TOWNSHIP OF UNION PUBLIC SCHOOLS

8th Grade Science

Curriculum Guide

July 2018 Revised

Mission Statement

The mission of the Township of Union Public Schools is to build on the foundations of honesty, excellence, integrity, strong family, and community partnerships. We promote a supportive learning environment where every student is challenged, inspired, empowered, and respected as diverse learners. Through cultivation of students' intellectual curiosity, skills and knowledge, our students can achieve academically and socially, and contribute as responsible and productive citizens of our global community.

Philosophy Statement

The Township of Union Public School District, as a societal agency, reflects democratic ideals and concepts through its educational practices. It is the belief of the Board of Education that a primary function of the Township of Union Public School System is the formulation of a learning climate conducive to the needs of all students in general, providing therein for individual differences. The school operates as a partner with the home and community.

Science Department Mission

The mission of the **Burnet Science Department** in the Union Township Public School System is to prepare the students to become independent, lifelong learners who think critically, collaborate and persevere. We are determined to inspire our students to hypothesize, explore and investigate using the scientific method integrated with technology. Our vision is to produce a student who has the vision of him/herself as a responsible, enthusiastic, engaged member of the school community.

The goal of the **Kawameeh Middle School Science Department** is to expose students to the different branches of science through the use of labs, modern technology, and field experiences. We aspire to develop scientific literacy in all students, allowing them to utilize problem solving and critical thinking skills. Students are encouraged to reach their highest potential by engaging in inquiry-based activities and experiments. When students develop a deep understanding of science they can truly appreciate the world in which they live.

Science Department Vision

We aspire to encourage creativity and imagination, as it allows students to explore the world around them on their own. Our classrooms are conducive to student learning and our activities are student centered. At Union Township we expect highly of our staff and students and uphold them to high standards. We would like to see students pursue science in college, their career choice, or personal interests.

Statement of District Goals

- Develop reading, writing, speaking, listening, and mathematical skills.
- Develop a pride in work and a feeling of self-worth, self-reliance, and self discipline.
- Acquire and use the skills and habits involved in critical and constructive thinking.
- Develop a code of behavior based on moral and ethical principals.
- Work with others cooperatively.
- Acquire a knowledge and appreciation of the historical record of human achievement and failures and current societal issues.
- Acquire a knowledge and understanding of the physical and biological sciences.
- Participate effectively and efficiently in economic life and the development of skills to enter a specific field of work.
- Appreciate and understand literature, art, music, and other cultural activities.
- Develop an understanding of the historical and cultural heritage.
- Develop a concern for the proper use and/or preservation of natural resources.
- Develop basic skills in sports and other forms of recreation.

Course Description

The eighth grade curriculum elaborates upon and deepens the concepts presented in grades six and seven. This "spiral of knowledge" engenders the continuity of connections among scientific concepts.

During the physical science unit, students will investigate forces and their interactions, different forms of energy and the relationships that exist between energy and forces. Students will also focus on the Law of Conservation of Energy to realize that the amount of energy within a system will not change but rather be transformed from one form to another. In addition, students will study the electromagnetic spectrum to understand the properties of waves.

During the earth science unit, students will study stability and change on earth. Students will continue their study with focus on the impacts that human activities have on our natural resources of land, energy, minerals, and water.

This course is designed to integrate the three dimensions of scientific and engineering practices, crosscutting concepts, and core ideas. This will enable students to engage in a multifaceted approach to inquiry based learning. The eighth grade science curriculum is just a link in the chain of knowledge that will allow our students to be empowered, life time learners.

Course Proficiencies- Eighth Grade Science

Unit 1: Stability and Change on Earth

- 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-ESS3-1
- Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. 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. MS-ESS3-4
- Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century. MS-ESS3-5

Unit 2: Human Impact on Earth Systems and Global Climate Change

- Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. 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.

Unit 3: Forces and Motion

- Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects . 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. 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

Unit 4: Types of Interactions

- 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. MS-PS2-3
- Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. 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. MS-PS2-5

Unit 5: Relationships among Forms of Energy

- 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. MS-PS3-1
- 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. MS-PS3-2
- 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 MS-PS3-5

Unit 6: Thermal Energy

- Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. 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. 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

Unit 7: The Electromagnetic Spectrum

- 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
- Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. MS-PS4-2
- 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

Curriculum Units – Eighth Grade Science

- **Unit 1**: Stability and Change on Earth
- **Unit 2**: Human Impacts on Earth Systems and Global Climate Change
- **Unit 3:** Forces and Motion
- **Unit 4:** Types of Interactions
- **Unit 5**: Relationships Among Forms of Energy
- **Unit 6**: Thermal Energy
- **Unit 7**: The Electromagnetic Spectrum

Pacing Guide- Eighth Grade Science

Unit 1: Stability and Change on Earth **Instructional Days: 30**

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.

This unit is based on MS-ESS3-1, MS-ESS3-2, MS-ESS3-4, and MS-ESS3-5.

Unit 2: Human Impacts **Instructional Days: 25**

In this unit of study, 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.

This unit is based on MS-ESS3-3, MS-ETS1-1, MS-ETS1-2, and MS-ETS1-3.

Unit 3: Forces and Motion **Instructional Days: 20**

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.

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

Unit 4: Types of Interactions **Instructional Days: 25**

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.

This unit is based on MS-PS2-3, MS-PS2-4, and MS-PS2-5.

Unit 5: Relationships Among Forms of Energy **Instructional Days: 20**

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.

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

Unit 6: Thermal Energy **Instructional Days: 30**

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 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.

This unit is based on MS-PS3-3, MS-PS3-4, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4.

Unit 7: The Electromagnetic Spectrum **Instructional Days: 20**

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 disciplinary core ideas. Students *develop and use models, use mathematical thinking,* and *obtain, evaluate, and communicate information.* Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on MS-PS4-1, MS-PS4-2, and MS-PS4-3.

