



Diocese of Alexandria ~ Catholic Schools

Where faith and knowledge grow



## DIOCESE OF ALEXANDRIA

As the Diocese of Alexandria seeks to provide a comprehensive learning environment, we are charged to “Teach More” by showing how all learning flows from and relates to our Creator. In this way, we will give our teaching a deeper meaning and purpose than simply the content itself. With this as our goal, the Catholic Schools Office has intertwined our selected curricular standards with the Catholic Standards developed by the Cardinal Newman Society. Through the merging of these two curricula, English Language Arts, Mathematics, Science, and Social Studies, teachers will be provided a roadmap to guide student’s understanding and recognition of the relationship between learning and the connection to our God.

Thomas E. Roque, Sr.  
Superintendent of Catholic Schools



## DIOCESE OF ALEXANDRIA

Through comprehensive review of curricula from high performing districts throughout the United States in combination with parochial schools and Newman Cardinal Standards, the Curriculum Team for the Diocese of Alexandria has generated curricula for English Language Arts, Mathematics, Science, and Social Studies. The development of this framework is designed to guide the instructional path of teachers as they focus on the formation of their students in the areas of faith, academic excellence, responsible citizenry, and effective communication and collaboration. This process is a continuous improvement process with no defined beginning or end.

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# Frameworks



THE DIOCESE  
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## HOW TO USE

The frameworks are guides to instruction. The frameworks assist teachers in planning and pacing instruction. Specific dates or weeks that may be included in this document are for reference. Each school and teacher must consider the make-up of their students, focusing on the needs and strengths of each child when pacing and planning instruction.

The cycles for the year help pace instruction and ensure students have consistent coverage of the content. The duration (the suggested amount of time to spend on each cycle) does not accommodate for the scheduling of special events, inclement weather or school events. Teachers, with principal guidance, should adjust pacing as needed to accommodate for these events.

## RESEARCH-BASED HIGH-YIELD PRACTICES FOR INSTRUCTION

These strategies have proven effective in affecting student learning and achievement gains. As you plan daily instruction, consider how and where to integrate these strategies into the instructional sequence. Effect size is in parentheses. Please refer to the works of John Hattie for a complete description of instructional effect size.

- Classroom Discussion/Discourse (.82)
- Teacher Clarity/making the learning visible with expectations for learning (.75)
- Reciprocal Teaching (.74)
- Feedback (.73)
- Metacognitive Strategies (.69)

# 8<sup>th</sup> Grade - Science



THE DIOCESE  
of ALEXANDRIA

Unit 1: EVIDENCE OF COMMON ANCESTRY

Summary

Instructional Days: 15

How do we know when an organism (fossil) was alive?

How do we know that birds and dinosaurs are related?

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

This unit is based on MS-LS4-1, MS-LS4-2, and MS-LS4-3.

## Student Learning Objectives

**Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.** *[Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]* ([MS-LS4-1](#))

**Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.** *[Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]* ([MS-LS4-2](#))

**Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.** *[Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]* ([MS-LS4-3](#))

## Unit Sequence

### Part A: *How do we know when an organism (fossil) was alive?*

#### Concepts

- The fossil record documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth.
- The collection of fossils and their placement in chronological order as identified through the location of sedimentary layers in which they are found or through radioactive dating is known as the fossil record.
- Relative fossil dating is achieved by examining the fossil's relative position in sedimentary rock layers.
- Objects and events in the fossil record occur in consistent patterns that are understandable through measurement and observation.
- Patterns exist in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in rock layers.
- Patterns can occur within one species of organism or across many species.

#### Formative Assessments

*Students who understand the concepts can:*

- Use graphs, charts, and images to identify patterns within the fossil record.
- Analyze and interpret data within the fossil record to determine similarities and differences in findings.
- Make logical and conceptual connections between evidence in the fossil record and explanations about the existence, diversity, extinction, and change in many life forms throughout the history of life on Earth.

