Weymouth Township
School District

Grade 6 Science Curriculum

Date Created: 08/18, Updated 07/22	
Board Approved: 08/2023	

Course Description:

Science in sixth grade consists of both physical and earth science. Topics include the following:

- **Science and Technology**: Students will review lab safety, practices used by scientists to make and classify observations, think critically, plan and carry out investigations, and the impact of science on everyday life. Tools and measurements will also be reviewed.
- **Introduction to Chemistry:** Students will review the properties and states of matter and model the structure and interactions of atoms. Students research and analyze the production and use of synthetic materials made from natural resources and their impacts on society.
- **Water and the Atmosphere:** Students will develop a model to describe the cycle of water through earth's systems and provide evidence for how the movement of air masses results in weather changes.
- **Astronomy and Space Science:** Students will develop models of motions throughout the solar system, the role of gravity in the motion of objects within galaxies and solar system

Pacing Guide		
Unit	**Core Ideas and Standard**	**Approximate Number of Days/90**
1: Science and Technology	**ETS1.A: Defining and Delimiting an Engineering Problem** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.(MS-ETS1-1) **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) Models of all kinds are important for testing solutions. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2) **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)	15

2: Structures and Properties of Matter	**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) **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)	10

3: Interactions of Matter	**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) **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)	10
4: Chemical Reactions	**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-PS1-5) ● The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) ● Some chemical reactions release energy, others store energy. (MS-PS1-6) **ETS1.B: Developing Possible Solutions** ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. *(secondary)* (MS-PS1-6) **ETS1.C: Optimizing the Design Solution** ● Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design. *(secondary)* (MS-PS1-6) ● The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary)* (MS-PS1-6)	10
5: Water and Atmosphere	**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. ● Global movements of water and its changes in form are propelled by sunlight and gravity. (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)	25

	• 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** • Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) **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) • 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)	
6: Astronomy and Space Science	**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** • 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 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) • The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS- ESS1-2)	20

Instructional Strategies
• Structure lessons around questions that are authentic, relate to students' interests, social/family background and knowledge of their community. • Provide students with multiple choices for how they can represent their understandings (e.g. multisensory techniques-auditory/visual aids; pictures, illustrations, graphs, charts, data tables, multimedia, modeling). • Provide opportunities for students to connect with people of similar backgrounds (e.g. conversations via digital tool such as SKYPE, experts from the community helping with a project, journal articles, and biographies). • Provide multiple grouping opportunities for students to share their ideas and to encourage work among various backgrounds and cultures (e.g. multiple representation and multimodal experiences). • Engage students with a variety of Science and Engineering practices to provide students with multiple entry points and multiple ways to demonstrate their understandings. • Use project-based science learning to connect science with observable phenomena. • Structure the learning around explaining or solving a social or community-based issue.

Instructional Modifications	
Special Needs: · Modified test items as needed · Allow extended time on assessments · Provide oral assessments · Assist students in preparing study guides · Allow use of references cards	*ELL:* · Assignments and assessments translated to native language · Provide multiple literacy strategies · Allow use of dictionary · Allow extra time for assignments and assessments · Modified test questions as necessary
At Risk: · Assist students in preparing study guides · Extra time for assignments · Modified tests	*Gifted:* · Enhanced expectations for deeper/extended understanding · Projects that extend the basic unit concepts

Unit 1: Science and Technology		
Essential Questions		
• *How do scientists investigate the natural world?* • *How do science and society affect each other?* • *How is mathematics important to the work of scientists?* • *How does technology affect our society?*		
Student Learning Objectives		
By the end of the course, students who demonstrate understanding can: 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)		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Asking Questions and Defining Problems Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, clarify arguments and models.	**ETS1.A: Defining and Delimiting an Engineering Problem** • 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	**Influence of Science, Engineering, and Technology on Society and the Natural World** • The uses of technologies and limitations on their use are driven by individual or societal needs,

• 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** Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world. • Evaluate competing design solutions based on jointly developed and agreed upon design criteria. (MS-ETS-1-2) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings. (MS-ETS1-3) **Developing and Using Models** Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. (MS-ETS1-4)	includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.(MS-ETS1-1) **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) Models of all kinds are important for testing solutions. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2) **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)	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) • 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)

Phenomena of Interest
● *So many careers involve science and technology.* ● *Science is a way of looking at the world, like art or philosophy.*

