CATHOLIC SCHOOLS

Communities of Faith, Knowledge and Service

Science

Grade 7

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.

Barbara Forest, M.A.
Courtney Gistorb, M.Ed.

Denese Carter, M.Ed.
Tracy Bock, Ed.S.

Frameworks

THE DIOCESE of ALEXANDRIA

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)

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 1: STRUCTURE AND PROPERTIES OF MATTER	Summary	Instructional Days: 20

How is it that everything is made of star dust?

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

Student Learning Objectives

Develop models to describe the atomic composition of simple molecules and extended structures. *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms. The substructure of atoms and the periodic table are learned in high school chemistry.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]* **(MS-PS1-1)**

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. *[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]* **(MS-PS1-2)**

<table>
<tr><th colspan="2">Unit Sequence</th></tr>
<tr><td colspan="2">Part A: If the universe is not made of Legos®, then what is it made of?</td></tr>
<tr><th>Concepts</th><th>Formative Assessment</th></tr>
<tr><td>

Substances are made from different types of atoms.
✓ Atoms are the basic units of matter.
Substances combine with one another in various ways.
✓ Molecules are two or more atoms joined together.
Atoms form molecules that range in size from two to thousands of atoms.
✓ Molecules can be simple or very complex.
Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).

</td><td>
Students who understand the concepts are able to:

Develop a model of a simple molecule.
Use the model of the simple molecule to describe its atomic composition.
Develop a model of an extended structure.
Use the model of the extended structure to describe its repeating subunits.
[Boundary: The substructure of atoms and the periodic table are learned in high school chemistry.]

</td></tr>
<tr><th colspan="2">Unit Sequence</th></tr>
<tr><td colspan="2">Part B: Is it possible to tell if two substances mixed or if they reacted with each other?</td></tr>
<tr><th>Concepts</th><th>Formative Assessments</th></tr>
<tr><td>

Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
Substances react chemically in characteristic ways.
In a chemical process, the atoms that make up the original substances are regrouped into different molecules; these new substances have different properties from those of the reactants.
The analysis of data on the properties of products and reactants can be used to determine whether a chemical process has occurred.
Density, melting point, boiling point, solubility, flammability, and odor are characteristic properties that can be used to identify a pure substance.
Macroscopic patterns are related to the nature of the atomic-level structure of a substance.

</td><td>
Students who understand the concepts are able to:

Analyze and interpret data to determine similarities and differences from results of chemical reactions between substances before and after they undergo a chemical process.
Analyze and interpret data on the properties of substances before and after they undergo a chemical process.
Identify and describe possible correlation and causation relationships evidenced in chemical reactions.
Make logical and conceptual connections between evidence that chemical reactions have occurred and explanations of the properties of substances before and after they undergo a chemical process.

</td></tr>
</table>

Sample of Open Education Resources
Middle school Chemistry, Chapter 1: Solids, Liquids, and Gases Students are introduced to the idea that matter is composed of atoms and molecules that are attracted to each other and in constant motion. Students explore the attractions and motion of atoms and molecules as they experiment with and observe the heating and cooling of a solid, liquid, and gas. Middle school Chemistry, Chapter 2: Changes of State Students help design experiments to test whether the temperature of water affects the rate of evaporation and whether the temperature of water vapor affects the rate of condensation. Students also look in more detail at the water molecule to help explain the state changes of water. (all activities/lessons) States of Matter: Use interactive computer models to trace an atom's trajectory at a certain physical stage, and investigate how molecular behavior is responsible for the substance's state. Molecular View of a Solid: Explore the structure of a solid at the molecular level. Molecules are always in motion, though molecules in a solid move slowly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts. Molecular View of a Liquid: Explore the structure of a liquid at the molecular level. Molecules are always in motion. Molecules in a liquid move moderately. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts. Molecular View of a Gas: Explore the structure of a gas at the molecular level. Molecules are always in motion. Molecules in a gas move quickly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts. http://nextgenscience.org/sites/ngss/files/Appendix D Diversity and Equity 6-14-13.pdf

Teacher Professional Learning Resources

Appendix A: NGSS and Foundations for the Unit		
Develop models to describe the atomic composition of simple molecules and extended structures. *[Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms. The substructure of atoms and the periodic table are learned in high school chemistry.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete depiction of all individual atoms in a complex molecule or extended structure.]* **(MS-PS1-1)**		
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. *[Clarification Statement: Examples of reactions could include burning sugar or steel wool, fat reacting with sodium hydroxide, and mixing zinc with hydrogen chloride.] [Assessment Boundary: Assessment is limited to analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]* **(MS-PS1-2)**		
The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models • Develop a model to predict and/or describe phenomena. (MS-PS1-1) **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)	**PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-2)	**Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (MS-PS1-1) **Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2)

	PS1.B: Chemical Reactions Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2)	

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 2: INTERACTION OF MATTER	Summary	Instructional Days: 20

How can we trace synthetic materials back to natural ingredients?