## Unit Sequence

### Part B: *How do we know that birds and dinosaurs are related?*

Concepts	Formative Assessments
<ul style="list-style-type: none"><li>• Similarities and differences exist in the gross anatomical structures of modern organisms.</li><li>• There are anatomical similarities and differences among modern organisms and between modern organisms and fossil organisms.</li><li>• Similarities and differences exist in the gross anatomical structures of modern organisms and their fossil relatives.</li><li>• Similarities and differences in the gross anatomical structures of modern organisms enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.</li><li>• Patterns and anatomical similarities in the fossil record can be used to identify cause-and-effect relationships.</li><li>• Science assumes that objects and events in evolutionary history occur in consistent patterns that are understandable through measurement and observation.</li></ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"><li>• Apply scientific ideas to construct explanations for evolutionary relationships.</li><li>• Apply the patterns in gross anatomical structures among modern organisms and between modern organisms and fossil organisms to construct explanations of evolutionary relationships.</li><li>• Apply scientific ideas about evolutionary history to construct an explanation for evolutionary relationships evidenced by similarities or differences in the gross appearance of anatomical structures.</li></ul>

### Unit Sequence

**Part C:** *Other than bones and structures being similar, what other evidence is there that birds and dinosaurs are related?*

Concepts	Formative Assessments
<ul style="list-style-type: none"><li>• Relationships between embryos of different species show similarities in their development.</li><li>• General patterns of relatedness among embryos of different organisms can be inferred by comparing the macroscopic appearance of diagrams or pictures.</li><li>• Pictorial data can be used to identify patterns of similarities in embryological development across multiple species.</li><li>• Similarities in embryological development across multiple species show relationships that are not evident in the fully formed organisms.</li></ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"><li>• Use diagrams or pictures to identify patterns in embryological development across multiple species.</li><li>• Analyze displays of pictorial data to identify where the embryological development is related linearly and where that linear nature ends.</li><li>• Infer general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.</li></ul>

### Sample of Open Education Resources

[NOVA: Judgement Day: Intelligent Design on Trial: Human Chromosome 2](#): This video segment from NOVA: "Judgment Day: Intelligent Design on Trial" reveals how genetic evidence helped to confirm an important component of Darwin's theory of evolution by natural selection: the common ancestry of humans and apes. In particular, it explains that humans have one fewer chromosome pair in their cells than apes, due to a mutation found in chromosome number 2 that caused two chromosomes to fuse into one.

[The Day the Mesozoic Died](#) This three-act film tells the story of the detective work that solved the mystery of what caused the disappearance of the dinosaurs at the end of the Cretaceous period. Shot on location in Italy, Spain, Texas, Colorado, and North Dakota, the film traces the uncovering of key clues that led to the discovery that an asteroid struck the Earth 66 million years ago, triggering a mass extinction of animals, plants, and microorganisms.

### Teacher Professional Learning Resources

## Appendix A: NGSS and Foundations for the Unit

**Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.** *[Clarification Statement: Emphasis is on finding patterns of changes in the level of complexity of anatomical structures in organisms and the chronological order of fossil appearance in the rock layers.] [Assessment Boundary: Assessment does not include the names of individual species or geological eras in the fossil record.]* [\(MS-LS4-1\)](#)

**Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.** *[Clarification Statement: Emphasis is on explanations of the evolutionary relationships among organisms in terms of similarity or differences of the gross appearance of anatomical structures.]* [\(MS-LS4-2\)](#)

**Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.** *[Clarification Statement: Emphasis is on inferring general patterns of relatedness among embryos of different organisms by comparing the macroscopic appearance of diagrams or pictures.] [Assessment Boundary: Assessment of comparisons is limited to gross appearance of anatomical structures in embryological development.]* [\(MS-LS4-3\)](#)