Learning Activities
By the time students reach middle school they should have had numerous experiences in engineering design. The goal for middle school students is to define problems more precisely, to conduct a more thorough process of choosing the best solution, and to optimize the final design. This unit will lay the groundwork for students to think like scientists and engineers during their secondary careers. The unit begins with students reviewing the nature of science, including vital vocabulary such as hypothesis, theory, controlled experiment, as well as lab safety. Activities on planning and carrying out investigations and constructing explanations will be practiced. Math skills such as graphing will be reviewed. Suggested activities include: ● **Science and Natural World:** Students will be using science practices to make observations and classify them (*Classifying Objects, How Keen Are Your Senses?),* think critically (*Thinking Like a Scientist, Using Scientific Thinking)*, plan and carry out investigations (*What's Happening?, Keeping Flowers Fresh)*, analyze data and draw conclusions (*Is It Really True?, Scientific Inquiry)*, and understand the difference between the scientific definitions of theories and laws (*Theories and Laws*). (MS-ETS1-3) ● **Safety in the Science Lab:** Students will report information on about the school's safety equipment in words and diagram form (*Where is the Safety Equipment in Your School?*), communicate the importance of lab safety (*Be Prepared*) and what should be done in case of an emergency *(Just in Case*). The topics now move to how science and society have influenced one another. Vocabulary to be introduced includes cost, benefit and opinion. Discussions will include what it means to be an informed consumer and citizen, and the role of scientific literacy in that process. Suggested activities: ● **Why Study Science?** By using observations to determine how common references to science are on the daily news, students will infer how important science is in everyday life, the level of truthfulness of a scientific claim, and their own level of scientific literacy (*How Much Do You See or Hear about Science?, Using Science, Posing Questions, Scientific Survey, Analyzing Claims, Sources of Information*). Students will explore a variety of career options in science, as well as the diversity of people within these fields (*What Do Scientists Do?, Careers in Science, What do Scientists Look Like? , Branches of Science)*. Students will practice working in teams like scientists and engineers, to solve a problem that they could not solve working alone *(Piecing Information Together)*, either as a direct or open inquiry activity.

Tools are necessary in all trades, and science is no exception. It is necessary to have scientists use common language, especially when discussing measurements. The tools and practices of science, including common SI units, mathematic skills, and the role of modeling will be reviewed.

Suggested activities:

- **Measurement--A Common Language:** Students will address the question "How is mathematics important to science?" through a number of activities. The importance of standard measurement will be reviewed (*History of Measurement, How Many Shoes?)*. Students will practice measuring and estimating answers (*Measuring Length in Metric, How Many Marble Are There?, For Good Measure)* and analyze their results (*How Close Is It?)*.
- **Graphs in Science:** The three activities here, *What's in a Picture, What's a Line Graph*, and *Density Graphs*, will help students explore the advantages of presenting data in graphs form, and why graphs are a powerful tool to communicate the results of scientific information.
- **Models as Tools in Science:** The activities in this lesson will allow students to understand the importance of modeling in science by building a scale model (*Scale Models*), representing objects that cannot be seen (*Making Models: Day and Night*), recognize how the parts of system work together to perform a function (*Systems*), and build and evaluate a model based on scientific information (*Models in Nature, Lead a Discussion: Model Storms*). (MS-ETS1-4)

Technology is how people solve practical problems and has an enormous impact on people's lives. Engineering is the use of science to solve those problems. Students will analyze the impact of technology on society. Important vocabulary in this area includes brainstorming, constraints, trade-offs, troubleshooting, and risk-benefit analysis. Students will also discuss a variety of engineering careers.

Suggested activities:

- **Understanding Technology:** The goals of technology will be explored (*What Are Some Examples of Technology, Classifying: Technology*), as well as how it has progressed (*Processing Words*), the components of a technological system (*Investigating a Technological System*) and how technology relates to science. (MS-ETS1-1)
- **Technological Design:** These activities will have students explore what is involved in a technological design and how designs change (*Why Redesign?*, *Watch Ideas Take Off, Lead a Discussion: Identifying Problems and Redesigning*). (MS-ETS1-2), (MS-ETS1-3)
- **Technology and Society:** How has technology changed over time? Students will explore how technology affects people's lives in positive and negative ways (*Technology Hunt, Time-Saving Technology, How Does Technology Affect Your LIfe?)*, as well as analyze its risks and benefits (*Considering Impacts*).(MS-ETS1-1)
- **Engineering:** Students will explore aspects of engineering as an application of science and technology (*What is Engineering?, Designing a Solution*). Students will identify branches of engineering and what the work of engineers involves (*Branches of Engineering, Advances in Transportation*). (MS-ETS1-3)