Unit 1: Stability and Change on Earth

Unit Summary
Why aren't minerals and groundwater distributed evenly across the world? 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. This unit is based on MS-ESS3-1, MS-ESS3-2, MS-ESS3-4, and MS-ESS3-5.

Student Learning Objectives
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 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 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)**

Unit Sequence

Part A: *Why aren't minerals and groundwater distributed evenly across the world?*

Concepts	Formative Assessments
• 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.	*Students who understand the concepts can:* • 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.

Unit Sequence	
Part B: *How can we predict and prepare for natural disasters?*	
Concepts	**Formative Assessments**
• 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.	*Students who understand the concepts can:* • Analyze and interpret data on natural hazards to determine similarities and differences and to distinguish between correlation and causation.

Unit Sequence
Part C: *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?)*

Concepts	Formative Assessments
• 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.	*Students who understand the concepts can:* • 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.

Unit Sequence	
Part D: *How can basic chemistry be used to explain the mechanisms that control the global temperature the atmosphere?*	
Concepts	**Formative Assessments**
• 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	*Students who understand the concepts can:* • 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.

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.	

Connections to Other Units

Grade 7 Unit 5: 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.
- Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
- Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

Grade 7 Unit 6: Interactions of Matter

- 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, 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.
- The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.

Grade 7 Unit 7: 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.
- The total number of each type of atom is conserved, and thus the mass does not change.
- Some chemical reactions release energy, others store energy.

Grade 8 Unit 5: Forms of Energy

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Grade 7 Unit 8: Weather and Climate

- 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.
- 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.
- Because these patterns are so complex, weather can only be predicted probabilistically.

Appendix A: NGSS and Foundations for the Unit
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 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 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)**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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) **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)	**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	**Patterns** • Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2) **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1),(MS-ESS3-4) **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

	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)	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)

English Language Arts	Mathematics
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**	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**

Unit 1: Stability and Change on Earth (30 days)			
This unit is based on:	SLO	Inquiry Menu	Quick Links
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.	1. What are Fossil Fuels? 2. Blame it on the Carbon	1. http://betterlesson.com/lesson/638641/what-are-fossil-fuels 2. http://betterlesson.com/lesson/638033/blame-it-on-the-carbon
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.	3. Earthquake Hazards 4. A Man Made Disaster	3. http://betterlesson.com/lesson/629624/earthquake-hazards 4. http://betterlesson.com/lesson/634718/a-man-made-disaster
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.	5. Design Your Society 6. Blame it on the Carbon 7. The Story of Stuff	5. http://betterlesson.com/lesson/644797/design-your-society 6. http://betterlesson.com/lesson/638033/blame-it-on-the-carbon 7. http://betterlesson.com/lesson/631899/the-story-of-stuff

MS-ESS3-5	Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.	8. 9. NASA Climate Change Modules (3 offered) 10. What is Climate? and what causes it to change? Earth's Changing Climate	8. http://climate.nasa.gov/resources/education/pbs_modules/ 9. http://betterlesson.com/lesson/635264/what-is-climate-and-what-causes-it-to-change 10. http://betterlesson.com/lesson/640758/earth-s-changing-climate

1. What are Fossil Fuels?-students will explain how fossil fuels were formed and how they impact climate change. They discuss why fossil fuels are important and introduces the role of fossil fuels in creating new technologies. Students create conceptual models of the formation of fossil fuels . After reading an article students are to support how fossil fuels are essential to our economy and include a citation
2. Blame it on the Carbon – as students describe how the carbon cycle contributes to the condition of our environment, they gain a better understanding of the cause and effect of human activities on the Earth's systems. Students will also calculate the carbon footprint of themselves as individuals and of their households, the class will compare results in order to calculate an average carbon foot print
3. Earthquake Hazards-Students will identify major seismic hazards and evaluate the effectiveness of various safety measures using an online interface. The lesson starts with a brief text excerpt on earthquake hazards and emergency preparedness. They read this in partners and answer some basic analysis questions, and then launch into a computer-based lesson asking them to prepare safety information for before, during, and after an earthquake happens. Finally, there's a brief writing assignment asking them to prioritize some of their selected safety information and give needed rationale for it
4. A Man Made Disaster-Students will read and annotate non fiction text and will examine a disaster to determine what could happen if there were better ways to prevent and respond to it.
5. Design Your Society – students will apply newly acquired knowledge to develop plans for a new society on Earth. End goals of activity: Design a resilient, self-sustaining society that can withstand the challenges that will be faced by the new hostile environment found on Earth. Points to consider are: Housing Structures/Safety, Energy, Transportation, Waste Management, and Food Production.

6. Blame it on the Carbon – as students describe how the carbon cycle contributes to the condition of our environment, they gain a better understanding of the cause and effect of human activities on the Earth's systems. Students will also calculate the carbon footprint of themselves as individuals and of their households, the class will compare results in order to calculate an average carbon foot print

7. The Story of Stuff – the way we consume and dispose of material goods reflect our culture and way of life. The culture of America is wasteful and we must consider ways to reduce our consumption of material goods in order to sustain life on our planet.

8. NASA Climate Change Modules (3 offered) – Module 1: Introduction to Earth's Dynamically Changing Climate - Examine evidence of climate change from different parts of the Earth's system and consider what it means to live on a planet with a dynamically changing climate. Module 2: Impacts of Artic Warming - Examine the evidence for changes in ice cover at the Arctic and explore why climate changes at the poles are so important to the rest of the climate system. Module 3: Coastal Consequences of Sea Level Rise - Learn how sea level rise will have increasingly serious consequences for human health and life quality.

9. What is Climate? and what causes it to change? – This is an opening activity, used to assess prior knowledge, use this lesson to find out what your students initial ideas are on climate and climarte change.