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
<p><b>Analyzing and Interpreting Data</b></p> <ul style="list-style-type: none"> <li>Analyze displays of data to identify linear and nonlinear relationships. (MS-LS4-3)</li> <li>Analyze and interpret data to determine similarities and differences in findings. (MS-LS4-1)</li> </ul> <p><b>Constructing Explanations and Designing Solutions</b></p> <ul style="list-style-type: none"> <li>Apply scientific ideas to construct an explanation for real-world phenomena, examples, or events. (MS-LS4-2)</li> </ul> <p><b>Connections to Nature of Science</b> <b>Scientific Knowledge is Based on Empirical Evidence</b></p>	<p><b>LS4.A: Evidence of Common Ancestry and Diversity</b></p> <ul style="list-style-type: none"> <li>The collection of fossils and their placement in chronological order (e.g., through the location of the sedimentary layers in which they are found or through radioactive dating) is known as the fossil record. It documents the existence, diversity, extinction, and change of many life forms throughout the history of life on Earth. (MS-LS4-1)</li> <li>Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record, enable the reconstruction of evolutionary history and the</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Patterns can be used to identify cause and effect relationships. (MS-LS4-2)</li> <li>Graphs, charts, and images can be used to identify patterns in data. (MS-LS4-1),(MS-LS4-3)</li> </ul> <p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4),(MS-LS4-5),(MS-LS4-6)</li> </ul> <p><b>Scientific Knowledge Assumes an Order and Consistency in Natural Systems</b></p>

<ul style="list-style-type: none"><li>• Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-LS4-1)</li></ul>	<p>inference of lines of evolutionary descent. (MS-LS4-2)</p> <ul style="list-style-type: none"><li>• Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy. (MS-LS4-3)</li></ul>	<ul style="list-style-type: none"><li>• Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS4-1),(MS-LS4-2)</li></ul>
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# 8<sup>th</sup> Grade - Science



THE DIOCESE  
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Unit 2: SELECTION AND ADAPTATION

Summary

Instructional Days: 20

## *Are Genetically Modified Organisms (GMO) safe to eat?*

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

This unit is based on MS-LS4-4, MS-LS4-5, and MS-LS4-6.

### Student Learning Objectives

**Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment.** *[Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]* **(MS-LS4-4)**

**Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.** *[Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]* **(MS-LS4-5)**

**Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.** *[Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.]* *[Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]* **(MS-LS4-6)**

<b>Unit Sequence</b>	
<b>Part A: <i>How can changes to the genetic code increase or decrease an individual's chances of survival?</i></b>	
<b>Concepts</b>	<b>Formative Assessments</b>
<ul style="list-style-type: none"> <li>Genetic variations of traits in a population increase or decrease some individuals' probability of surviving and reproducing in a specific environment.</li> <li>Natural selection leads to the predominance of certain traits in a population and the suppression of others.</li> <li>Natural selection may have more than one cause, and some cause-and-effect relationships within natural selection can only be described using probability.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>Construct an explanation that includes probability statements regarding variables and proportional reasoning of how genetic variations of traits in a population increase some individuals' probability surviving and reproducing in a specific environment.</li> <li>Use probability to describe some cause-and-effect relationships that can be used to explain why some individuals survive and reproduce in a specific environment.</li> </ul>
<b>Unit Sequence</b>	
<b>Part B: <i>How can the environment effect natural selection?</i></b>	
<b>Concepts</b>	<b>Formative Assessments</b>
<ul style="list-style-type: none"> <li>Natural selection, which over generations leads to adaptations, is one important process through which species change over time in response to changes in environmental conditions.</li> <li>The distribution of traits in a population changes.</li> <li>Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common.</li> <li>Natural selection may have more than one cause, and some cause-and-effect relationships in natural selection can only be described using probability.</li> <li>Mathematical representations can be used to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>Explain some causes of natural selection and the effect it has on the increase or decrease of specific traits in populations over time.</li> <li>Use mathematical representations to support conclusions about how natural selection may lead to increases and decreases of genetic traits in populations over time.</li> </ul>

**Unit Sequence**

**Part C: Are Genetically Modified Organisms (GMO) safe to eat?**

**Concepts**

- In artificial selection, humans have the capacity to influence certain characteristics of organisms by selective breeding.
- In artificial selection, humans choose desirable, genetically determined traits in to pass on to offspring.
- Phenomena, such as genetic outcomes in artificial selection, may have more than one cause, and some cause-and-effect relationships in systems can only be described using probability.
- Technologies have changed the way humans influence the inheritance of desired traits in organisms.
- Engineering advances have led to important discoveries in the field of selective breeding.
- Engineering advances in the field of selective breeding have led to the development of entire industries and engineered systems.
- Scientific discoveries have led to the development of entire industries and engineered systems.