Formative Assessments	*Summative Assessments*	*Resources*
• Quizzes • Exit Tickets • Questioning Techniques • Performance on Learning Activities	Tests Lab Practicals Problem-Based Assessments	Textbook Lab Supplies Access to online resources Evidence Statements: ○ MS-ETS1-1 ○ MS-ETS1-2 ○ MS-ETS1-3 ○ MS-ETS1-4

Unit 2: Structure and Properties of Matter
Essential Questions
• *In what ways can we describe matter?* • *How does the structure of matter affect its properties?*
Student Learning Objectives
By the end of the course, students who demonstrate understanding can: **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.] [*Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.*] (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)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to predict and/or describe phenomena. (MS-PS1-1)	**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)	**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)

Analyzing and Interpreting Data Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)	● 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) **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)	**Patterns** ● Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

Phenomena of Interest

- *Water can exist in three phases all at once.*
- *My grandmother said when she was young that you had to shake milk to mix the cream into it.*
- *Both diamonds and coal are carbon, but they don't look alike.*

Learning Activities

Within this unit, students will use informational text and models (which can include student-generated drawings, 3-D ball-and-stick structures, or computer representations) to understand that matter is composed of atoms and molecules. These models should reflect that substances are made from different types of atoms. Student models can be manipulated to show that molecules can be disassembled into their various atoms and reassembled into new substances according to chemical reactions. This scientific knowledge can be used to explain the properties of substances. Students will examine and differentiate between physical and chemical properties of matter. They are limited to the analysis of the following characteristic properties: density, melting point, boiling point, solubility, flammability, and odor. This analysis of properties serves as evidence to support that chemical reactions of substances cause a rearrangement of atoms to form different molecules.

- **Quick Lab: Observing Physical Properties.** Students will observe and compare the physical properties of melting and freezing in the substance of water (Interactive Science)
- **Inquiry: How Do You Describe Matter?** Students observe, describe, and classify the properties of several different materials. (IS)
- 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
- **Quick Lab: Thick as Honey** Students compare the viscosity of liquids.
- **Quick Lab: Separating Mixtures** Students use the properties of substances to separate a mixture.
- **Quick Lab: Calculating Volume** Students learn two ways of calculating volume as a step towards calculating density of materials.
- **Lab: Making Sense of Density** Students find the mass and volume of a variety of objects to calculate and compare their densities and their properties.
- **Quick Lab: What Is a Physical Change?** Students observe paper chromatography as an example of a separation of a mixture.

Students will also recognize that they are using models to observe phenomena too small to be seen. Students who demonstrate this understanding can develop or modify a model of simple molecules to describe the molecules' atomic composition. Examples of molecules that can be modeled include water, oxygen, carbon dioxide, ammonia, and methanol. Additionally, students will develop and modify a model that describes the atomic composition of an extended structure showing a pattern of repeating subunits. Examples may include sodium chloride and diamonds. Due to the repeating subunit patterns, models can include student-generated drawings, 3-D ball-and-stick structures, and computer representations.

- **Quick Lab: Modeling Atoms and Molecules.** Students model compounds by combining objects that represent elements.
- 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.

- **Quick Lab: Modeling Particles** Students make a model of the particles in a solid.
- **Quick Lab: How Do the Particles in a Gas Move?** Students create models to show how the particles in a gas move.

Formative Assessments	***Summative Assessments***	***Resources***

• Quizzes
• Exit Tickets
• Questioning Techniques
• Performance on Learning Activities
• Check Your Understanding Activity
	• Tests
	• Lab Practicals
	• Problem-Based Assessments
		• Student Workbook
		• Lab Supplies
		• Access to online resources
		• Evidence Statements
		  ○ MS-PS1-1
		  ○ MS-PS1-2

Unit 3: Interactions of Matter
Essential Questions
• *What role does energy play in the interactions of matter?* • *How have humans used natural resources to change how we live?*
Student Learning Objectives
By the end of the course, students who demonstrate understanding can: **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**)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to predict and/or describe phenomena. (MS-PS1-1) **Analyzing and Interpreting Data**	**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)	**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**

Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2)	● 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) **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)	● Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

Phenomena of Interest

- *Gasoline, diesel fuel, kerosene, butane, coal tar, and asphalt all come from crude oil.*
- *Holding a piece of ice causes it to melt, but my hand gets cold.*
- *My skin feels cold when rubbing alcohol is put on it.*

Learning Activities

Students will locate information that describes changes in particle motion, changes in temperature, or changes in state as thermal energy is added to or removed from a pure substance. Students will then use models to predict and describe the changes in particle motion, temperature, and state of a pure substance. An example could include the change of state of water from its solid (ice) to liquid and vapor with the addition of thermal energy. Students will come to understand that this process is reversible through the removal of thermal energy, where the pure substance can return from a vapor to a liquid and back to a solid state.