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

Student Learning Objectives

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. *[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]* **(MS-PS1-3)**

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. *[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]* **(MS-PS1-4)**

Unit Sequence	
Part A: *How can you tell what the molecules are doing in a substance?*	
Concepts	**Formative Assessment**
• Changes in particle motion, temperature, and state of a pure substance occur when thermal energy is added or removed. • Qualitative molecular-level models of solids, liquids, and gases can be used to show that adding or removing thermal energy increases or decreases the kinetic energy of the particles until a change of state occurs. • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. • In a liquid, the molecules are constantly in contact with others. • In a gas, the molecules are widely spaced except when they happen to collide. • In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. • The changes of state that occur with variations in temperature or pressure can be described and predicted using models of matter. • The term heat as used in everyday language refers both to thermal energy and the transfer of that thermal energy from one object to another. • Thermal energy is the motion of atoms or molecules within a substance. • In science, heat is used to refer to the energy transferred due to the temperature difference between two objects. • The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). • The details of the relationship between the average internal kinetic energy and the potential energy per atom	*Students who understand the concepts are able to:* • Develop a model that predicts and describes changes in particle motion that could include molecules or inert atoms or pure substances. • Use cause-and-effect relationships to predict changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural or designed systems.

or molecule depend on the type of atom or molecule and the interactions among the atoms in the material. • Temperature is not a direct measure of a system's total thermal energy. • The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. • Cause-and-effect relationships may be used to predict and describe changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed in natural systems.	

Unit Sequence	
Part B: *How can we trace synthetic materials back to natural ingredients?*	
Concepts	**Formative Assessment**
• Each pure substance has characteristic physical and chemical properties that can be used to identify it. • Substances react chemically in characteristic ways. • In a chemical process, the atoms that make up the original substances are regrouped into different molecules. • New substances that result from chemical processes have different properties from those of the reactants. • Natural resources can undergo a chemical process to form synthetic material. • Structures can be designed to serve particular functions by taking into account properties of different materials and how materials can be shaped and used. • Engineering advances have led to discoveries of important synthetic materials, and scientific discoveries have led to the development of entire industries and engineered systems using these materials. • Technology use varies from region to region and over time. • The uses of technologies (engineered/synthetic materials) and any limitations on their use are driven by individual or societal needs, desires, and values. • The uses of technologies (engineered/synthetic materials) and any limitations on their use are driven by the findings of scientific research and by differences in such factors as climate, natural resources, and economic conditions.	*Students who understand the concepts are able to:* • Obtain, evaluate, and communicate information to show that synthetic materials come from natural resources and affect society. • Gather, read, and synthesize information about how synthetic materials formed from natural resources affect society. • Assess the credibility, accuracy, and possible bias of each publication and methods used within the publication. • Describe how information about how synthetic materials formed from natural resources affect society is supported or not supported by evidence.

Sample of Open Education Resources
Middle school Chemistry, Chapter 1: Solids, Liquids, and Gases Students are introduced to the idea that matter is composed of atoms and molecules that are attracted to each other and in constant motion. Students explore the attractions and motion of atoms and molecules as they experiment with and observe the heating and cooling of a solid, liquid, and gas. Middle school Chemistry, Chapter 2: Changes of State Students help design experiments to test whether the temperature of water affects the rate of evaporation and whether the temperature of water vapor affects the rate of condensation. Students also look in more detail at the water molecule to help explain the state changes of water. States of Matter: Use interactive computer models to trace an atom's trajectory at a certain physical stage, and investigate how molecular behavior is responsible for the substance's state. http://nextgenscience.org/sites/ngss/files/Appendix D Diversity and Equity 6-14-13.pdf Molecular View of a Gas: Explore the structure of a gas at the molecular level. Molecules are always in motion. Molecules in a gas move quickly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts. Molecular View of a Liquid: Explore the structure of a liquid at the molecular level. Molecules are always in motion. Molecules in a liquid move moderately. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts. Molecular View of a Solid: Explore the structure of a solid at the molecular level. Molecules are always in motion, though molecules in a solid move slowly. All molecules are attracted to each other. Molecules can be weakly or strongly attracted to each other. The way that large molecules interact in physical, chemical and biological applications is a direct consequence of the many tiny attractions of the smaller parts.

Teacher Professional Learning Resources

Appendix A: NGSS and Foundations for the Unit		
Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. *[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form the synthetic material. Examples of new materials could include new medicine, foods, and alternative fuels.] [Assessment Boundary: Assessment is limited to qualitative information.]* **(MS-PS1-3)**		
Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. *[Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]* **(MS-PS1-4)**		
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**
Obtaining, Evaluating, and Communicating Information • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or not supported by evidence. (MS-PS1-3) **Developing and Using Models** Develop a model to predict and/or describe phenomena. (MS-PS1-4)	**PS1.A: Structure and Properties of Matter** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) • Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) • In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4) **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the	**Structure and Function** • Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) **Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** • Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and

	original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-2),(MS-PS1-3) **PS3.A: Definitions of Energy** • The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. *(secondary to MS-PS1-4)* • The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. *(secondary to MS-PS1-4)*	engineered systems. (MS-PS1-3) **Influence of Science, Engineering and Technology on Society and the Natural World** • The uses of technologies and any limitation on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 3: INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS	Summary	Instructional Days: 25

What happens to ecosystems when the environment changes?

