selection on Finch Beak Size is one of a series of Data Point resources from HHMI Biointeractive. Data Points engage students in analyzing and interpreting data from primary literature in the biological sciences. The…

- Teaching With Tarantulas
- *Teaching With Tarantulas* is a lesson plan that provides a sequence of learning activities to help students understand the roles of predators in the health of ecosystems and the importance of preserving Earth's ecosystems. T…

- Biomimicry: The "Natural" Intersection of Biology and Engineering
- The article describes an engineering project that is to be done as the culminating event in a unit on biodiversity and adaptation. Students apply what they have learned about these disciplinary core ideas to design products for human…

Textbook Used:

Life's Diversity – McDougall Littell Science

Suggested Time Frame:	14-20 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Earth and Space Science	Grade(s) 8
Unit Plan Title:	Unit 8 - Stability and Change on Earth	

Overview/Rationale

Students construct an understanding of the ways that human activities affect Earth's systems. Students use practices to understand the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts on the development of these resources. Students also understand that the distribution of these resources is uneven due to past and current geosciences processes or removal by humans. The crosscutting concepts of patterns, cause and effect, and stability and change are called out as organizing concepts for these disciplinary core ideas. In this unit of study students are expected to demonstrate proficiency in asking questions, analyzing and interpreting data, constructing explanations, and designing solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

MS-ESS3-1 Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
MS-ESS3-2 Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ESS3-5 Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Disciplinary Core Ideas

ESS3.A: Natural Resources
Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.(MS-ESS3-1)

ESS3.B: Natural Hazards
Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. (MS-ESS3-2)

ESS3.C: Human Impacts on Earth Systems
Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-4)

ESS3.D: Global Climate Change
Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

Science and Engineering Practices

SEP 6 - Constructing Explanations and Designing Solutions
Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (MS-ESS3-1)

SEP 7 - Engaging in Argument from Evidence
Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)

Cross-Cutting Concepts

CCC-1: Patterns
Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

CCC-2: Cause and Effect
Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1),(MS-ESS3-4)

CCC-7: Stability and Change
Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)

Connections to Engineering, Technology, and Applications of Science

Influence of Science, Engineering, and Technology on Society and the Natural World
All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1),(MS-ESS3-4)
The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2)

Connections to Nature of Science

Science Addresses Questions About the Natural and Material World
Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)

Technology Standard(s)

8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.
8.1.8.B.1 Synthesize and publish information about a local or global issue or event (ex. telecollaborative project, blog, school web).

Interdisciplinary Standard(s)

English Language Arts
Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1),(MS-ESS3-2) **RST.6-8.1**
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-ESS3-2) **RST.6-8.7**
Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1) **WHST.6-8.2**
Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1) **WHST.6-8.9**

Mathematics
Reason abstractly and quantitatively. (MS-ESS3-2) **MP.2**
Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (MS-ESS3-1),(MS-ESS3-2) **6.EE.B.6**
Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. (MS-ESS3-1),(MS-ESS3-2) **7.EE.B.4**

Enduring Understandings:

- Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources.
- All human activities draw on Earth's land, ocean, atmosphere, and biosphere resources and have both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
- Minerals, fresh water, and biosphere resources are distributed unevenly around the planet as a result of past geologic processes.
- Cause-and-effect relationships may be used to explain how uneven distributions of Earth's mineral, energy, and groundwater resources have

resulted from past and current geosciences processes.