10. Earth's Changing Climate – Remember the old adage, "a picture is worth a thousand words." Our Earth is in a period of warming but how warm will the planet get? Take a look at these models and data to make perdictions about the future.

Unit 2: Human Impacts on Earth Systems and Global Climate Change

Unit Summary
How do we monitor the health of the environment (our life support system)? ***Is it possible to predict and protect ourselves from natural hazards?*** In this unit of study, 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. This unit is based on MS-ESS3-3, MS-ETS1-1, MS-ETS1-2, and MS-ETS1-3.

Student Learning Objectives	
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)	
Unit Sequence	
Part A: *How do we monitor the health of the environment (our life support system)?*	
Concepts	**Formative Assessments**
• 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,	*Students who understand the concepts can:* • Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

natural resources, and economic conditions. Thus technology use varies from region to region and over time.	

Connections to Other Units

Grade 6, Unit 2: Matter and Energy in Organisms and Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
- 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.
- Growth of organisms and population increases are limited by access to resources.
- 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.

Grade 6, Unit 5: Types of Interactions

- 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.
- 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.
- 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.

Appendix A: NGSS and Foundations for the Unit

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)

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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) **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) **Engaging in Argument from Evidence** • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2) **Analyzing and Interpreting Data**	**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.	**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**

• Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)	(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)	**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)

English Language Arts	Mathematics
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	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,

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**	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**

Unit 2:Earth and Human Activity (25 days)			
This unit is based on:	**SLO**	**Inquiry Menu**	**Quick Links**
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	1. Carbon Sinks 2. Climate change and the greenhouse effect 3. Where does the waste go?	1. http://betterlesson.com/lesson/636043/carbon-sinks-modeling-the-future 2. http://betterlesson.com/lesson/631905/climate-change-and-the-greenhouse-effect 3. http://betterlesson.com/lesson/631904/where-the-waste-goes
MS-ETS1-1	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful	4. Renewable and non-renewable energy sources	4. http://betterlesson.com/lesson/6299

	solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	5. Designing an eco-friendly building (part 2)	13/renewable-and-non-renewable-energy-sources 5. http://betterlesson.com/lesson/636976/designing-an-eco-friendly-building-part-2
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	6. 7. Designing an eco-friendly building (part 4) Designing an eco-friendly building (part 1)	6. http://betterlesson.com/lesson/637438/designing-an-eco-friendly-building-part-4 7. http://betterlesson.com/lesson/633426/designing-an-eco-friendly-building-part-1
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.	8. Designing an eco-friendly building (part 3)	8. http://betterlesson.com/lesson/637437/designing-an-eco-friendly-building-part-3

1. In this activity, MS_ESS3-3 students develop and run scenarios for future human emissions and future carbon sinks in the oceans and on the land. Running an applet allows them to simulate the impact on atmospheric CO2 and global mean temperature. The applet is part of the Carbon and Climate website at the University of Wisconsin, Madison.
2. Students will explain the relationship between the carbon cycle, the formation of greenhouse gases, and the effect on climate. After recording temperatures for 10 cycles, students graph their data in their lab guide. We discuss as a class, identifying patterns or trends, pointing out outliers and discussing possible reasons to explain their appearance and their significance to the investigation. This activity goes along with MS-ESS3-3

3. In this lesson students investigate their own trash consumption and become aware of how the disposal of non-biodegradable waste impacts the environment. This activity can go along with MS-ESS3-3
4. Using their design ideas from the research of eco-friendly components, students will create a model of their eco-friendly building. This goes along with MS-ETS1-2
5. This activity goes with MS-ETS1-1. Students will investigate what is the best energy source and can renewables be the future?
6. This lesson allows students to research eco-friendly components as students determine the best solution an authentic design problem. This activity can go along with MS-ETS1-1.
7. This lesson helps students understand why eco-friendly architecture is an important design problem goes along with MS-ESS3-3, MS-ETS1-1, MS-ETS1-2 and MS-ETS1-2.
8. In this lesson, using their research students will begin to design a floor plan, thinking about the best way to solve the design problem. This activity can go along with MS-ETS1-1, MS-ETS1-2, MS-ETS1-3

Unit 3: Forces and Motion

Unit Summary
How can we predict the motion of an object?   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.

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

Student Learning Objectives

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * *[Clarification 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)

Unit Sequence

Part A: *How does a sailboat work?*

Concepts	**Formative Assessment**
• For any pair of interacting objects, the force exerted by the first	*Students who understand the concepts are able to:*

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). • Models can be used to represent the motion of objects in colliding systems and their interactions, such as inputs, processes, and outputs, as well as energy and matter flows within systems. • 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. • 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, which are likely to limit possible solutions.	• Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects. • Define a design problem involving the motion of two colliding objects that can be solved through the development of an object, tool, process, or system and that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. • Evaluate competing design solutions involving the motion of two colliding objects based on jointly developed and agreed-upon design criteria. • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. • Analyze and interpret data to determine similarities and differences in findings.

Unit Sequence	
Part B: *Who can build the fastest sailboat?*	
Concepts	**Formative Assessment**
• The change in an object's motion depends on balanced (Newton's first law) and unbalanced forces in a system 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 includes qualitative comparisons of forces, mass, and changes in motion (Newton's second law); frame of reference; and specification of units • 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. • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at	*Students who understand the concepts are able to:* • Plan an investigation individually and collaboratively 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. • Design an investigation and 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. • Make logical and conceptual connections between evidence and explanations. • Examine the changes over time and forces at different scales to explain the stability and change in designed systems.

different scales.	

Connections to Other Units

Grade 8 Unit 4: Relationships among Forms 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.
- A system of objects may also contain stored (potential) energy, depending on their relative positions.
- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.

Grade 8 Unit 5: Thermal 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.

Grade 7 Unit 8: 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.
- 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.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.