**Formative Assessments**

- Students who understand the concepts can:*
- Gather, read, and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection) from multiple appropriate sources.
  - Describe how information from publications about technologies and methods that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection) used are supported or not supported by evidence.
  - Assess the credibility, accuracy, and possible bias of publications and they methods they used when gathering information about technologies that have changed the way humans influence the inheritance of desired traits in organisms (artificial selection).

### Sample of Open Education Resources

[99.99% Antibacterial Products and Natural Selection](#): This activity is a hands-on simulation using Skittles and mini-marshmallows to show how natural selection can act as a mechanism to increase the presence of antibacterial resistance in a population.

[An Origin of Species: Pollenpeepers](#): This web simulation allows students to explore adaptive radiation of a fictitious group of birds called Pollenpeepers over a period of 5 million years.

[Making Sense of Natural Selection](#): This article from The Science Teacher magazine describes a unit of study on natural selection. Students begin by trying to explain the phenomenon of the exponential increase in a population of fish.

[Bug Hunt](#) “Bug Hunt” uses NetLogo software and simulates an insect population that is preyed on by birds. There are six speeds of bugs from slow to fast and the bird tries to catch as many insects as possible in a certain amount of time. Students are able to see the results graphed as the average insect speed over time, the current bug population and the number of insects caught.

[Color Variation over Time in Rock Pocket Mouse Populations](#): This activity provides an introduction to natural selection and the role of genetic variation by asking students to analyze illustrations of rock pocket mouse populations (dark/light fur) on different color substrates in the Sonoran Desert (light/dark) over time. Based on this evidence, and what they learn about variation and natural selection in the accompanying short film, students use this evidence to explain the change in the rock pocket mouse populations on the lava flow (dark substrate) over time.

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

### Teacher Professional Learning Resources

## Appendix A: NGSS and Foundations for the Unit

Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment. *[Clarification Statement: Emphasis is on using simple probability statements and proportional reasoning to construct explanations]* (MS-LS4-4)

Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms. *[Clarification Statement: Emphasis is on synthesizing information from reliable sources about the influence of humans on genetic outcomes in artificial selection (such as genetic modification, animal husbandry, gene therapy); and, on the impacts these technologies have on society as well as the technologies leading to these scientific discoveries.]* (MS-LS4-5)

Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time. *[Clarification Statement: Emphasis is on using mathematical models, probability statements, and proportional reasoning to support explanations of trends in changes to populations over time.]* *[Assessment Boundary: Assessment does not include Hardy Weinberg calculations.]* (MS-LS4-6)

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
<p><b>Constructing Explanations and Designing Solutions</b></p> <ul style="list-style-type: none"> <li>Construct an explanation that includes qualitative or quantitative relationships between variables that describe phenomena. (MS-LS4-4)</li> </ul> <p><b>Obtaining, Evaluating, and Communicating Information</b></p> <ul style="list-style-type: none"> <li>Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-LS4-5)</li> </ul> <p><b>Using Mathematics and Computational Thinking</b></p>	<p><b>LS4.B: Natural Selection</b></p> <ul style="list-style-type: none"> <li>Natural selection leads to the predominance of certain traits in a population, and the suppression of others. (MS-LS4-4)</li> <li>In <i>artificial</i> selection, humans have the capacity to influence certain characteristics of organisms by selective breeding. One can choose desired parental traits determined by genes, which are then passed on to offspring. (MS-LS4-5)</li> </ul> <p><b>LS4.C: Adaptation</b></p> <ul style="list-style-type: none"> <li>Adaptation by natural selection acting over generations is one important process by which species change over time in response to changes in environmental conditions. Traits that support successful</li> </ul>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. (MS-LS4-4),(MS-LS4-5),(MS-LS4-6)</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Interdependence of Science, Engineering, and Technology</b></p> <ul style="list-style-type: none"> <li>Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-LS4-5)</li> </ul> <p><b>Connections to Nature of Science</b></p>

<ul style="list-style-type: none"><li>• Use mathematical representations to support scientific conclusions and design solutions. (MS-LS4-6)</li></ul>	survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. (MS-LS4-6)	<b>Science Addresses Questions About the Natural and Material World</b> <ul style="list-style-type: none"><li>• Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS4-5)</li></ul>
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# 8<sup>th</sup> Grade - Science



THE DIOCESE  
of ALEXANDRIA

Unit 3: STABILITY AND CHANGE ON EARTH

Summary

Instructional Days: 30

## 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

- 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.