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

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

This unit is based on MS-LS2-4, MS-LS2-5, MS-ETS1-1, and MS-ETS1-3.

Student Learning Objectives

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. *[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]* **(MS-LS2-4)**

Evaluate competing design solutions for maintaining biodiversity and ecosystem services. * *[Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]* **(MS-LS2-5)**

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)

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 can a single change to an ecosystem disrupt the whole system?*	
Concepts	**Formative Assessment**
• Ecosystems are dynamic in nature. • The characteristics of ecosystems can vary over time. • Disruptions to any physical or biological component of an ecosystem can lead to shifts in all the ecosystem's populations. • Small changes in one part of an ecosystem might cause large changes in another part. • Patterns in data about ecosystems can be recognized and used to make warranted inferences about changes in populations. • Evaluating empirical evidence can be used to support arguments about changes to ecosystems.	*Students who understand the concepts are able to:* • Construct an argument to support or refute an explanation for the changes to populations in an ecosystem caused by disruptions to a physical or biological component of that ecosystem. Empirical evidence and scientific reasoning must support the argument. • Use scientific rules for obtaining and evaluating empirical evidence. • Recognize patterns in data and make warranted inferences about changes in populations. • Evaluate empirical evidence supporting arguments about changes to ecosystems.

Unit Sequence	
Part B: *What limits the number and variety of living things in an ecosystem?*	
Concepts	**Formative Assessment**
• Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. • The completeness, or integrity, of an ecosystem's biodiversity is often used as a measure of its health. • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines. • Changes in biodiversity can influence ecosystem services that humans rely on. • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • A solution needs to be tested and then modified on the basis of the test results, in order to improve it. • Models of all kinds are important for testing solutions. • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. • Small changes in one part of a system might cause large changes in another part. • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.	*Students who understand the concepts are able to:* • Construct a convincing argument that supports or refutes claims for solutions about the natural and designed world(s). • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. • Create design criteria for design solutions for maintaining biodiversity and ecosystem services. • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.

Sample of Open Education Resources
In Exploring the "Systems" in Ecosystems, students are introduced to the concept of an ecosystem, and explore how to analyze ecosystems using a systems thinking approach. A class discussion brings out students' ideas about ecosystems and introduces basic information about the components and processes of ecosystems. Next, students encounter a hypothetical ecosystem and gain experience analyzing it the way scientists do. Students then select a local ecosystem and apply what they have learned to analyze it. Finally, students extend their understanding by characterizing three different types of ecosystems and describing their components and processes. The Flow of Matter and Energy in Ecosystems SciPack explores the systemic interplay and flow of matter and energy throughout ecosystems, populations and organisms. Energy from the sun is the direct or indirect source of energy for nearly all organisms, it can flow only in one direction through ecosystems: from the sun to producers, to consumers, and finally to decomposers. Unlike the unidirectional transformation of energy, matter cycles among ecosystem components. One key ecosystem function, the cycling of carbon from non-living to living components and back, serves as a primary example in this SciPack for how all nutrients cycle on Earth. Webs and pyramids are used to model and communicate about the transfer of energy and cycling of matter within an ecosystem, representing how the total living biomass stays roughly constant—cycling materials from old to new life—accompanied by an irreversible flow of energy from captured sunlight into dissipated heat. **Problem Based Learning Scenario** You are a cargo inspection agent working in Guam to prevent the introduction of non-native species to your island. People coming into your territory often do not understand why you must spend so much time checking their cargo. Working in small groups, develop a public service announcement and media campaign to explain to the public how devastating the introduction of non-native species can be to an island ecosystem. Research how the region has been affected by invasive species. Connect with experts in the field to further your understandings. Use video clips, podcasts, and other authentic media to help explain the impact. Focus your message on how non-native species can become invasive and affect the biodiversity of the island. **Resources** Annenberg Media's Teachers' Resources offer short video courses covering essential science content for teachers. http://www.learner.org/resources/series179.html National Invasive Species Information Center (NISIC) provides data and information regarding invasive species, including covering Federal, State, local, and international sources. This site supports the performance assessment associated with the CPI. http://www.invasivespeciesinfo.gov/

Teacher Professional Learning Resources

Appendix A: NGSS and Foundations for the Unit		
Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. *[Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.]* **(MS-LS2-4)**		
Evaluate competing design solutions for maintaining biodiversity and ecosystem services. * *[Clarification Statement: Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.]* **(MS-LS2-5)**		
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)		
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 Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Engaging in Argument from Evidence • Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-LS2-4) • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5) **Asking Questions and Defining Problems** • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations. (MS-LS2-4) • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. (MS-LS2-5) **LS4.D: Biodiversity and Humans** • Changes in biodiversity can influence humans' resources, such	**Stability and Change** • Small changes in one part of a system might cause large changes in another part. (MS-LS2-4),(MS-LS2-5) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The use 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

knowledge that may limit possible solutions. (MS-ETS1-1) **Developing and Using Models** • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4) **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3)	as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. (secondary to MS-LS2-5) **ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary to MS-LS2-5)* **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3)	technology use varies from region to region and over time. (MS-LS2-5) ***Connections to Nature of Science*** **Scientific Knowledge Assumes an Order and Consistency in Natural Systems** • Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. (MS-LS2-3) **Scientific Knowledge is Based on Empirical Evidence** • Science disciplines share common rules of obtaining and evaluating empirical evidence. (MS-LS2-4) **Science Addresses Questions About the Natural and Material World** • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5)

	• Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3)	

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 4: FORCE AND MOTION	Summary	Instructional Days: 25

How can we predict the motion of an object?

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

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

Student Learning Objectives

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * *[Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]* **(MS-PS2-1)**

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. *[Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]* **(MS-PS2-2)**

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1)

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2)

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MS-ETS1-4)

<table>
<tr><th colspan="2">Unit Sequence</th></tr>
<tr><td colspan="2">Part A: How does a sailboat work?</td></tr>
<tr><th>Concepts</th><th>Formative Assessment</th></tr>
<tr><td>

For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton’s third law).
Models can be used to represent the motion of objects in colliding systems and their interactions, such as inputs, processes, and outputs, as well as energy and matter flows within systems.
The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values, by the findings of scientific research and by differences in such factors as climate, natural resources, and economic conditions.
The more precisely a design task’s criteria and constraints can be defined, the more likely it is that the designed solution will be successful.
Specification of constraints includes consideration of scientific principles and other relevant knowledge, which are likely to limit possible solutions.

</td><td>
Students who understand the concepts are able to:

Apply Newton’s third law to design a solution to a problem involving the motion of two colliding objects.
Define a design problem involving the motion of two colliding objects that can be solved through the development of an object, tool, process, or system and that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
Evaluate competing design solutions involving the motion of two colliding objects based on jointly developed and agreed-upon design criteria.
Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.
Analyze and interpret data to determine similarities and differences in findings.

</td></tr>
</table>

Unit Sequence	
Part B: *Who can build the fastest sailboat?*	
Concepts	**Formative Assessment**
• The change in an object's motion depends on balanced (Newton's first law) and unbalanced forces in a system Evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object includes qualitative comparisons of forces, mass, and changes in motion (Newton's second law); frame of reference; and specification of units • The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. • The greater the mass of the object, the greater the force needed to achieve the same change in motion. • For any given object, a larger force causes a larger change in motion. • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.	*Students who understand the concepts are able to:* • Plan an investigation individually and collaboratively to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. • Design an investigation and identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. • Make logical and conceptual connections between evidence and explanations. • Examine the changes over time and forces at different scales to explain the stability and change in designed systems.

Sample of Open Education Resources
Force and Motion is a teacher-submitted, NGSS-mindful lesson plan for using the PhET model "Forces and Motion - Basics". The model uses a tug-of-war with participants of different sizes and strengths, placed different distances from the center, in order to show how forces can combine in different ways to affect the motion of an object. The lesson itself includes a framing question, several investigations, and a request to back up a claim with evidence. NOTE: the web page given above is not itself the resource. The web page provides a link to a downloadable Microsoft Word document of the lesson plan, which is the resource. Seeing Motion: Students explore straight-line motion using a motion sensor to generate distance versus time graphs of your own motion. Learn how changes in speed and direction affect the graph, and gain an understanding of how motion can be represented on a graph.
Teacher Professional Learning Resources

Appendix A: NJSLS-S and Foundations for the Unit		
Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * *[Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.]* **(MS-PS2-1)**		
Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. *[Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.]* **(MS-PS2-2)**		
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1)		
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2)		
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)		
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MS-ETS1-4)		
The Student Learning Objectives above were developed using the following elements from the NRC document ***A Framework for K-12 Science Education***:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Planning and Carrying Out Investigations • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2)	**PS2.A: Forces and Motion** • For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1) • The motion of an object is determined by the sum of the forces	**Systems and System Models** • Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1) **Stability and Change** • Explanations of stability and change in natural or designed systems can

Constructing Explanations and Designing Solutions • Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1) **Asking Questions and Defining Problems** • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. (MS-ETS1-1) **Engaging in Argument from Evidence** Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-ETS1-2)	acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2) • All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2) **ETS1.A: Defining and Delimiting Engineering Problems** • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2) • A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4)	be constructed by examining the changes over time and forces at different scales. (MS-PS2-2) ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-PS2-1) • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-ETS1-1)

	• There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) • Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 5: TYPES OF INTERACTIONS	Summary	Instructional Days: 25

Is it possible to exert on an object without touching it?

Students use *cause and effect*; *system and system models*; and *stability and change* to understand ideas that explain why some materials are attracted to each other while others are not. Students apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while others repel. In particular, students develop understandings that gravitational interactions are always attractive but that electrical and magnetic forces can be both attractive and negative. Students also develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields. Students are expected to consider the influence of science, engineering, and technology on society and the natural world. Students are expected to demonstrate proficiency in *asking questions*, *planning and carrying out investigations*, *designing solutions*, and *engaging in argument*. Students are also expected to use these practices to demonstrate understanding of the core ideas.