Appendix A: NGSS and Foundations for the Unit

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * *[Clarification 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)

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
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. (MS-PS2-2) **Constructing Explanations and Designing Solutions** • Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1) **Asking Questions and Defining Problems**	**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	**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) **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. (MS-PS2-2) - - - - - - - - - - - - - - - - ***Connections to Engineering, Technology, and Applications of Science***

• 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) **Engaging in Argument from Evidence** • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	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	**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. (MS-PS2-1) • 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)

	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)	

English Language Arts	Mathematics
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	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**

additional related, focused questions that allow for multiple avenues of exploration. (MS-ETS1-2) **WHST.6-8.7**	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**

Unit 3: Force and Motion (25 days)			
This unit is based on:	**SLO**	**STEM**	**Quick Links**
MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.	1. Newton's Second and Third Laws of Motion: Bumper Boats Investigation 2. Newton's Laws of Motion Simulation Investigation 3. Newton's Laws Graffiti	1. http://betterlesson.com/lesson/634470/newton-s-second-and-third-laws-of-motion-bumper-boats-investigation 2. http://betterlesson.com/lesson/634620/newton-s-laws-of-motion-simulation-investigation AND https://phet.colorado.edu/en/simulation/forces-and-motion-basics 3. http://betterlesson.com/lesson/634616/newton-s-laws-graffiti
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.		
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.	4. Dream Invention 5. Thermal Protection Systems 6. Hot Air Balloons	4. http://betterlesson.com/lesson/617482/dream-invention 5. http://betterlesson.com/lesson/634000/thermal-protection-systems-day-1 AND http://betterlesson.com/lesson/635048/thermal-protection-systems-day-2-and-day-3?from=owner_unit 6. http://betterlesson.com/lesson/640487/hot-air-balloons
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.		
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		

1. Newton's Second and Third Laws of Motion: Bumper Boats Investigation – Students will through inquiry discover the way Newton's laws of motion affect moving objects, students will take part in both teacher designed inquiry, and student designed inquiry

2. Newton's Laws of Motion Simulation Investigation – SWBAT understand that the motion of objects depends on the sum of the forces on the object and the mass of the object, this lesson includes the use of a PHet simulation

3. Newton's Laws Graffiti – SWBAT describe Newton's Laws of motion, SWBAT demonstrate understanding that Newton's laws help us to explain and predict the motion of objects through art

4. Dream Invention – SWBAT use the design process to dream up an original invention or innovation, and present it to the class

5. Thermal Protection Systems - SWBAT apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer

6. Hot Air Balloons – SWBAT create hot air balloons that lift off the ground, using the scientific and engineering design process.

Unit 4: Types of Interactions

Unit Summary
Is it possible to exert on an object without touching it?   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.

This unit is based on MS-PS2-3, MS-PS2-4, and MS-PS2-5.

Student Learning Objectives

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 does not include Newton's Law of Gravitation or Kepler's Laws.]* **(MS-PS2-4)**

Unit Sequence

Part A: *Can you apply a force on something without touching it?*

Concepts	Formative Assessment
• 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.	*Students who understand the concepts are able to:* • Students will conduct an investigation and evaluate an experimental design to produce data that can serve as the basis for evidence that fields 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.	• Students will identify the cause-and-effect relationships between fields that exist between objects and the behavior of the objects.

Unit Sequence	
Part B: *How does a Maglev train work?*	
Concepts	**Formative Assessment**
• 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	*Students who understand the concepts are able to:* • Students will ask questions about data to determine the effect of the strength of electric and magnetic forces 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. • Students will perform investigations using devices that use electromagnetic forces. • Students will collect and analyze data that 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.

Unit Sequence	
Part C: *If I were able to eliminate air resistance and dropped a feather and a hammer at the same time, which would land first?*	
Concepts	**Formative Assessment**
• 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	*Students who understand the concepts are able to:* • Students construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

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.	• Students use models to represent the gravitational interactions between two masses.

Connections to Other Units

Grade 6 Unit 1: Astronomy

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.
- 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.
- The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

Grade 7 Unit 8: Weather and Climate

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
- Global movements of water and its changes in form are propelled by sunlight and gravity.
- Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land.
- 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.
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.

Grade 7 Unit 9: Earth Systems

- 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.

Appendix A: NGSS and Foundations for the Unit
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 does not include Newton's Law of Gravitation or Kepler's Laws.]* **(MS-PS2-4)**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science*

Education:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5)	**PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4) **PS2.A: Forces and Motion** • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-3) **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary) (HS-PS2-3) **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) **Cause and Effect** • Systems can be designed to cause a desired effect. (HS-PS2-3) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5) - - - - - - - - - - - - - - - - ***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-4) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

	systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary HS-PS2-3)* **PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-5) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-5) **PS3.A: Definitions of Energy** • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(secondary HS-PS2-5)*	

English Language Arts	Mathematics
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.(HS-PS2-5), (HS-PS2-3) **WHST.11-12.7** Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS2-5),(HS-PS2-4) **HSN.Q.A.1** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS2-5),(HS-PS2-4) **HSN.Q.A.2** Choose a level of accuracy appropriate to limitations on measurement

audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS2-5) **WHST.11-12.8** Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS2-5) **WHST.11-12.9**	when reporting quantities. (HS-PS2-5),(HS-PS2-4) **HSN.Q.A.3** Reason abstractly and quantitatively. (HS-PS2-4) **MP.2** Model with mathematics. (HS-PS2-4) **MP.4** Interpret expressions that represent a quantity in terms of its context. (HS-PS2-4) **HSA.SSE.A.1** Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (HS-PS2-4) **HSA.SSE.B.3**