- 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)
- **Quick Lab: Observing Sublimatio**n Dry ice is used to demonstrate sublimation.
- **Lab: Melting Ic**e Students compare the the temperature of an ice cube's surroundings to the rate at which it melts. This can be done as either a directed or open inquiry activity.
- **Quick Lab: Where Was the Energy?** Students observe an energy transfer and draw conclusions about the source of the energy.
- **Quick Lab: Keeping Cool** Students measure the temperature change that occurs when two liquids evaporate.

- **Quick Lab: How are Pressure and Temperature Related?** Students observe Charles' Law by cooling a plastic bottle in an ice bath.
- **Quick Lab: Hot and Cold Balloons** Two identical balloons are placed into water baths at different temperatures to note the effect on volume, as Boyle's Law predicts.
- Middle School Chemistry, Chapter 5: The Water Molecule and Dissolving: Students investigate the polarity of the water molecule and design tests to compare water to less polar liquids for evaporation rate, surface tension, and ability to dissolve certain substances. Students also discover that dissolving applies to solids, liquids, and gasses.

Students who accurately demonstrate understanding will be able to develop qualitative molecular-level models of solids, liquids, and gases to show the cause-and-effect relationships of adding or removing thermal energy, which increases or decreases the kinetic energy of the particles until a change of state occurs. Models could include drawings and diagrams.

- 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.
- **Quick Lab: As Thick as Honey** Previously, students compared the viscosity of different fluids. Now students can heat or cool these liquids and compare the changes in viscosity.

Students will also need to use mathematics to demonstrate their understanding of the particle motion that is taking place during these changes in state. They will use positive and negative numbers to represent the changes in particle motion and temperature as thermal energy is added or removed. They will then integrate an expression of that same quantitative information in a visual format.

- 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.

Within this unit, students will gather, read, and synthesize qualitative information from multiple sources about the use of natural resources to form synthetic materials and how these new materials affect society. Examples of new materials could include new medicine, foods, and alternative fuels. A variety of fuels come from crude oil, using only physical distillation to separate them. Some sources of information could include journals, articles, brochures, or digital media from government publications and/or private industries. Students will cite some of these sources to support the analysis of evidence that these synthetic materials were formed from natural resources and have an impact on society. They will pay special attention to the precise details of explanations or descriptions of how these new substances affect society. Students will also include relevant information from multiple print and digital sources about these impacts. While gathering this information, they will use search terms effectively, assess the credibility and accuracy of each source, and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

Formative Assessments	*Summative Assessments*	*Resources*

• Quizzes
• Exit Tickets
• Questioning Techniques
• Performance on Learning Activities
	• Tests
	• Lab Practicals
	• Problem-Based Assessments
		• Textbook
		• Lab Supplies
		• Access to online resources
		• Evidence Statements
		  ○ MS-PS1-3
		  ○ MS-PS1-4

Unit 4: Chemical Reactions		
Essential Questions		
● *Why is mass conserved during a chemical reaction?* ● *Why do some chemical reactions get hot while others feel cold?*		
Student Learning Objectives		
By the end of the course, students who demonstrate understanding can: **Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.** [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, which represent atoms.] [*Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.*] (MS-PS1-5) **Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.*** [Clarification Statement: Emphasis is on the design, controlling the transfer of energy to the environment, and modification of a device using factors such as type and concentration of a substance. Examples of designs could involve chemical reactions such as dissolving ammonium chloride or calcium chloride.] [*Assessment Boundary: Assessment is limited to the criteria of amount, time, and temperature of substance in testing the device.*] (MS-PS1-6)		
Science & Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Developing and Using Models Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to describe unobservable mechanisms. (MS-PS1-5)	**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-PS1-5) .	**Energy and Matter** ● Matter is conserved because atoms are conserved in physical and chemical processes. (MS-PS1-5) ● The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS1-6)

Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories. ● Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (MS-PS1-6)	● The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) ● Some chemical reactions release energy, others store energy. (MS-PS1-6) **ETS1.B: Developing Possible Solutions** ● A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. *(secondary)* (MS-PS1-6) **ETS1.C: Optimizing the Design Solution** ● Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process - that is, some of the characteristics may be incorporated into the new design. *(secondary)* (MS-PS1-6) ● The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. *(secondary)* (MS-PS1-6)	**Patterns** ● Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

Phenomena of Interest

- *I love the Mentos and Diet Coke videos on YouTube!*
- *As a candle burns, wax melts, gas is given off, and heat and light are emitted.*
- *Mixing vinegar and baking soda in a plastic baggie shows no change in mass.*

Learning Activities

Students will apply their understanding of particle and chemical change from earlier to make sense of how natural resources react chemically to produce new substances. Students will explain that as a result of the rearrangement of atoms during a chemical process, the synthetic substance has different characteristic properties than the original pure substance. For example, pure substances like methane, carbon monoxide, and carbon dioxide can be combined chemically to form synthetic fuel. The synthetic fuel would have different characteristic properties than the original pure substances.

- *Middle School Chemistry*, Chapter 4: Periodic Table and Bonding: (Lesson 1 and 2 only) Students look deeply into the structure of the atom and play a game to better understand the relationship between protons, neutrons, electrons, and energy levels in atoms and their location in the periodic table. Predict how elements will react to each other based on their location in the periodic table. Lesson 1: Students are constructing an explanation of why charges attract or repel.
- Gumdrop Models: Students will design a model to explain the structure of an atom. This activity will allow for fast pacing for the gifted and talented students. Students will be given Data Cards to develop and modify models of molecules.
- *Middle School Chemistry*, Chapter 6: Chemical Change: Students explore the concept that chemical reactions involve the breaking of certain bonds between atoms in the reactants, and the rearrangement and rebonding of these atoms to make the products. Students also design tests to investigate how the amount of products and the rate of the reaction can be changed. Students will also explore endothermic and exothermic reactions. Students are using models to match what happens during a chemical change and mass is conserved.

Building upon these experiences, students will analyze and interpret data on the properties of substances in order to provide evidence that a chemical reaction has occurred. They will also analyze and interpret data to determine similarities and differences in findings. Students will recognize that macroscopic patterns are related to the nature of microscopic and atomic-level structure. They will use patterns to identify cause-and-effect relationships and graphs and charts to identify patterns in data. (MS-PS1-5)

- **Quick Lab: Demonstrating Tarnishing** Students observe a chemical reaction.

Students will undertake a design project, engaging in the design cycle, to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes. Specific criteria will be developed to limiting the amount, time, and temperature of a substance. Students will then analyze and interpret their data for the amount, time, and temperature of a substance in testing a device that either releases or absorbs thermal energy by chemical processes to determine similarities and differences in findings. They will then be able to develop a model to generate data for testing a device that either releases or absorbs thermal energy by chemical processes, including those representing inputs and outputs of thermal energy. Students could then track the transfer of thermal energy as energy flows through a designed system that either releases or absorbs thermal energy by chemical processes. (MS-PS1-6)

Formative Assessments	***Summative Assessments***	***Resources***

• Quizzes
• Exit Tickets
• Questioning Techniques
• Performance on Learning Activities
	• Tests
	• Lab Practicals
	• Problem-Based Assessments
		• Textbook
		• Lab Supplies
		• Access to online resources
		• Evidence Statements:
		  ○ MS-PS1-5
		  ○ MS-PS1-6

Unit 5: Water and Atmosphere

Essential Questions

- *How does Earth's water move through the water cycle?*
- *What causes ocean currents?*
- *How do you predict the weather?*
- *What factors interact and influence weather and climate?*

Student Learning Objectives

By the end of the unit, students who demonstrate understanding can:

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)

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)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop a model to describe unobservable mechanisms. (MS-ESS2-4) ● Develop and use a model to describe phenomena. (MS-ESS2-6) **Planning and Carrying Out Investigations** Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions. ● 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)	**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. ● Global movements of water and its changes in form are propelled by sunlight and gravity. (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) ● 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** ● Because these patterns are so complex, weather can only be predicted probabilistically. (MS-ESS2-5) **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) ● 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)	**Energy and Matter** ● Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. (MS-ESS2-4) **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)