#### Formative Assessments

*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

- 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.

#### Formative Assessments

*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

- 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.

### Formative Assessments

*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

- Stability in Earth's surface temperature might be disturbed either by sudden events or gradual changes that accumulate over time.
- Human activities and natural processes are examples of factors that have caused the rise in global temperatures over the past century.
- Human activities play a major role in causing the rise in global temperatures.
- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming).
- Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior, and on applying that knowledge wisely in decisions and activities.
- Evidence that some factors have caused the rise in global temperature over the last century can include tables, graphs, and maps of global and regional temperatures, atmospheric levels of gases such as carbon dioxide and methane, and the rates of human activities.

#### Formative Assessments

*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.

### Sample of Open Education Resources

[USGS Educational Resources for Secondary Grades \(7-12\)](#): This web site contains selected USGS educational resources that may be useful to educators in secondary school grades. Many of these resources can be used directly in the classroom or will be useful in classroom lessons or demonstration activities preparation, or as resources for teacher education and curriculum development.

[NOAA Education Resources](#): This website contains access to curriculum resources, professional development opportunities, student opportunities, and outreach events.

## Teacher Professional Learning Resources

### 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
<p><b>Constructing Explanations and Designing Solutions</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>Engaging in Argument from Evidence</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul>	<p><b>ESS3.A: Natural Resources</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>ESS3.B: Natural Hazards</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>ESS3.C: Human Impacts on Earth Systems</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>ESS3.D: Global Climate Change</b></p> <ul style="list-style-type: none"> <li>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).</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)</li> </ul> <p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1),(MS-ESS3-4)</li> </ul> <p><b>Stability and Change</b></p> <ul style="list-style-type: none"> <li>Stability might be disturbed either by sudden events or gradual changes that accumulate over time. (MS-ESS3-5)</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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)</li> <li>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</li> </ul>

	<p>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)</p>	<p>climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-2)</p> <p><i>Connections to Nature of Science</i></p> <p><b>Science Addresses Questions About the Natural and Material World</b></p> <ul style="list-style-type: none"><li>• Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)</li></ul>
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# 8<sup>th</sup> Grade - Science



THE DIOCESE  
of ALEXANDRIA

## Unit 4: FORCE AND MOTION

## Summary

Instructional Days: 25

**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

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species.
- Changes to Earth's environments can have different impacts (negative and positive) for different living things.
- Typically as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise.
- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation.
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

### Formative Assessments

*Students who understand the concepts can:*

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

## Sample of Open Education Resources

[USGS Educational Resources for Secondary Grades \(7-12\)](#): This web site contains selected USGS educational resources that may be useful to educators in secondary school grades. Many of these resources can be used directly in the classroom or will be useful in classroom lessons or demonstration activities preparation, or as resources for teacher education and curriculum development.

[NOAA Education Resources](#): This website contains access to curriculum resources, professional development opportunities, student opportunities, and outreach events.