Unit 4: Types of Interactions (25 days)			
This unit is based on:	**SLO**	**STEM**	**Quick Links**
MS-PS2-3	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.	1. Electromagnetics 2. Circuits: A Probe for Prior Knowledge Becomes a Lesson 3. Static Electricity	1.http://betterlesson.com/lesson/637179/electromagnets 2. http://betterlesson.com/lesson/636486/circuits-a-probe-for-prior-knowledge-becomes-a-lesson 3. http://betterlesson.com/lesson/638084/static-electricity
MS-PS2-4	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces	4. Mass vs. Weight 5. Gravity: Motion on a slope	4. http://betterlesson.com/lesson/638056/mass-versus-weight-travel-to-other-planets 5. http://betterlesson.com/lesson/640498/gravity-part-3
MS-PS2-5	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.	6. Measurement: Forces 7. Using Scientific formula 8. Exploring magnetic levitation	6.http://betterlesson.com/lesson/637564/measurement-forces 7. http://betterlesson.com/lesson/638982/using-scientific-formulas 8. http://betterlesson.com/lesson/601238/exploring-magnetic-levitation

1. This lesson connects prior student knowledge of magnets to electricity. Electromagnets help prepare students to connect their understanding of the Earth's magnetosphere in Earth Science. Students will then be able to make connections to see the Earth as an electromagnet with the source of the current in the movement of the core. **This lesson is specifically designed to meet the following NGSS: MS-PS2-3.** Students make a connection between electricity and magnetism. They develop their understanding of cause and effect relationships.
2. Students will take a closer look at electric motors and electromagnets when I decided to check for student understanding of basic circuits. This lesson quickly brings students up to speed so we can explore middle school standards. **This lesson is specifically designed to meet the following NGSS: MS-PS2-3.**
3. In electrical circuits charges are moving all the time. Therefore static electricity is called static since the charges are mostly stationary. This lesson helps clarify the terminology along with supporting the standard MS-PS2-3 *Ask questions about data to determine the factors that affect the strength and direction of electric forces.*
4. By virtually visiting other planets, students use mathematical computations (**SP5**) to explore the scientific relationship between mass and gravitational acceleration (**MS-PS2-4)** by using algebraic expressions and equations (**CCC**) to calculate their weight on other planets. This lesson links physics to chemistry by exposing how forces interact with matter - and that properties of matter (like mass) have an effect on the magnitude of those forces (**MS-PS1-2**).
5. In this lesson students will understand the forces that act on an object on a slope and the acceleration that result. Understand how to represent motion on a slope in a velocity over time graph and understand where F=ma is in motion on a slope. **This lesson is specifically designed to meet the following NGSS: MS-PS2-4.**
6. This lesson is not a comprehensive exploration of forces, but rather an introduction to the concept and practice measuring forces using a spring scale. Understanding forces and how to measure them is fundamental be accessing several NGSS Disciplinary Core Ideas (DCI), especially those related to **MS-PS2 Motion and Stability: Forces and Interactions** and **MS-PS1 Matter and its Interactions**. Additionally, as students learn about measurement of forces, they access the **Crosscutting Concept** related to measurement (standard units are used to measure and describe physical quantities). Also, practice collecting data accurately to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions (**SP3**) is a scientific practice necessary for planning and carrying out investigations.
7. This lesson helps student's use mathematical reasoning to calculate the power of a wind turbine by plugging data into science formulas. This lesson is designed to meet the following NGSS: MS-PS2-5
8. This lesson uses a wide variety of strategies to help students understand how the future of transportation engineering includes some really cool science concepts. This lesson is designed to meet the following NGSS: MS-PS2-5
9. This lesson connects prior student knowledge of magnets to electricity. Electromagnets help prepare students to connect their understanding of the Earth's magnetosphere in Earth Science. Students will then be able to make connections to see the Earth as an electromagnet with the source of the current in the movement of the core. **This lesson is specifically designed to meet the following NGSS: MS-PS2-3.** Students make a connection between electricity and magnetism. They develop their understanding of cause and effect relationships.

10. Students will take a closer look at electric motors and electromagnets when I decided to check for student understanding of basic circuits. This lesson quickly brings students up to speed so we can explore middle school standards. **This lesson is specifically designed to meet the following NGSS: MS-PS2-3.**
11. In electrical circuits charges are moving all the time. Therefore static electricity is called static since the charges are mostly stationary. This lesson helps clarify the terminology along with supporting the standard MS-PS2-3 *Ask questions about data to determine the factors that affect the strength and direction of electric forces.*
12. By virtually visiting other planets, students use mathematical computations (**SP5**) to explore the scientific relationship between mass and gravitational acceleration (**MS-PS2-4)** by using algebraic expressions and equations (**CCC**) to calculate their weight on other planets. This lesson links physics to chemistry by exposing how forces interact with matter - and that properties of matter (like mass) have an effect on the magnitude of those forces (**MS-PS1-2**).
13. In this lesson students will understand the forces that act on an object on a slope and the acceleration that result. Understand how to represent motion on a slope in a velocity over time graph and understand where F=ma is in motion on a slope. **This lesson is specifically designed to meet the following NGSS: MS-PS2-4.**
14. This lesson is not a comprehensive exploration of forces, but rather an introduction to the concept and practice measuring forces using a spring scale. Understanding forces and how to measure them is fundamental be accessing several NGSS Disciplinary Core Ideas (DCI), especially those related to **MS-PS2 Motion and Stability: Forces and Interactions** and **MS-PS1 Matter and its Interactions**. Additionally, as students learn about measurement of forces, they access the **Crosscutting Concept** related to measurement (standard units are used to measure and describe physical quantities). Also, practice collecting data accurately to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions (**SP3**) is a scientific practice necessary for planning and carrying out investigations.
15. This lesson helps student's use mathematical reasoning to calculate the power of a wind turbine by plugging data into science formulas. This lesson is designed to meet the following NGSS: MS-PS2-5
16. This lesson uses a wide variety of strategies to help students understand how the future of transportation engineering includes some really cool science concepts. This lesson is designed to meet the following NGSS: MS-PS2-5

Unit 5: Relationships Among Forms of Energy

Unit Summary
How can physics explain sports? 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.