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

Student Learning Objectives

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. *[Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]* **(MS-PS2-5)**

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. *[Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]* **(MS-PS2-3)**

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. *[Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]* **(MS-PS2-4)**

Unit Sequence	
Part A: *Can you apply a force on something without touching it?*	
Concepts	**Formative Assessment**
• Fields exist between objects that exert forces on each other even though the objects are not in contact. • The interactions of magnets, electrically charged strips of tape, and electrically charged pith balls are examples of fields that exist between objects exerting forces on each other, even though the objects are not in contact. • Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object or a ball, respectively). • Cause-and-effect relationships may be used to predict phenomena in natural or designed systems.	*Students who understand the concepts are able to:* • Students will conduct an investigation and evaluate an experimental design to produce data that can serve as the basis for evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. • Students will identify the cause-and-effect relationships between fields that exist between objects and the behavior of the objects.

Unit Sequence	
Part B: *How does a Maglev train work?*	
Concepts	**Formative Assessment**
• Factors affect the strength of electric and magnetic forces. • Devices that use electric and magnetic forces could include electromagnets, electric motors, and generators. • Electric and magnetic (electromagnetic) forces can be attractive or repulsive. • The size of an electric or magnetic (electromagnetic) force depends on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. • Cause-and-effect relationships may be used to predict the factors that affect the strength of electrical and magnetic forces in natural or designed systems.	*Students who understand the concepts are able to:* • Students will ask questions about data to determine the effect of the strength of electric and magnetic forces that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. • Students will perform investigations using devices that use electromagnetic forces. • Students will collect and analyze data that could include the effect of the number of turns of wire on the strength of an electromagnet or the effect of increasing the number or strength of magnets on the speed of an electric motor.

Unit Sequence	
Part C: *If I were able to eliminate air resistance and dropped a feather and a hammer at the same time, which would land first?*	
Concepts	**Formative Assessment**
• Gravitational interactions are always attractive and depend on the masses of interacting objects. • There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass. • Evidence supporting the claim that gravitational interactions are attractive and depend on the masses of interacting objects could include data generated from simulations or digital tools and charts displaying mass, strength of interaction, distance from the sun, and orbital periods of objects within the solar system.	*Students who understand the concepts are able to:* • Students construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. • Students use models to represent the gravitational interactions between two masses.

Sample of Open Education Resources
Electromagnetic Power! Students investigate the characteristics of electromagnetism and then use what they learn to plan and conduct an experiment on electromagnets. Inspector Detector Challenge: Students use the engineering design process to design and build magnetic-field detectors, and use them to find hidden magnets. Parallels are drawn to real-world NASA missions and how NASA scientists use magnetic field data from planets and moons. The website has video clips, teaching suggestions, a student handout, and a link to the pdf of the Teacher's Guide for Mission: Solar System. The Inspector Detector challenge is a series of activities that form a unit in the Mission: Solar System collection. * NOTE: The Teacher's Guide does not contain the lesson plan. You will need to click on the Student Handout heading of the website to download the "Inspector Detector Challenge Leader's Notes". Or you can go to the Design Squad webpage.

Teacher Professional Learning Resources

Appendix A: NGSS and Foundations for the Unit

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. *[Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.] [Assessment Boundary: Assessment is limited to electric and magnetic fields, and is limited to qualitative evidence for the existence of fields.]* **(MS-PS2-5)**

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. *[Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor.] [Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.]* **(MS-PS2-3)**

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. *[Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system.] [Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.]* **(MS-PS2-4)**

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Using Mathematics and Computational Thinking • Use mathematical representations of phenomena to describe explanations. (HS-PS2-4) **Constructing Explanations and Designing Solutions** • Apply scientific ideas to solve a design problem, taking into account possible unanticipated effects. (HS-PS2-3) **Planning and Carrying Out Investigations** • Plan and conduct an investigation individually and collaboratively to	**PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-4) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-4)	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. (HS-PS2-4) **Cause and Effect** • Systems can be designed to cause a desired effect. (HS-PS2-3) • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-PS2-5)

produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS2-5)	**PS2.A: Forces and Motion** • If a system interacts with objects outside itself, the total momentum of the system can change; however, any such change is balanced by changes in the momentum of objects outside the system. (HS-PS2-3) **ETS1.A: Defining and Delimiting an Engineering Problem** • Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (secondary) (HS-PS2-3) **ETS1.C: Optimizing the Design Solution** • Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *(secondary HS-PS2-3)* **PS2.B: Types of Interactions** • Newton's law of universal gravitation and Coulomb's law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. (HS-PS2-5) • Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space.	***Connections to Nature of Science*** **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Theories and laws provide explanations in science. (HS-PS2-4) • Laws are statements or descriptions of the relationships among observable phenomena. (HS-PS2-4)

	Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields. (HS-PS2-5) **PS3.A: Definitions of Energy** • "Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents. *(secondary HS-PS2-5)*	

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 6: ASTRONOMY	Summary	Instructional Days: 20

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

This unit is based on MS-ESS1-1, MS-ESS1-2, and MS-ESS1-3.