## Teacher Professional Learning Resources

## 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
<p><b>Constructing Explanations and Designing Solutions</b></p> <ul style="list-style-type: none"> <li>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)</li> <li>Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)</li> </ul> <p><b>Asking Questions and Defining Problems</b></p> <ul style="list-style-type: none"> <li>Define a design problem that can be</li> </ul>	<p><b>ESS3.C: Human Impacts on Earth Systems</b></p> <ul style="list-style-type: none"> <li>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)</li> <li>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)</li> </ul> <p><b>ETS1.A: Defining and Delimiting Engineering Problems</b></p>	<p><b>Cause and Effect</b></p> <ul style="list-style-type: none"> <li>Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS-ESS3-3)</li> </ul> <p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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</li> </ul>

<p>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)</p> <p><b>Engaging in Argument from Evidence</b></p> <ul style="list-style-type: none"> <li>Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)</li> </ul> <p><b>Analyzing and Interpreting Data</b></p> <ul style="list-style-type: none"> <li>Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)</li> </ul>	<ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>ETS1.B: Developing Possible Solutions</b></p> <p>A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)</p> <ul style="list-style-type: none"> <li>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)</li> <li>Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)</li> <li>Models of all kinds are important for testing solutions. (MS-ETS1-4)</li> </ul>	<p>such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-ESS3-3)</p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>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)</li> <li>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)</li> </ul>
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# 8<sup>th</sup> Grade - Science



THE DIOCESE  
of ALEXANDRIA

Unit 5: RELATIONSHIPS AMONG FORMS OF ENERGY

Summary

Instructional Days: 20

## 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	
<b>Part A:</b> <i>Is it better to have an aluminum (baseball/softball) bat or a wooden bat?</i>	
Concepts	Formative Assessments
<ul style="list-style-type: none"> <li>• Kinetic energy is related to the mass of an object and to the speed of an object.</li> <li>• Kinetic energy has a relationship to mass separate from its relationship to speed.</li> <li>• 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.</li> <li>• Proportional relationships among different types of quantities provide information about the magnitude of properties and processes.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>• 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.</li> </ul>

Unit Sequence	
<b>Part B:</b> <i>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?</i>	
Concepts	Formative Assessments
<ul style="list-style-type: none"> <li>• When the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.</li> <li>• A system of objects may contain stored (potential) energy, depending on the objects' relative positions.</li> <li>• When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the objects.</li> <li>• 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.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>• 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</li> <li>• 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.</li> </ul>

## Unit Sequence

**Part C:** *Who can design the best roller coaster?*

### Concepts

- 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).

### Formative Assessments

*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.

## Sample of Open Education Resources

[Soccer - Kick It](#): In this video, watch how two young soccer players investigate the relationship between the size of a player's leg and how far the ball can be kicked.

[It's All Downhill: Forces and Sports Lesson Plan](#): This lesson plan allows the learner to do free research to find information on a sport and the physics in that particular sport. This lesson references a streaming video from Discovery School. It is not entirely necessary to complete the lesson.

[Energy Skate Park: Basics](#): With this lesson, students learn about conservation of energy with a skateboarding simulation. Students build tracks, ramps, and jumps for the skater and view the kinetic energy, potential energy and friction as he moves. There are teacher-suggested lessons using the simulation.

[Energy: Different Kinds of Energy](#): Students use simulations to learn about potential and kinetic energy, how it is classified and how to calculate it.

## Teacher Professional Learning Resources

## 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
<p><b>Developing and Using Models</b></p> <ul style="list-style-type: none"> <li>Develop a model to describe unobservable mechanisms. (MS-PS3-2)</li> </ul> <p><b>Analyzing and Interpreting Data</b></p> <ul style="list-style-type: none"> <li>Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)</li> </ul> <p><b>Engaging in Argument from Evidence</b></p> <ul style="list-style-type: none"> <li>Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a</li> </ul>	<p><b>PS3.A: Definitions of Energy</b></p> <ul style="list-style-type: none"> <li>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)</li> <li>A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)</li> </ul> <p><b>PS3.B: Conservation of Energy and Energy Transfer</b></p> <ul style="list-style-type: none"> <li>When the motion energy of an object changes, there is inevitably some other change in energy at the same</li> </ul>	<p><b>Scale, Proportion, and Quantity</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>Systems and System Models</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>Energy and Matter</b></p>

<p>phenomenon. (MS-PS3-5)</p> <p><i>Connections to Nature of Science</i></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-5)</li> </ul>	<p>time. (MS-PS3-5)</p> <p><b>PS3.C: Relationship Between Energy and Forces</b></p> <ul style="list-style-type: none"> <li>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)</li> </ul>	<ul style="list-style-type: none"> <li>Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5)</li> </ul>
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# 8<sup>th</sup> Grade - Science



THE DIOCESE  
of ALEXANDRIA

## Unit 6: THERMAL ENERGY

## Summary

Instructional Days: 30

**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

- 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.