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

Student Learning Objectives

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. *[Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]* **(MS-PS3-1)**

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. *[Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]* **(MS-PS3-2)**

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. *[Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]* **(MS-PS3-5)**

Unit Sequence

Part A: *Is it better to have an aluminum (baseball/softball) bat or a wooden bat?*

Concepts	Formative Assessments
• 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	*Students who understand the concepts can:* • Construct and interpret graphical displays of data to identify linear and nonlinear relationships of kinetic energy to the mass of an object and to the speed of an object.

provide information about the magnitude of properties and processes.	

Unit Sequence	
Part B: *What would give you a better chance of winning a bowling match, using a basketball that you can roll really fast, or a bowling ball that you can only roll slowly?*	
Concepts	**Formative Assessments**
• When the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. • A system of objects may contain stored (potential) energy, depending on the objects' relative positions. • When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the objects. • Models that could include representations, diagrams, pictures, and written descriptions of systems can be used to represent systems and their interactions, such as inputs, processes, and outputs, and energy and matter flows within systems.	*Students who understand the concepts can:* • 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 Sequence	
Part C: *Who can design the best roller coaster?*	
Concepts	**Formative Assessments**
• When the kinetic energy of an object changes, energy is transferred to or from the object. • When the motion energy of an object changes, there is inevitably some other change in energy at the same time. • Kinetic energy may take different forms (e.g., energy in fields, thermal energy, energy of motion).	*Students who understand the concepts can:* • Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. • Conduct an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of an object. Do not include calculations of energy.

Appendix A: NGSS and Foundations for the Unit
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. *[Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.]* **(MS-PS3-1)**
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. *[Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.]* **(MS-PS3-2)**
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. *[Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object.] [Assessment Boundary: Assessment does not include calculations of energy.]* **(MS-PS3-5)**

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to describe unobservable mechanisms. (MS-PS3-2) **Analyzing and Interpreting Data** • Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1) **Engaging in Argument from Evidence** • Construct, use, and present oral and written arguments supported by empirical evidence	**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	**Scale, Proportion, and Quantity** • Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1) **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-PS3-2)

and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5) - ***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-PS3-5)	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)	**Energy and Matter** • Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)

English Language Arts	Mathematics
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.6-8.1** 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-PS3-1) **RST.6-8.7** Write arguments focused on discipline content. *(MS-PS3-5)* **WHST.6-8.1** 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-PS3-3) **WHST.6-8.7** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-PS3-2)* **SL.8.5**	Reason abstractly and quantitatively. (MS-PS3-1),(MS-PS3-5) **MP.2** 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.1** 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) **6.RP.A.2** Recognize and represent proportional relationships between quantities. (MS-PS3-1),(MS-PS3-5) **7.RP.A.2** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1) **8.EE.A.1** Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (MS-PS3-1) **8.EE.A.2** Interpret the equation $y = mx + b$ as defining a linear function, whose

	graph is a straight line; give examples of functions that are not linear. (MS-PS3-1),(MS-PS3-5) **8.F.A.3**

Unit 5: Relationships among Forms of Energy (20 days)

This unit is based on:	SLO	Inquiry Menu	Quick Links
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.	1. Bowling for Science 2. Skate park simulation 3. Ramp Activity – part 1	1. Attachment 2. http://betterlesson.com/lesson/640019/exploring-the-relationship- between-potential-kinetic-energy 3. Attachment
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	4. 5. 6. 7. Roller coaster simulator Ramp activity – part 2 Marble drop activity Rubber band cannons	4. http://www.physicsclassroom.com/Physics-Interactives/Work-and-Energy/Roller-Coaster-Model/Roller-Coaster-Model-Interactive 5. Attachment 6. http://betterlesson.com/lesson/633998/kinetic-and-potential-energy-lab-rotation 7. http://betterlesson.com/lesson/633996/rubber-band-cannon-lab

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.	8. Rube Goldberg Machines 9. Transformation demonstration	8. Attachment 9. Attachment

1. This activity will demonstrate that the kinetic energy an object possesses is determined by its mass and the speed with which it's moving. It will show that kinetic energy has a relationship to mass separate from its relationship to speed, by conducting the activity in two parts – one with speed constant and one
2. This simulation allows the user to change the mass of the skater and records the change to the amount of kinetic energy, potential energy, and speed of the skater. Student worksheets are provided. (Can be done in a computer lab or as a demo on the smartboard)
3. This activity will allow students to predict how mass impacts kinetic energy. Students will roll balls of different masses down a ramp, and will calculate the amount of kinetic energy that each ball possesses. Students can collect the data and represent it graphically.
4. This simulation allows students to design a roller coaster with various heights, loops, etc., and determine the effect each has on both potential and kinetic energy
5. Students will use ramps of varying heights to collect evidence to support the claim that potential energy is dependent upon height.
6. Students will drop marbles from various heights into flour or clay, and measure the "crater" is produces to determine the relationship between height and the amount of potential energy.
7. Students will explore elastic potential energy through this investigation.
8. Students will a Rube Goldberg machine to investigate how energy transfers from one object to or from another object.
9. Students will observe various energy transformations, and will predict and identify the types of energy involved
10.

Unit 6: Thermal Energy

Unit Summary
How can a standard thermometer be used to tell you how particles are behaving?
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 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. This unit is based on MS-PS3-3, MS-PS3-4, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4.
Student Learning Objectives
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)
Unit Sequence
Part A: *How can a standard thermometer be used to tell you how particles are behaving?*

Concepts	Formative Assessments
• There are relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of particles as measured by the temperature of the sample. • 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. • 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. • Proportional relationships among the amount of energy transferred, the mass, and the change in the average kinetic energy of particles as measured by temperature of the sample provide information about the magnitude of properties and processes.	*Students who understand the concepts can:* • Individually and collaboratively 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 particles as measured by the temperature of the sample. • As part of a planned investigation, 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. • Make logical and conceptual connections between evidence and explanations.