- Resources that are unevenly distributed as a result of past processes include but are not limited to petroleum, metal ores, and soil.
- Mineral, fresh water, ocean, biosphere, and atmosphere resources are limited, and many are not renewable or replaceable over human lifetimes.
- The distribution of some of Earth's land, ocean, atmosphere, and biosphere resources are changing significantly due to removal by humans.
- Natural hazards can be the result of interior processes, surface processes, or severe weather events.
- Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable.
- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces, can help forecast the locations and likelihoods of future events.
- Data on natural hazards can be used to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- Data on natural hazards can include the locations, magnitudes, and frequencies of the natural hazards.
- Graphs, charts, and images can be used to identify patterns of natural hazards in a region.
- Graphs, charts, and images can be used to understand patterns of geologic forces that can help forecast the locations and likelihoods of future events.
- Technologies that can be used to mitigate the effects of natural hazards can be global or local.
- Technologies used to mitigate the effects of natural hazards vary from region to region and over time.
- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
- Increases in human population and per-capita consumption of natural resources impact Earth's systems.
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems.
- The consequences of increases in human populations and consumption of natural resources are described by science
- Science does not make the decisions for the actions society takes.
- Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes.
- Increases in human population and per-capita consumption of natural resources impact Earth's systems.
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.
- Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems
- The consequences of increases in human populations and consumption of natural resources are described by science.
- Science does not make the decisions for the actions society takes.
- Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes.
- Stability in Earth's surface temperature might be disturbed either by sudden events or gradual changes that accumulate over time.
- Human activities and natural processes are examples of factors that have caused the rise in global temperatures over the past century.

- Human activities play a major role in causing the rise in global temperatures.
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming).
- Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, and on applying that knowledge wisely in decisions and activities.
- Evidence that some factors have caused the rise in global temperature over the last century can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities.

Essential Question(s) : (What provocative questions will foster inquiry, understanding, and transfer of learning?)

Unit Essential Question:
Why aren't minerals and groundwater distributed evenly across the world?

Lesson Essential Questions:
Why aren't minerals and groundwater distributed evenly across the world?
How can we predict and prepare for natural disasters?
How might we treat resources if we thought about the Earth as a spaceship on an extended survey of the solar system? (How would astronauts manage their resources?)
How can basic chemistry be used to explain the mechanisms that control the global temperature the atmosphere?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. **21st Centur y Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Centur y Skills**	
X	Global Awareness	E	Critical Thinking & Problem Solving
X	Environmental Literacy	E	Creativity and Innovation
	Health Literacy	E,T,A	Collaboration, Teamwork and Leadership
X	Civic Literacy		Cross-Cultural and Interpersonal Communication
X	Financial, Economic, Business and	E	Communication and Media Fluency

	Entrepreneurial Literacy		Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

	CRP1. Act as a responsible and contributing citizen and employee
A	**CRP2. Apply appropriate academic and technical skills**
E	**CRP3. Attend to personal health and financial well-being**
T	**CRP4. Communicate clearly and effectively with reason**
E	**CRP5. Consider the environmental, social and economic impacts of decisions**
E	**CRP6. Demonstrate creativity and innovation**
	CRP7. Employ valid and reliable research strategies
T	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
	CRP9. Model integrity, ethical leadership and effective management
E	**CRP10. Plan education and career paths aligned to personal goals**
E	**CRP11. Use technology to enhance productivity**
	CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:

Students will know….	***Students will be able to (do)…***
• Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. • All human activities draw on Earth's land, ocean, atmosphere, and biosphere resources and have both short and long-term consequences, positive as well as negative, for the health of people	• Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. *[Clarification Statement: Emphasis is on how these resources are limited and typically nonrenewable, and how their distributions are significantly changing as a result of removal by humans. Examples of*

and the natural environment.

- Minerals, fresh water, and biosphere resources are distributed unevenly around the planet as a result of past geologic processes.
- Cause-and-effect relationships may be used to explain how uneven distributions of Earth’s mineral, energy, and groundwater resources have resulted from past and current geosciences processes.
- Resources that are unevenly distributed as a result of past processes include but are not limited to petroleum, metal ores, and soil.
- Mineral, fresh water, ocean, biosphere, and atmosphere resources are limited, and many are not renewable or replaceable over human lifetimes.
- The distribution of some of Earth’s land, ocean, atmosphere, and biosphere resources are changing significantly due to removal by humans.
- Natural hazards can be the result of interior processes, surface processes, or severe weather events.
- Some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable.
- Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces, can help forecast the locations and likelihoods of future events.
- Data on natural hazards can be used to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
- Data on natural hazards can include the locations, magnitudes, and frequencies of the natural hazards.

uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).] (MS-ESS3-1)

- Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. *[Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).] (MS-ESS3-2)*
- Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. *[Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth’s systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.] (MS-ESS3-4)*
- Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. *[Clarification Statement: Examples of factors include human activities (such as fossil fuel combustion, cement production, and agricultural activity) and*

• Graphs, charts, and images can be used to identify patterns of natural hazards in a region. • Graphs, charts, and images can be used to understand patterns of geologic forces that can help forecast the locations and likelihoods of future events. • Technologies that can be used to mitigate the effects of natural hazards can be global or local. • Technologies used to mitigate the effects of natural hazards vary from region to region and over time. • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. • Increases in human population and per-capita consumption of natural resources impact Earth's systems. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. • Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems. • The consequences of increases in human populations and consumption of natural resources are described by science • Science does not make the decisions for the actions society takes. • Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes.	*natural processes (such as changes in incoming solar radiation or volcanic activity). Examples of evidence can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities. Emphasis is on the major role that human activities play in causing the rise in global temperatures.](MS-ESS3-5)*

• Increases in human population and per-capita consumption of natural resources impact Earth's systems. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. • Cause and effect relationships may be used to predict how increases in human population and per-capita consumption of natural resources impact Earth's systems • The consequences of increases in human populations and consumption of natural resources are described by science. • Science does not make the decisions for the actions society takes. • Scientific knowledge can describe the consequences of human population and per-capita consumption of natural resources impact Earth's systems but does not necessarily prescribe the decisions that society takes. • Stability in Earth's surface temperature might be disturbed either by sudden events or gradual changes that accumulate over time. • Human activities and natural processes are examples of factors that have caused the rise in global temperatures over the past century. • Human activities play a major role in causing the rise in global temperatures. • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). • Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, and	

on applying that knowledge wisely in decisions and activities. • Evidence that some factors have caused the rise in global temperature over the last century can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities.	
Assessment Evidence:	
Summative ***Other benchmarks include homework, tests, quizzes, etc.*** Crayon Rock Cycle **In this activity students take a "crayon rock" through different parts of the rock cycle. Students first create "sediments" by shaving crayons to create a pile of bits and piece…** Minerals on the Edge The Geology for Investors website is a source of information about why mineral deposits are where they are. The link takes you to the page, "Minerals on the Edge – Plate Boundaries and Minerals." This provides a basic understanding of how minerals … ***Reference Scale*** ***Rubrics*** ***Various labs/activities***	**Formative** • Construct a scientific explanation based on valid and reliable evidence of how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geosciences processes. • Obtain evidence from sources, which must include the student's own experiments. • Construct a scientific explanation based on the assumption that theories and laws that describe the current geosciences process operates today as they did in the past and will continue to do so in the future. • Analyze and interpret data on natural hazards to determine similarities and differences and to distinguish between correlation and causation. • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. • Ask questions to identify and clarify a variety of evidence for an argument about the factors that have caused the rise in global temperatures over the past century. • Ask questions to clarify human activities and natural processes that are major factors in the current rise in Earth's mean surface temperature.

Teaching and Learning Actions:	
Instructional Strategies and Activities *D - modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

Additional considerations for English Language Learners (ELLs), Special Needs, Below Level (BSI)

Individualized Education Plans (IEPs):

⇒ Exemplars of varied performance levels
⇒ Multi-media presentations Consultation with ESL teachers
⇒ Manipulatives
⇒ Tiered/Scaffolded Lessons
⇒ Mnemonic devices
⇒ Visual aids
⇒ Modeling
⇒ Guided note-taking
⇒ Study Guides
⇒ Modified homework
⇒ Differentiated pre-typed class notes and example problems

Advanced/Gifted Students:

⇒ Open-ended responses
⇒ Curriculum Compacting
⇒ Advanced problems to extend the critical thinking skills of advanced learner
⇒ Supplemental reading material for independent study
⇒ Flexible grouping
⇒ Tiered assignments

USGS Educational Resources for Secondary Grades (7–12): This web site contains selected USGS educational resources that may be useful to educators in secondary school grades. Many of these resources can be used directly in the classroom or will be useful in classroom lessons or demonstration activities preparation, or as resources for teacher education and curriculum development.