### Formative Assessment

*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 device 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 device must operate on either side of the Moon (<https://spaceflight systems.grc.nasa.gov/education/rocket/moon.html>).

#### Concepts

- 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 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.

#### Formative Assessment

- 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 in order to improve them.
  - Use a systematic process for evaluating solutions with respect to how well they meet criteria and constraints.

### Sample of Open Education Resources

[Energy Forms and Changes](#): Explore how heating and cooling iron, brick, and water adds or removes energy. See how energy is transferred between objects. Build your own system, with energy sources, changers, and users. Track and visualize how energy flows and changes through your system.

[States of Matter](#): Watch different types of molecules form a solid, liquid, or gas. Add or remove heat and watch the phase change. Change the temperature or volume of a container and see a pressure-temperature diagram respond in real time. Relate the interaction potential to the forces between molecules.

### Teacher Professional Learning Resources

## 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
<p><a href="#">Planning and Carrying Out Investigations</a></p> <ul style="list-style-type: none"> <li>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</li> </ul>	<p><a href="#">PS3.A: Definitions of Energy</a></p> <ul style="list-style-type: none"> <li>Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4)</li> </ul>	<p><a href="#">Scale, Proportion, and Quantity</a></p> <ul style="list-style-type: none"> <li>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-PS3-4)</li> </ul> <p><a href="#">Energy and Matter</a></p>

<p>are needed to support a claim. (MS-PS3-4)</p> <p><b><u>Constructing Explanations and Designing Solutions</u></b></p> <ul style="list-style-type: none"> <li>Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)</li> </ul> <p><b><u>Asking Questions and Defining Problems</u></b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b><u>Developing and Using Models</u></b></p> <ul style="list-style-type: none"> <li>Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)</li> </ul> <p><b><u>Analyzing and Interpreting Data</u></b></p> <ul style="list-style-type: none"> <li>Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)</li> </ul> <p><b><u>Engaging in Argument from Evidence</u></b></p> <ul style="list-style-type: none"> <li>Evaluate competing design</li> </ul>	<p><b><u>PS3.B: Conservation of Energy and Energy Transfer</u></b></p> <ul style="list-style-type: none"> <li>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)</li> <li>Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)</li> </ul> <p><b><u>ETS1.A: Defining and Delimiting Engineering Problems</u></b></p> <ul style="list-style-type: none"> <li>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)</li> </ul> <p><b><u>ETS1.B: Developing Possible Solutions</u></b></p> <ul style="list-style-type: none"> <li>A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)</li> <li>There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-</li> </ul>	<ul style="list-style-type: none"> <li>The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3)</li> </ul> <p><b><u>Influence of Science, Engineering, and Technology on Society and the Natural World</u></b></p> <ul style="list-style-type: none"> <li>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)</li> <li>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)</li> </ul>
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<p>solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)</p>	<p>2), (MS-ETS1-3)</p> <ul style="list-style-type: none"><li>• Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)</li><li>• Models of all kinds are important for testing solutions. (MS-ETS1-4)</li></ul> <p><u><a href="#">ETS1.C: Optimizing the Design Solution</a></u></p> <ul style="list-style-type: none"><li>• 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)</li><li>• 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)</li></ul>	
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# 8<sup>th</sup> Grade - Science



THE DIOCESE  
of ALEXANDRIA

Unit 7: ELECTROMAGNETIC SPECTRUM

Summary

Instructional Days: 20

## 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	
<b>Part A: Why do surfers love physicists?</b>	
Concepts	Formative Assessments
<ul style="list-style-type: none"> <li>• A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude.</li> <li>• Describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.</li> <li>• Graphs and charts can be used to identify patterns in data.</li> <li>• Waves can be described with both qualitative and quantitative thinking.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Use mathematical representations to describe a simple model.</li> </ul>
Unit Sequence	
<b>Part B: How do the light and sound system in the auditorium work?</b>	
Concepts	Formative Assessments
<ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media.</li> <li>• Waves are reflected, absorbed, or transmitted through various materials.</li> <li>• A sound wave needs a medium through which it is transmitted.</li> <li>• Because light can travel through space, it cannot be a matter wave, like sound or water waves.</li> <li>• 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.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>• Develop and use models to describe the movement of waves in various materials.</li> </ul>