Student Learning Objectives

Generate and analyze evidence (through simulations or long term investigations) to explain why the Sun's apparent motion across the sky changes over the course of a year. (ESS1.B) *[Clarification Statement: This SLO is based on a disciplinary core idea found in the Framework. It is included as a scaffold to the following SLO.]*

Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. *[Clarification Statement: Examples of models can be physical, graphical, or conceptual.]* **(MS-ESS1-1)**

Develop and use a model that shows how gravity causes smaller objects to orbit around larger objects at increasing scales, including the gravitational force of the sun causes the planets and other bodies to orbit around it holding together the solar system. (ESS1.A; ESS1.B) *[Clarification Statement: This SLO is based on disciplinary core ideas found in the Framework. It is included as a scaffold to the following SLO.]*

Analyze and interpret data to determine scale properties of objects in the solar system. *[Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]* **(MS-ESS1-3)**

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. *[Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]* **(MS-ESS1-2)**

Unit Sequence	
Part A: *What pattern in the Earth–sun–moon system can be used to explain lunar phases, eclipses of the sun and moon, and seasons?*	
Concepts	**Formative Assessment**
• Patterns in the apparent motion of the sun, moon, and stars in the sky can be observed, described, predicted, and explained with models. • The Earth and solar system model of the solar system can explain eclipses of the sun and the moon. • Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. • The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. • Patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky. • Science assumes that objects and events in the solar system systems occur in consistent patterns that are understandable through measurement and observation.	*Students who understand the concepts are able to:* • Students will develop and use a physical, graphical, or conceptual model to describe patterns in the apparent motion of the sun, moon, and stars in the sky.

<table>
<tr><th colspan="2">Unit Sequence</th></tr>
<tr><td colspan="2">Part B: What is the role of gravity in the motions within galaxies and the solar system?</td></tr>
<tr><th>Concepts</th><th>Formative Assessment</th></tr>
<tr><td>
Gravity plays a role in the motions within galaxies and the solar system.
Gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them.
Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.
The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them.
The solar system appears to have formed from a disk of dust and gas, drawn together by gravity.
Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system.
Science assumes that objects and events in the solar systems occur in consistent patterns that are understandable through measurement and observation.
</td><td>Students who understand the concepts are able to:
Students develop and use models to explain the relationship between the tilt of Earth’s axis and seasons.
</td></tr>
</table>

Unit Sequence	
Part C: *What are the scale properties of objects in the solar system?*	
Concepts	**Formative Assessment**
• Objects in the solar system have scale properties. • Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects. • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. • · Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large. • · Engineering advances have led to important discoveries in space science, and scientific discoveries have led to the development of entire industries and engineered systems.	*Students who understand the concepts are able to:* • Analyze and interpret data to determine similarities and differences among objects in the solar system.

Sample of Open Education Resources
NASA Solar System Exploration: This link will connect you to NASA's Solar system Exploration website. The website offers a wide variety of student activities. Seasons Interactive provides students with the opportunity to investigate how Earth's angle of inclination affects three factors: the angle of incoming sunlight, average daily temperatures and the Sun's ecliptic path. Three preset values for the angle of inclination are available (corresponding to the values of Earth, Venus and Uranus). Additionally, users may select an angle value from a sliding scale. Users can control the speed of the simulation or may pause it when needed. Students are able to compare the heights of the ecliptic paths during the course of the year by checking the "Trace Sun's Path" box. From this information, students will be able to construct an explanation for the occurrence of seasons. Exercises with solutions are included, as well as a self-assessment located below the simulation. Teachers should be aware of several weaknesses in the simulation. First, the model allows students to reverse the motion of the Earth around the Sun which could lead to misconceptions. Secondly, the model overemphasizes the elliptical path of the Earth which often leads to the misconception that seasons are caused by distance from the Sun. Lastly, while the Sun is shown moving across the sky during the day (from Earth's view), the stars are left static during the night. In Eclipse Interactive, students investigate both lunar and solar eclipses by manipulating up to three independent variables: Moon's tilt from orbit, Earth-Moon distance and size of the Moon. By viewing the effects of changes to these variables, students will be able to construct explanations for solar and lunar eclipses. The model includes both top and side views of the Earth-Moon system during the Moon's revolution. In addition, students can toggle to show outlines of the Earth and Moon. Teachers should note that the simulation has been designed as a single screen model that automatically moves between solar and lunar eclipses without any indication of time. As a result, younger students may become confused and will need to be reminded about the duration of lunar months. The simulation includes bare-bones introductory content, how-to instructions, the interactive model itself, related exercises, and solutions to the exercises. One minor inconvenience is the lack of a reset button. The Pull of the Planets is part of a thematic series of lessons highlighting the Juno mission to Jupiter. It is a traditional hands-on activity that models how gravitational forces can keep planets and asteroids in orbit within the Solar System. Using a stretchable fabric held in place with an embroidery hoop, students work with spheres of various materials to explore how mass and sizes affect the strength of gravitational forces. Background materials, including a materials sheet, aid teachers in organizing this activity.