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Events.

- Asteroid Impact
- The president has sent out a memo to engineers in the state of “Alabraska”—your help is needed to save the human population from an asteroid impact! This lesson plan is the first in a series of 8 developed at the Colorado School of Mines. In this int…

- Next Generation Climate - Grades 6-8 - Lesson 2

- *Next Generation Climate* contains six lessons on climate change for middle school students. In the curriculum, the students investigate causes of global temperature change, research the major repercussions of climate change, and find out h…

- Climate Change and Michigan Forests
- The Middle School unit entitled *Climate Change and Michigan Forests* consists of 10 lessons on climate change and the local environmentin Michigan based on forest ecology research conducted at the University of Michigan. The lessons can b…

Textbooks Used:

Earth's Atmosphere – McDougall Littell Science
Earth's Surface – McDougall Littell Science

Suggested Time Frame:	21-30 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

Content Area:	Earth and Space Science	Grade(s) 8
Unit Plan Title:	Unit 9 - Human Impact	

Overview/Rationale

Students analyze and interpret data and design solutions to build on their understanding of the ways that human activities affect Earth's systems. The emphasis of this unit is the significant and complex issues surrounding human uses of land, energy, mineral, and water resources and the resulting impacts of these uses. The crosscutting concepts of cause and effect and the influence of science, engineering, and technology on society and the natural world are called out as organizing concepts for these disciplinary core ideas.

Building on Unit 3, students define a problem by precisely specifying criteria and constraints for solutions as well as potential impacts on society and the natural environment; systematically evaluate alternative solutions; analyze data from tests of different solutions; combining the best ideas into an improved solution; and develop and iteratively test and improve their model to reach an optimal solution. In this unit of study students are expected to demonstrate proficiency in analyzing and interpreting data and designing solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

Science Standards (Established Goals)

- **MS-ESS3-3** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
- **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems
Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. ***(MS-ESS3-3)***

Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. ***(MS-ESS3-3),(MS-ESS3-4)***

ETS1.A: Defining and Delimiting Engineering Problems
The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. ***(MS-ETS1-1)***

ETS1.B: Developing Possible Solutions
A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. ***(MS-ETS1-4)***
There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. ***(MS-ETS1-2), (MS-ETS1-3)***

Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. ***(MS-ETS1-3)***
Models of all kinds are important for testing solutions. ***(MS-ETS1-4)***

Science and Engineering Practices

SEP-1: Asking Questions and Defining Problems
Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **(MS-ETS1-1)**

SEP-4: Analyzing and Interpreting Data
Analyze and interpret data to determine similarities and differences in findings. **(MS-ETS1-3**)

SEP-6: Constructing Explanations and Designing Solutions
Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **(MS-ESS3-1)**
Apply scientific principles to design an object, tool, process or system. **(MS-ESS3-3)**

SEP-7: Engaging in Argument from Evidence
Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. **(MS-ETS1-2)**

Cross-Cutting Concepts
CCC-2: Cause and Effect Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. ***(MS-ESS3-3)*** ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. ***(MS-ESS3-3)*** **Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. ***(MS-ETS1-1)*** The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. ***(MS-ETS1-1)***
Technology Standard(s)
8.2.8.A.1 Research a product that was designed for a specific demand and identify how the product has changed to meet new demands (i.e. telephone for communication - smart phone for mobility needs). **8.2.8.A.2** Examine a system, consider how each part relates to other parts, and discuss a part to redesign to improve the system. **8.2.8.A.3** Investigate a malfunction in any part of a system and identify its impacts. The relationships among technologies and the connections between technology and other fields of study. **8.2.8.A.4** Redesign an existing product that impacts the environment to lessen its impact(s) on the environment.
Interdisciplinary Standard(s)
English Language Arts • Cite specific textual evidence to support analysis of science and technical texts. *(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)* **RST.6-8.1** • Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). *(MS-ESS3-3),(MS-ETS1-3)* **RST.6-8.7** • Compare and contrast the information gained from experiments, simulations, videos, or multimedia sources with that gained from reading a text on the same topic. *(MS-ETS1-2),(MS-ETS1-3)* **RST.6-8.9**

- Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. *(MS-ETS1-2)* **WHST.6-8.7**
- Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. *(MS-ESS3-3),(MS-ETS1-1)* **WHST.6-8.8**
- Draw evidence from informational texts to support analysis, reflection, and research. *(MS-ETS1-2)* **WHST.6-8.9**
- Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ETS1-4)* **SL.8.5**

Mathematics

- Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. *(MS-ESS3-3)* **6.EE.B.6**
- Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. *(MS-ESS3-3)* **7.EE.B.4**
- Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *(MS-ESS3-3)* **6.RP.A.1**
- Recognize and represent proportional relationships between quantities. *(MS-ESS3-3)* **7.RP.A.2**
- Reason abstractly and quantitatively. *(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)* **MP.2**
- Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3)* **7.EE.3**

Enduring Understandings:

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species.
- Changes to Earth's environments can have different impacts (negative and positive) for different living things.
- Typically as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise.
- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Essential Question(s) :

Unit Essential Question:
How do we monitor the health of the environment (our life support system)?

Lesson Essential Question:
Is it possible to predict and protect ourselves from natural hazards
How do we monitor the health of the environment (our life support system)?

In this unit plan, the following 21st Century themes and skills are addressed:

Check all that apply. 21st Centur y Themes		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* 21st Centur y Skills	
X	Global Awareness	E,T	Critical Thinking & Problem Solving
X	Environmental Literacy	E,A	Creativity and Innovation
X	Health Literacy	E	Collaboration, Teamwork and Leadership
X	Civic Literacy		Cross-Cultural and Interpersonal Communication
X	Financial, Economic, Business and Entrepreneurial Literacy	E	Communication and Media Fluency
			Accountability, Productivity and Ethics

In this unit plan, the following Career Ready Practices are addressed:

*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.*

E	CRP1. Act as a responsible and contributing citizen and employee
E	CRP2. Apply appropriate academic and technical skills
	CRP3. Attend to personal health and financial well-being
E	CRP4. Communicate clearly and effectively with reason

	E,T	**CRP5. Consider the environmental, social and economic impacts of decisions**
	A	**CRP6. Demonstrate creativity and innovation**
		CRP7. Employ valid and reliable research strategies
	E	**CRP8. Utilize critical thinking to make sense of problems and persevere in solving them**
		CRP9. Model integrity, ethical leadership and effective management
	E	**CRP10. Plan education and career paths aligned to personal goals**
		CRP11. Use technology to enhance productivity
		CRP12. Work productively in teams while using cultural global competence

Student Learning Goals/Objectives:

Students will know….	***Students will be able to (do)…***
• Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. • Changes to Earth's environments can have different impacts (negative and positive) for different living things. • Typically as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise. • Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.	• Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. *[Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating) solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).] (MS-ESS3-3)* • Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1) • Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2)

	• Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)
Assessment Evidence:	
Formative ***Web resources:*** • Asteroid Impact • The president has sent out a memo to engineers in the state of "Alabraska"—your help is needed to save the human population from an asteroid impact! This lesson plan is the first in a series of 8 developed at the Colorado School of Mines. In this int… • Next Generation Climate - Grades 6-8 - Lesson 2 • *Next Generation Climate* contains six lessons on climate change for middle school students. In the curriculum, the students investigate causes of global temperature change, research the major repercussions of climate change, and find out h… • Climate Change and Michigan Forests • The Middle School unit entitled *Climate Change and Michigan Forests* consists of 10 lessons on climate change and the local environment in Michigan based on forest ecology research conducted at the University of Michigan. The lessons can b… Reference scale Rubrics Various labs	**Other Assessment Measures:** ***Summative*** • Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. • Classwork • Homework • Quizzes • Tests • Labs

Teaching and Learning Actions:	
Instructional Strategies and Activities *D- modifications*	• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, • graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community • helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple • representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their • understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue. • Provide ELL students with multiple literacy strategies. • Collaborate with after-school programs or clubs to extend learning opportunities. • Restructure lesson using UDL principals (http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA)