Unit Sequence

Part B: You are an engineer working for NASA. In preparation for a manned space mission to the Moon, you are tasked with designing, constructing, and testing a device that will keep a hot beverage hot for the longest period of time. It costs approximately $10,000 per pound to take payload into orbit so the devise must be lightweight and compact. The lack of atmosphere on the Moon produces temperature extremes that range from -157 degrees C in the dark to +121 degrees C in the light. Your devise must operate on either side of the Moon (https://spaceflightsystems.grc.nasa.gov/education/rocket/moon.html).

Concepts	Formative Assessments
• 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. • 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	*Students who understand the concepts can:* • Apply scientific ideas or principles to design, construct, and test a design of a device that either minimizes or maximizes thermal energy transfer. • Determine design criteria and constraints for a device that either minimizes or maximizes thermal energy transfer. • Test design solutions and modify them on the basis of the test results

designed or natural system. • 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.	in order to improve them. • Use a systematic process for evaluating solutions with respect to how well they meet criteria and constraints.

Connections to Other Units

Grade 8, Unit 3: 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).
- 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.
- 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.

Grade 7, Unit 8: Weather and Climate

- Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.
- 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 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.
- Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents.
- 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.

- Because these patterns are so complex, weather can only be predicted probabilistically.
- 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.

Grade 7, Unit 5: Structure and Properties of Matter

- Each atom has a charged substructure consisting of a nucleus, which is made of protons and neutrons, surrounded by electrons.
- The periodic table orders elements horizontally by the number of protons in the atom's nucleus and places those with similar chemical properties in columns. The repeating patterns of this table reflect patterns of outer electron states.

Grade 7, Unit 6: Interactions of Matter

- The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
- A stable molecule has less energy than the same set of atoms separated; one must provide at least this energy in order to take the molecule apart.

Grade 7, Unit 7: Chemical Reactions

- Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.
- In many situations, a dynamic and condition-dependent balance between a reaction and the reverse reaction determines the numbers of all types of molecules present.
- The fact that atoms are conserved, together with knowledge of the chemical properties of the elements involved, can be used to describe and predict chemical reactions.

Grade 7, Unit 9: Earth 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.
- 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.

Grade 8, Unit 1: Stability and Change on Earth

- 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.

Appendix A: NGSS and Foundations for the Unit

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)

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Planning and Carrying Out Investigations • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and	**PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and	**Scale, Proportion, and Quantity** • Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide

controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4) **Constructing Explanations and Designing Solutions** • Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3) **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) **Developing and Using Models** • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **Engaging in Argument from Evidence** • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	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	information about the magnitude of properties and processes. (MS-PS3-4) **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) **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)

	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)	

English Language Arts	Mathematics
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.6-8.1** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3),(MS-PS3-4) **RST.6-8.3** 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.6-8.7** 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	Reason abstractly and quantitatively. (MS-PS3-4),(MS-ETS1-1),(MS-ETS1-2),(MS-ETS1-3),(MS-ETS1-4) **MP.2** Summarize numerical data sets in relation to their context. (MS-PS3-4) **6.SP.B.5** 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** 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) **7.SP**

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-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**	

Unit 6: Thermal Energy (30 days)			
This unit is based on:	**SLO**	**Inquiry Menu**	**Quick Links**
MS-PS3-3	Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer	1. 2. Build a better thermos activity Designing Thermal protection systems activity	1. http://betterlesson.com/lesson/628050/build-a-thermos 2. http://betterlesson.com/lesson/634000/thermal-protection-systems-day-1
MS-PS3-4	Plan an investigation to determine the relationships among the energy transferred, the type of matter, the	3. Heating sand and water activity 4. Activity: Impact of ice on water	3. Refer to "Weather and climate" book activity on page 40

	mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.	temperature	4. See description below
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.	5. Design a hot air balloon (links with MS-PS3 -4 and MS-ETS1 -3 and MS-ETS1 -4) 6. Solar Smores (links with MS-PS3 -3)	5. http://betterlesson.com/lesson/640487/hot-air-balloons 6. http://betterlesson.com/lesson/640858/exploring-radiation-solar-s-mores
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	1. Thermos competition	
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.	5. Balloon activity	
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.	5. Balloon activity	

1. In this activity students will apply scientific principles to design construct and test a device that minimizes or maximizes thermal energy transfer
2. In this activity, students will use informational text to create design criteria for objects re-entering Earth's atmosphere.
3. Students will collect evidence to investigate the relationship among the energy transferred and the type of matter (specific heat) by recording the change in average kinetic energy in particles as measured by the temperature of the sample, as sand and water are heated. (Extension can be to use different masses of the same material)

4. Students will collect evidence to compare final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature.
5. Students will design a hot air balloon powered by birthday candles to explore the concept of convection and heat transfer.
6. Students will construct a solar powered oven, and must determine the best location to provide optimum energy transfer.

Unit 7: The Electromagnetic Spectrum

Unit Summary

How do cell phones work?

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 disciplinary core ideas. Students *develop and use models, use mathematical thinking,* and *obtain, evaluate, and communicate information.* Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on MS-PS4-1, MS-PS4-2, and MS-PS4-3.

Student Learning Objectives

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. *[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.]* **(MS-PS4-1)**

Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. *[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.]* **(MS-PS4-2)**

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. *[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.]* **(MS-PS4-3)**

Unit Sequence

Part A: *Why do surfers love physicists?*

Concepts	Formative Assessments
• 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.	*Students who understand the concepts can:* • Use mathematical representations to describe and/or support scientific conclusions about how the amplitude of a wave is related to the energy in a wave. • Use mathematical representations to describe a simple model.

• Waves can be described with both qualitative and quantitative thinking.	