Phenomena of Interest
● *There are more thunderstorms in the summer than in the winter.*
Learning Activities
During this unit, students will answer the question "What factors interact and influence weather and climate?" beginning with the cycling of water in Earth's systems. Models will be created and emphasis will be on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Students will model the continuous movement of water from land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation. Students will focus on the global movement of water and its changes in form that are driven by sunlight as it heats the Earth's surface water. They will also describe how water moves through underground layers of soil and rock, and how people obtain water from an aquifer. This will lead into descriptions and functions of common types of freshwater wetlands. ● **Water on Earth:** Students will research how Earth's water is used and reinforce their mathematical skills by presenting the information in a circle graph (*Water, Water, Everywhere),* and determine how much water is in the form of ice and freshwater (*Do the Math!, Lead a Discussion)*. Parts of the water cycle will be observed, analyzed, and modeled (*Water on Earth, Water from Trees).* ● **Inquiry Where Does Water Come From:** Students will demonstrate that the Earth's atmosphere contains water even when it cannot be seen. ● **Quick Lab** Water Water Everywhere**:** Students will make a circle graph showing the major uses of freshwater in the United States. ● **Lab** Students will observe and measure how much water leaves of a tree give off through transpiration during a 24-hour period. ● **Quick Lab** Water on Earth**:** Students will investigate how Earth's water is distributed. ● **Research Paper** Students will write a brief "history of a drop of water" tracing a single drop of water from sometime in the past to the present day school water fountain. ● **Four door book foldable** on the parts of the water cycle. *Freshwater* ● **Inquiry:** Mapping surface waters Students will use a map to locate and classify surface waters in New Jersey. ● **Quick Lab:** What is a watershed? Students will model a river system and watershed. ● **Quick Lab:** Modeling how a lake forms Students will make a model that shows one type of lake formation. ● **Inquiry:** Where does the water go? Students will model what happens to water that sinks into the ground. ● **Four door book foldable:** Students will explain how water moves underground: permeable, impermeable, saturation zone, and unsaturated zone, with definitions and examples. ● **Quick Lab:** Soil percolation. Students will model the effect various soil types have on the speed at which water moves through underground rock and soil. ● **Quick Lab:** An artesian well. Students will model an artesian well.

- **Lab:** Eco-friendly Water Filtration Activity. Students will build a model and demonstrate how ground water gets filtered www.toppartyideas.com/eco-friendly-water/filtration/
- **Inquiry Warm-up:** Wet or Dry. Students will model how wetlands protect coastal areas and observe the difference in the flow of water on wet and dry land.
- **Quick Lab:** A Natural Filter Students will model filtration by wetlands.
- **Quick Lab:** Describing Wetlands Students will build a model of a swamp, marsh, or bog and then share the model with the class.
- **Inquiry:** Mapping Surface Waters Students will use a map to locate and classify surface waters in New Jersey.

Saltwater/Oceans

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

The motions and complex interactions of air masses result in changes in weather conditions. The 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. Students will collect data from weather maps, diagrams, visualizations, and laboratory experiments to explain how the movements of air masses from regions of high pressure to regions of low pressure cause weather at a fixed location. For example, students can observe the movement of colored water that simulates the movement of hot and cold air masses. Students can observe the cooler water flowing in the direction of the warmer area and equate this with wind being created from the uneven heating of the Earth.

- **Quick Lab:** Water in the Air Students will create conditions that will make water vapor change into liquid water.
- **Quick Lab:** Measuring to Find the Dew point Students will measure the dew point in the classroom and observe its effects.
- **Inquiry:** How Do Fluids of Different Densities Move? Students will use fluids of different densities to model the behavior of colliding air masses.
- **Four Door Foldable:** Define and explain the four major air masses: tropical, polar, maritime, and continental air masses.
- **Quick Lab:** Tracking Air Masses Students will use a map to identify the major North American air masses.
- 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
- **Quick Lab:** Weather Fronts Students will use water and oil to model how air masses interact along fronts.
- **Quick Lab:** Cyclones and Anticyclones Students will create a model of a cyclone using a pair of soda bottles.
- **Inquiry:** Can You Make a Tornado? Students will use a jar of swirling water to model the spinning winds of a tornado.
- **Quick Lab:** Deep Currents Students will explore the way temperature affects the movement of deep currents.

Students will compare data collected from sources such as simulations, video, or experiments to identify the patterns of change in the movement of water in the atmosphere that are used to make weather predictions, understanding that any predictions are reported within probability ranges. Students will also make predictions about the conditions that result in sudden changes in weather.