Teacher Professional Learning Resources

Appendix A: NGSS and Foundations for the Unit

Generate and analyze evidence (through simulations or long term investigations) to explain why the Sun's apparent motion across the sky changes over the course of a year. (ESS1.B)

Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. *[Clarification Statement: Examples of models can be physical, graphical, or conceptual.]* **(MS-ESS1-1)**

Develop and use a model that shows how gravity causes smaller objects to orbit around larger objects at increasing scales, including the gravitational force of the sun causes the planets and other bodies to orbit around it holding together the solar system. (ESS1.A; ESS1.B)

Analyze and interpret data to determine scale properties of objects in the solar system. *[Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.]* **(MS-ESS1-3)**

Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. *[Clarification Statement: Emphasis for the model is on gravity as the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them. Examples of models can be physical (such as the analogy of distance along a football field or computer visualizations of elliptical orbits) or conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state).] [Assessment Boundary: Assessment does not include Kepler's Laws of orbital motion or the apparent retrograde motion of the planets as viewed from Earth.]* **(MS-ESS1-2)**

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop and use a model to describe phenomena. (MS-ESS1-1),(MS-ESS1-2) **Analyzing and Interpreting Data** Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)	**ESS1.A: The Universe and Its Stars** • Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.	**ESS1.A: The Universe and Its Stars** • Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. (MS-ESS1-1) • Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.

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

7th Grade - Science

THE DIOCESE of ALEXANDRIA

Unit 7: WEATHER AND CLIMATE	Summary	Instructional Days: 20

What factors interact and influence weather and climate?

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

This unit is based on MS-ESS2-4, MS-ESS2-5, and MS-ESS2-6.

Student Learning Objectives

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

Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. *[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]* **(MS-ESS2-5)**

Explain how variations in density result from variations in temperature and salinity drive a global pattern of interconnected ocean currents. *[Note: This SLO is based on a disciplinary core idea found in the Framework. It is included as a scaffold to the following SLO.]* (ESS2.C)

Use a model to explain the mechanisms that cause varying daily temperature ranges in a coastal community and in a community located in the interior of the country. *[Note: This SLO is based disciplinary core ideas found in the Framework. It is included as a scaffold to the following SLO.]* (ESS2.C; ESS2.D)

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]* **(MS-ESS2-6)**

Unit Sequence	
Part A: *What are the processes involved in the cycling of water through Earth's systems?*	
Concepts	**Formative Assessment**
• Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. • Global movements of water and its changes in form are propelled by sunlight and gravity. • The cycling of water through Earth's systems is driven by energy from the sun and the force of gravity. • Within Earth's systems, the transfer of energy drives the motion and/or cycling of water.	*Students who understand the concepts are able to:* • Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. • Model the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle.

Unit Sequence	
Part B: *What is the relationship between the complex interactions of air masses and changes in weather conditions?*	
Concepts	**Formative Assessment**
• The motions and complex interactions of air masses result in changes in weather conditions. • The complex patterns of the changes in and movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. • Examples of data that can be used to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions include weather maps, diagrams, and visualizations; other examples can be obtained through laboratory experiments. • Air masses flow from regions of high pressure to regions of low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time. • Because patterns of the changes and the movement of water in the atmosphere are so complex, weather can only be predicted probabilistically. • Sudden changes in weather can result when different air masses collide. • Weather can be predicted within probabilistic ranges. • Cause-and effect-relationships may be used to predict changes in weather.	*Students who understand the concepts are able to:* • Collect data to serve as the basis for evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

<table>
<tr><th colspan="2">Unit Sequence</th></tr>
<tr><td colspan="2">Part C: What are the major factors that determine regional climates?</td></tr>
<tr><th>Concepts</th><th>Formative Assessment</th></tr>
<tr><td>

Unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.
Patterns of atmospheric and oceanic circulation that determine regional climates vary by latitude, altitude, and geographic land distribution.
Atmospheric circulation that, in part, determines regional climates is the result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds.
Ocean circulation that, in part, determines regional climates is the result of the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents.
Models that can be used to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates can be diagrams, maps and globes, or digital representations.