Unit Sequence	
<b>Part C: If rotary phones worked for my grandparents, why did they invent cell phones?</b>	
Concepts	Formative Assessments
<ul style="list-style-type: none"> <li>Structures can be designed to use properties of waves to serve particular functions.</li> <li>Waves can be used for communication purposes.</li> <li>Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information than are analog signals.</li> <li>Wave-related technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations.</li> </ul>	<p><i>Students who understand the concepts can:</i></p> <ul style="list-style-type: none"> <li>Integrate qualitative scientific and technical information in written 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.</li> </ul>

Sample of Open Education Resources
<p><a href="#">Waves on a String</a>: With this simulation (from PHeT), students explore the properties of waves and the behavior of waves through varying mediums and at reflective endpoints. There is a teacher's guide and suggested lessons on related topics that incorporate the simulation.</p> <p><a href="#">Sound Waves</a>: Students will learn about frequency, amplitude, how to calculate the speed of sound, and sound waves.</p> <p><a href="#">Electromagnetic Math</a> is designed to supplement teaching about electromagnetism. Students explore the simple mathematics behind light and other forms of electromagnetic energy including the properties of waves, wavelength, frequency, the Doppler shift, and the various ways that astronomers image the universe across the electromagnetic spectrum to learn more about the properties of matter and its movement. This collection of 84 problems provides a variety of practical application in mathematics and science concepts including proportions, analyzing graphs, evaluating functions, the inverse-square law, parts of a wave, types of radiation, and energy. Each one-page assignment includes background information. One-page answer keys accompany the assignments.</p>

Teacher Professional Learning Resources

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

Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. *[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]* [\(MS-ESS2-4\)](#)

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
<p><b>Using Mathematics and Computational Thinking</b></p> <ul style="list-style-type: none"> <li>Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1)</li> </ul> <p><b>Developing and Using Models</b></p> <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena. (MS-PS4-2)</li> </ul> <p><b>Obtaining, Evaluating, and Communicating Information</b></p>	<p><b>PS4.A: Wave Properties</b></p> <ul style="list-style-type: none"> <li>A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1)</li> <li>A sound wave needs a medium through which it is transmitted. (MS-PS4-2)</li> </ul> <p><b>PS4.B: Electromagnetic Radiation</b></p> <ul style="list-style-type: none"> <li>When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the</li> </ul>	<p><b>Patterns</b></p> <ul style="list-style-type: none"> <li>Graphs and charts can be used to identify patterns in data. (MS-PS4-1)</li> </ul> <p><b>Structure and Function</b></p> <ul style="list-style-type: none"> <li>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)</li> <li>Structures can be designed to serve particular functions. (MS-PS4-3)</li> </ul>

<ul style="list-style-type: none"> <li>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)</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Scientific Knowledge is Based on Empirical Evidence</b></p> <ul style="list-style-type: none"> <li>Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS4-1)</li> </ul>	<p>frequency (color) of the light. (MS-PS4-2)</p> <ul style="list-style-type: none"> <li>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)</li> <li>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)</li> <li>However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2)</li> </ul> <p><b>PS4.C: Information Technologies and Instrumentation</b></p> <ul style="list-style-type: none"> <li>Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)</li> </ul>	<p><b>Connections to Engineering, Technology, and Applications of Science</b></p> <p><b>Influence of Science, Engineering, and Technology on Society and the Natural World</b></p> <ul style="list-style-type: none"> <li>Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3)</li> </ul> <p><b>Connections to Nature of Science</b></p> <p><b>Science is a Human Endeavor</b></p> <ul style="list-style-type: none"> <li>Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)</li> </ul>
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