- **Inquiry:** Predicting Weather Students will collect weather forecasts and compare them with the actual weather.
- **Project:** Students will pretend to be a meteorologist, draw their own weather map, and give a weather report.
- **Lab:** Reading a weather map Students will interpret and draw conclusions by looking at information on a weather map.

Students will use models, diagrams, maps, and globes to understand atmospheric and ocean circulation patterns. Since 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, the ocean will be studied as a system with interactions such as inputs, outputs, processes, energy, and matter. Students will model how the unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates. They will describe how the unequal heating of the global ocean produces convection currents. By examining maps, globes and digital representations of the movement of ocean currents, students will model the patterns by latitude, altitude, and geographic distribution. They will show that these patterns vary as a result of sunlight-driven latitudinal banding, the Coriolis effect, and resulting prevailing winds.

- **Lab:** Modeling Ocean Currents Students will make models and observe how winds cause surface ocean currents.
- **Inquiry:** Bottom to Top Students will model the effect that wind has on the movement of surface and deep currents.
- **Quick Lab:** Where Do Hurricanes Come From? Students will investigate why hurricanes cause such severe flooding in coastal area.
- **Debate: Science Controversy-The Breakdown of Ocean Currents** Students can debate if global warming is affecting ocean currents and temperature.
- 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.
- **Digital models** like NOAA videos can be used to help students visualize how variations in density due to temperature and salinity drive a global pattern of interconnected ocean currents. This can be demonstrated in the classroom using models in which colored water with different temperatures or water with different densities is added to clear tubs of water. Students can observe that the warmer water is pushed upwards by the colder water. This same demonstration can be used with water that has different salinities. Using a turntable and drawing a straight line from the middle to the edge can model the Coriolis effect. If a turntable is not available, a Lazy Susan is a great substitute. The turntable or Lazy Susan can be painted with chalk paint, and the students can draw the line using chalk. Using chalk paint and chalk will enable the teacher to use them over and over. After the turntable is stopped, students will see that the motion of the turntable resulted in a curved line, and they will then be able to correlate how the rotation of Earth results in the movement of air.

Formative Assessments	***Summative Assessments***	***Resources***

• Quizzes
• Exit Tickets
• Questioning Techniques
• Performance on Learning Activities
	• Tests
	• Lab Practicals
	• Problem-Based Assessments
		• Textbook
		• Lab Supplies
		• Access to online resources
		• Evidence Statements
		  ○ MS-ESS2-4
		  ○ MS-ESS2-5
		  • MS-ESS2-6

Unit 6: Astronomy and Space Science

Essential Questions

- *How do the Earth, the Sun, and the moon interact and affect one another through gravitational forces?*
- *How do we know how old the universe, the solar system, and the Earth are?*
- *How do I compare to the size of other objects?*

Student Learning Objectives

By the end of the course, students who demonstrate understanding can:

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 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)

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)

Science & Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-ESS1-1)(MS-ESS1-2) **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3)	**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** ● 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 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) ● The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. (MS-ESS1-2)	**Patterns** ● Patterns can be used to identify cause-and- effect relationships. (MS-ESS1-1) **Systems and System Models** ● Models can be used to represent systems and their interactions. (MS-ESS1-2) **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-ESS1-3)

Phenomena of Interest

- *There was an eclipse mentioned in the news, but I didn't see it happen here.*
- *The moon moves throughout the night, and change shape throughout the month.*

Learning Activities

At the beginning of the unit, students will develop and use mathematical, physical, graphical or conceptual models to describe the cyclical patterns of lunar phases, eclipses of the sun and moon, and seasons. Students can use mathematics to create scale models of the solar system to investigate relative distances between the planets and their orbits around the sun or to represent the distance from the sun to the Earth during different Earth seasons. Students can also use physical models to examine the phases of the moon using a light source and a moon model to view the various shapes of the moon as it orbits the earth. Students may also keep a lunar calendar for one month and analyze the results by looking for differences and patterns. Using a model of the sun, Earth, and moon, students can view the positions of these planetary objects during a solar or lunar eclipse. To investigate seasons, students can simulate the position and tilt of the Earth as it revolves around the sun, using computer simulations, hands-on models, and videos.