Unit Sequence

Part B: *How do the light and sound system in the auditorium work?*

Concepts	Formative Assessments
• 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. • 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.	*Students who understand the concepts can:* • Develop and use models to describe the movement of waves in various materials.

Unit Sequence

Part C: *If rotary phones worked for my grandparents, why did they invent cell phones?*

Concepts	Formative Assessments
• Structures can be designed to use properties of waves to serve particular functions. • Waves can be used for communication purposes.	*Students who understand the concepts can:* • Integrate qualitative scientific and technical information in written

• Digitized signals (sent as 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.	text with that contained in media and visual displays to clarify claims that digitized signals are a more reliable way to encode and transmit information than analog signals are.

Connections to Other Units
Grade 7, Unit 4: 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.

Appendix A: NGSS and Foundations for the Unit		
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. *[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.]* **(MS-PS4-1)**		
Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. *[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.]* **(MS-PS4-2)**		
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. *[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.]* **(MS-PS4-3)**		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Using Mathematics and Computational Thinking • Use mathematical representations to	**PS4.A: Wave Properties** • A simple wave has a repeating pattern with a specific wavelength, frequency, and	**Patterns** • Graphs and charts can be used to identify patterns in data. (MS-PS4-1)

describe and/or support scientific conclusions and design solutions. (MS-PS4-1) **Developing and Using Models** • Develop and use a model to describe phenomena. (MS-PS4-2) **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) - ***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-PS4-1)	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)	**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) - ***Connections to Engineering, Technology, and Applications of Science*** **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) - ***Connections to Nature of Science*** **Science is a Human Endeavor** • Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

English Language Arts	Mathematics
Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-3) **RST.6-8.1** Determine the central ideas or conclusions of a text; provide an accurate	Reason abstractly and quantitatively. (MS-PS4-1) **MP.2** Model with mathematics. (MS-PS4-1) **MP.4**

summary of the text distinct from prior knowledge or opinions. (MS-PS4-3) **RST.6-8.2** 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-PS4-3) **RST.6-8.9** Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3) **WHST.6-8.9** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1),(MS-PS4-2) **SL.8.5**	Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1) **6.RP.A.1** Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1) **6.RP.A.3** Recognize and represent proportional relationships between quantities. (MS-PS4-1) **7.RP.A.2** Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS4-1) **8.F.A.3**

Unit 7: The Electromagnetic Spectrum (20 days)			
This unit is based on:	**SLO**	**Inquiry Menu**	**Quick Links**
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.	1. Properties of waves: making waves visible. 2. West/Nawaz Inquiry 3. West Web Quest 4. Electromagnetic Math	1. http://betterlesson.com/lesson/633527/the-electromagnetic-spectrum 2. Attachment 3. Attachment 4. http://www.nasa.gov/pdf/574861main_Electromagnetic_Math.pdf
MS-PS4-2	Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.	5. Absorption, Transmission and Reflection: Creating Models 6. Sound Waves vs. Light Waves "Un-notes"	5. http://betterlesson.com/lesson/633209/absorption-transmission-and-reflection-creating-models 6. http://betterlesson.com/lesson/633530/sound-waves-vs-light-waves-un-

			notes-2-days
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.	7. Digital vs. Analog Signal Argument from Evidence. 8. Electromagnetic Waves in Communication	7. https://sciencewithmrsbowling.wordpress.com/resources/digital-vs-analog-signal-project/ 8. Attachment.

1. This activity provides demonstrations to make the invisible waves of seismic, radiant and sound energy "visible". There are guided notes provided with inquiry based demonstrations hat the students will complete to understand the difference between key terms (wavelength, medium, amplitude, frequency, crest, trough, transverse, longitudinal, pitch).
2. West/Nawaz Inquiry can go along with both MS-PS4-1 & MS-PS4-2. These inquiry stations involve modeling sound waves, investigating the electromagnetic spectrum, understanding absorption, transmission and reflection through various objects and reflections through concave and convex mirrors.
3. West Web Quest can go along with both MS-PS4-1 & MS-PS4-2. Students explore the different types of waves and their animations, furthermore students will sketch and label the model of each wave. Students will also determine the behavior of waves including reflection, absorption, diffraction, scattering and refraction. Lastly, in a chart students will be able to determine the frequency of each electromagnetic wave along with a description and example.
4. Electromagnetic math provides you with a large manual that allows students to calculate wavelength, frequency and speed of a wave.
5. This lesson provides a formative assessment regarding energy vs. amplitude (MS-PS4-1). The modeling "Mystery Box" Student Activity involves MS-PS4-2 where each group has approximately 6 students – each group is provided with the following terms: "reflection of light, absorption of light, transmission of light, reflection of sound, absorption of sound, transmission of sound". Each group will be given a mystery box that students can utilize to create a model of the term they were assigned. Each student in the group will be modeling one of the terms – along with sharing their model with the group they must describe the evidence they are seeing/hearing.
6. Students are provided with notes that include terms, but questions regarding mini demonstrations that need to be answered. Students will provide evidence that different types of waves interact with matter differently.
7. Students will construct a Venn Diagram to compare and contrast digital signal versus an analog signal. Research the definition for each and place the definition in the appropriate circle for the venn diagram. Use the websites provided to research information and place in each part of the diagram. Watch the videos provided to add more information. When completed, on the back of the Venn Diagram write an argument explaining why digital signals are better than analog signals.
8. This activity contains 7 assignments that will be done in groups of 4. Activities include:
    a. Your first digital message
    b. Digital vs. Analog
    c. Your third message – A Higher Resolution Text
    d. Your second message – a low resolution letter X
    e. Connecting Digital Images to Computer Monitors

f. Beyond Black and White (Gray and Color)
g. Sending Digital Movies

Additional resources:
https://sciencewithmrsbowling.wordpress.com/resources/waves-light-and-sound-ms-ps4-1-ms-ps4-2-ms-ps4-3/ - provides several activities that could fit into these three standards.