Modifications & Resources

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Textbooks used: Astronomy – Prentice Hall Science Explorer Earth's Atmosphere – McDougall Littell Science Life's Diversity – McDougall Littell Science	
Suggested Time Frame:	16-25 days

D – Indicates differentiation at the Lesson Level (Identify Modifications for ELL, Gifted and Talented, Title 1, Special Education)

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Earth and Space Sciences				
MS-ESS1 Earth's Place in the Universe				
MS-ESS1-1	Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.			X
MS-ESS1-2	Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system.			X
MS-ESS1-3	Analyze and interpret data to determine scale properties of objects in the solar system.			X
MS-ESS1-4	Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.		X	
MS-ESS2 Earth's Systems				
MS-ESS2-1	Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.		X	
MS-ESS2-2	Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.		X	
MS-ESS2-3	Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.		X	
MS-ESS2-4	Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.			X
MS-ESS2-5	Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions.			X
MS-ESS2-6	Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.			X
MS-ESS3 Earth and Human Activity				
MS-ESS3-1	Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.			X
MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.			X
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	X		X
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.			X
MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Life Science				
MS-LS1 From Molecules to Organisms: Structures and Processes				
MS-LS1-1	Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.	X		X
MS-LS1-2	Develop and use a model to describe the function of a cell as a whole and ways parts of cells contribute to the function.	X		X
MS-LS1-3	Use argument supported by evidence for how the body is a system of interacting subsystems composed of groups of cells.	X		X
MS-LS1-4	Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.	X		
MS-LS1-5	Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.	X		
MS-LS1-6	Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.	X		
MS-LS1-7	Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as the matter moves through organism.	X		
MS-LS1-8	Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.	X		X
MS-LS2 Ecosystems: Interactions, Energy, and Dynamics				
MS-LS2-1	Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.	X		
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	X		
MS-LS2-3	Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.	X		
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	X		
MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services.	X		
MS-LS3 Heredity: Inheritance and Variation of Traits				
MS-LS3-1	Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.			X
MS-LS3-2	Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Life Science				
MS-LS4 Biological Evolution: Unity and Diversity				
MS-LS4-1	Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.		X	
MS-LS4-2	Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.		X	
MS-LS4-3	Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.		X	
MS-LS4-4	Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.			X
MS-LS4-5	Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.			X
MS-LS4-6	Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.			X

STANDARD	PERFORMANCE EXPECTATION	6TH GRADE	7TH GRADE	8TH GRADE
Physical Science				
MS-PS1 Matter and Its Interactions				
MS-PS1-1	Develop models to describe atomic composition of simple molecules and extended structures.			X
MS-PS1-2	Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.			X
MS-PS1-3	Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.			X
MS-PS1-4	Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.			X
MS-PS1-5	Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.			X
MS-PS1-6	Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.			X
MS-PS2 Motion and Stability: Forces and Interactions				
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.		X	
MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.		X	
MS-PS2-3	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.		X	
MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.		X	X
MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.		X	
MS-PS3 Energy				
MS-PS3-1	Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.		X	
MS-PS3-2	Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.		X	
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer		X	
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.		X	
MS-PS3-5	Construct, use, and present arguments to support the claim that when the kinetic energy of an		X	

	object changes, energy is transferred to or from the object.			
STANDARD	**PERFORMANCE EXPECTATION**	6TH GRADE	7TH GRADE	8TH GRADE
Physical Science				
MS-PS4 Waves and Their Applications in Technologies for Information Transfer				
MS-PS4-1	**Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.**	**X**		
MS-PS4-2	**Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.**	**X**		
MS-PS4-3	**Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.**	**X**		

STANDARD	**PERFORMANCE EXPECTATION**	**6TH GRADE**	**7TH GRADE**	**8TH GRADE**
Engineering Design				
MS – ETS1 Engineering Design				
MS-ETS1-1	**Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**	**X**	**X**	**X**
MS-ETS1-2	**Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.**		**X**	**X**
MS-ETS1-3	**Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.**	**X**	**X**	**X**
MS-ETS1-4	**Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.**		**X**	