- **Quick Lab: Watching the Skies.** Students will discuss apparent motions caused by Earth's rotation and revolution.
- **Inquiry What Causes Day and Night?** Students will model how the sun and Earth interact to produce day and night.
- **Quick Lab: Sun Shadows.** Students will predict how shadows caused by the sun change throughout the day.
- **Project:** Students will create a four door book foldable of the four seasons.
- **Quick Lab: Eclipses.** Students will model Solar and Lunar Eclipses with flashlights.
- **Quick Lab: Moon Phases.** Students will identify the phases of the moon.
- **Project:** Students will create a circular 8 flap moon foldable on the moon's phases.
- 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.
- **Project:** Students will construct a simple sundial and predict where the shadow falls every hour.
- **Project:** Students will create a model showing the phases of the moon.
- 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.
- Gravity and Orbits Move the sun, earth, moon and space station to see how it affects their gravitational forces and orbital paths. Visualize the sizes and distances between different heavenly bodies, and turn off gravity to see what would happen without it.

Students will explore, through the development and use of models, the role of the force of gravity in explaining the motions within our solar system and the Milky Way Galaxy. As part of their study of the solar system and its components, including the sun, planets and their moons, and asteroids, they will use models and examine simulations to determine how gravity holds these systems together. To visualize how gravity pulls objects down towards its center, students can experiment with dropping spheres of different masses but of the same diameter as a way to determine that gravity acts on both objects and that they drop at the same rate. If technology is available, students can measure the acceleration of the objects as they fall from various heights. Students will be able to determine that the objects speed up as they fall, therefore proving that a force is acting on them. If motion detectors are not available for student use, they could observe these using simulations.

- **Inquiry What Factors Affect Gravity?** Students will graph data to explore factors that affect the force of gravity.
- **Quick Lab: What's Doing the Pulling?** Students will use magnets to model the force of gravity between two objects.
- **Quick Lab: Around and Around We Go.** Students will explore factors that affect an object's orbit.
- **Inquiry How Does the Moon Move?** Students will infer why an observer on Earth always sees the same side of the moon.
- **Inquiry When is High Tide?** Students will use a map and tide times to predict the next tide times.
- **Quick Lab: Modeling the Moon's Pull of Gravity** Students will model effects of the moon on Earth's Tides.

- **Project:** Students will track, chart, and graph high and low tides of different bodies of water for a period of time. They can include the moon phases.
- 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.

After students have had opportunities to participate in the investigations, they should prepare multimedia visual displays the present their findings. As part of their presentation, students will use mathematical models or simulations that show the relationship between relative sizes of objects in the solar system and the size of the gravitational force that is being exerted on the object. They should be able to compare and contrast the weight of an object if it were on the surface of different-sized planets that have very different masses. Students will gather evidence that every object in the solar system is attracted to every other object in the solar system with a force that is related to the mass of the objects and the distance between the objects. They should extend this understanding of gravity to explain why objects in the solar system do not simply flow away from each other. Students should also make connections between their understanding of the force of gravity and the formation of the solar system from a cloud of dust and gas. As part of their mathematical model of the solar system, students will use variables to represent numbers and write expressions when solving a problem involving the role of gravity in the motions within galaxies and within the solar system. The variable can represent an unknown number or any number in a specified set.

- **Project:** Students will create a layered book foldable on the inner and outer planets.
- 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.
- **Research Project:** Students will research a different planet, moon, or object in the solar system.
- **Interactive Activity:** Students will demonstrate how their planet, moon, or object from their research paper rotates and revolves throughout the solar system in a whole group setting.

Students will also analyze and interpret data from Earth-based instruments to determine the scale properties of objects within our solar system. Examples of models that students could use include physical (such as the analogy of distance along a football field or computer visualization of elliptical orbits), conceptual (such as mathematical proportions relative to the size of familiar objects such as students' school or state). Students can construct scale models of the solar system that will help them visualize relative sizes of objects in the system as well as distances between objects. Students can use graphs or tables to make comparisons between the size and gravitational pull of the planets and their moons.

- **Quick Lab: Toilet Paper Solar System:** Students will analyze the distances between the planets, the sun, and other objects in the solar system.
- **Project:** Students will create a flip book foldable of the different types of galaxies.

Formative Assessments	***Summative Assessments***	***Resources***
• Quizzes • Exit Tickets • Questioning Techniques	• Tests • Lab Practicals • Problem-Based Assessments	• Textbook • Lab Supplies • Access to online resources

• Performance on Learning Activities		• Evidence Statements: ○ MS-ESS1-1 ○ MS-ESS1-2 ○ MS-ESS1-3

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