</td><td>
Students who understand the concepts are able to:

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

</td></tr>
</table>

Sample of Open Education Resources
Air Masses of a set of Level 1 activities designed by the Science Center for Teaching, Outreach, and Research on Meteorology (STORM) Project. The authors suggest that previous activities in the unit be completed before Activity 12: Air Masses, including those that address pressure systems and dew point temperature. In Activity 12, the students learn about the four main types of air masses that affect weather in the United States, their characteristic temperatures, and humidity levels as it relates to dew point temperatures. The lesson plan follows the 5E format. Initially, students discuss local weather and then examine surface temperature and dew point data on maps to determine patterns and possible locations of air masses. They learn about the source regions of air masses and compare their maps to a forecast weather map with fronts and pressure systems drawn in. During the Extension phase, students access current maps with surface and dew point temperatures at http://www.uni.edu/storm/activities/level1 and try to identify locations of air masses. They sketch in fronts and compare their results to the fronts map. Evaluation consists of collection of student papers. Ocean Currents and Sea Surface Temperature allows students to gather data using My NASA Data micro sets to investigate how differential heating of Earth results in circulation patterns in the oceans and the atmosphere that globally distribute the heat. They examine the relationship between the rotation of Earth and the circular motions of ocean currents and air. Students also make predictions based on the data to concerns about global climate change. They begin by examining the temperature of ocean's surface currents and ocean surface winds. These currents, driven by the wind, mark the movement of surface heating as monitored by satellites. Students explore the link between 1) ocean temperatures and currents, 2) uneven heating and rotation of Earth, 3) resulting climate and weather patterns, and 4) projected impacts of climate change (global warming). Using the Live Access Server, students can select data sets for various elements for different regions of the globe, at different times of the year, and for multiple years. The information is provided in maps or graphs which can be saved for future reference. Some of the data sets accessed for this lesson include Sea Surface Temperature, Cloud Coverage, and Sea Level Height for this lesson. The lesson provides directions for accessing the data as well as questions to guide discussion and learning. The estimated time for completing the activity is 50 minutes. Inclusion of the Extension activities could broaden the scope of the lesson to several days in length. Links to informative maps and text such as the deep ocean conveyor belt, upwelling, and coastal fog as needed to answer questions in the extension activities are included. Adopt a Drifter: Do Ocean Surface Currents Influence Climate? Students construct climographs showing both precipitation and temperature for 3 coastal cities and describe how ocean surface currents affect climate on nearby land. They are provided with the research question, "Do ocean currents influence climate?" and are asked to construct a hypothesis. The students are asked to read an introductory paragraph explaining the relationship between the temperature of the ocean current and temperature and precipitation on adjacent land and examine a map of major ocean currents. They construct 3 climographs using data provided. The labels on the graphs are not directly on the lines, so the teacher would need to instruct students on the placement of their data points. Conclusion and analysis questions are provided asking students to examine the direction of flow of ocean currents, temperature of the water, source regions of the current, and impact on both temperature and precipitation on coastal regions. Extension activities include researching additional information on vegetation, culture and physical geography of the 3 cities studied, plus comparing data for 2 additional cities. The activity should take 2 class periods.

Teacher Professional Learning Resources

Appendix A: NGSS and Foundations for the Unit
Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity. *[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]* **(MS-ESS2-4)**
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions. *[Clarification Statement: Emphasis is on how air masses flow from regions of high pressure to low pressure, causing weather (defined by temperature, pressure, humidity, precipitation, and wind) at a fixed location to change over time, and how sudden changes in weather can result when different air masses collide. Emphasis is on how weather can be predicted within probabilistic ranges. Examples of data can be provided to students (such as weather maps, diagrams, and visualizations) or obtained through laboratory experiments (such as with condensation).] [Assessment Boundary: Assessment does not include recalling the names of cloud types or weather symbols used on weather maps or the reported diagrams from weather stations.]* **(MS-ESS2-5)**
Explain how variations in density result from variations in temperature and salinity drive a global pattern of interconnected ocean currents. (ESS2.C)
Use a model to explain the mechanisms that cause varying daily temperature ranges in a coastal community and in a community located in the interior of the country. (ESS2.C; ESS2.D)
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. *[Clarification Statement: Emphasis is on how patterns vary by latitude, altitude, and geographic land distribution. Emphasis of atmospheric circulation is on the sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds; emphasis of ocean circulation is on the transfer of heat by the global ocean convection cycle, which is constrained by the Coriolis effect and the outlines of continents. Examples of models can be diagrams, maps and globes, or digital representations.] [Assessment Boundary: Assessment does not include the dynamics of the Coriolis effect.]* **(MS-ESS2-6)**
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)**

<table>
<tr><th colspan="3">The Student Learning Objectives above were developed using the following elements from the NRC document A Framework for K-12 Science Education:</th></tr>
<tr><th>Science and Engineering Practices</th><th>Disciplinary Core Ideas</th><th>Crosscutting Concepts</th></tr>
<tr>
<td>Developing and Using Models
Develop and use a model to describe phenomena. (MS-ESS2-6)
Develop a model to describe unobservable mechanisms. (MS-ESS2-4)
Planning and Carrying Out Investigations
Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. (MS-ESS2-5)</td>
<td>ESS2.C: The Roles of Water in Earth's Surface Processes
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. (MS-ESS2-4)
The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)
Global movements of water and its changes in form are propelled by sunlight and gravity. (MS-ESS2-4)
Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. (MS-ESS2-6)
ESS2.D: Weather and Climate
Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)</td>
<td>Cause and Effect
Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS2-5)
Systems and System Models
Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems. (MS-ESS2-6)
Energy and Matter
Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4)</td>
</tr>
</table>

	• Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) • The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)	