Branchburg Township Public Schools

Office of Curriculum and Instruction

Grade 8 Science Curriculum

Adopted by the Board of Education September 2023

This curriculum is aligned with the 2020 New Jersey Student Learning Standards in Science

Curriculum Scope and Sequence			
Content Area	Science	**Course Title/Grade Level:**	Physical Science/8th Grade

Topic/Unit Name		Suggested Pacing (Months)
Topic/Unit #1	Introduction to Matter The Engineering Design Process	September - October September - June
Topic/Unit #2	States of Matter	November
Topic/Unit #3	Elements and the Periodic Table	December - January
Topic/Unit #4	Energy	January - February
Topic/Unit #5	Waves	February - March
Topic/Unit #6	Motion and Stability; Forces and Interactions	March - June

Topic/Unit 1 Title	Introduction to Matter	Approximate Pacing	September - October
STANDARDS			
Science Standards (NGSS)			

Science and Engineering Practices (Students will be able to…)	Disciplinary Core Ideas (Students will know…)	Crosscutting Concepts (Students will connect…)
MS-PS1-1. 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 depiction of all individual atoms in a complex molecule or extended structure.] **MS-PS1-2.** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [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	**PS1.A: Structure and Properties of Matter** Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. (MS-PS1-1) Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. (MS-PS1-3) (Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)· Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) **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.	**Patterns** Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. (MS-PS1-1) **Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **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) **Energy and Matter** Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. (MS-PS1-2)

analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.] **MS-PS1-5.** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.] **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.	(MS-PS1-2),(MS-PS1-5) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)* The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) Some chemical reactions release energy, others store energy. (MS-PS1-6) **ETS1.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)	**Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) - ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3) **Influence of Science, Engineering and Technology on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus

MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	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)	technology use varies from region to region and over time. (MS-PS1-3) **Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2) **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)

Interdisciplinary Connections:	
ELA / Literacy:	**Mathematics:**
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. **(MS-PS1-2)** Example: Students are provided a statement such as “All particles of matter are in motion.” Students are expected to state whether they agree or	**MP.4** Model with mathematics. **(MS-PS1-5)** Example: Determine the density of liquids based on its mass and volume. **8.EE.A.3** Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. **(MS-PS1-1)** Example: Use everyday objects to understand the size of a gram and kilogram.

disagree with this statement and use data from labs to support their response. **WHST.6-8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. **(MS-PS1-6)** Example: Students plan their own investigation based on observations of bubble gum losing its flavor.	
Computer Science & Design Thinking:	**Career Readiness, Life Literacies, and Key Skills:**
8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. Example: In MakerSpace, students will apply the steps of the engineering design process, and use materials and references provided by the media center specialist to research into their topics related to climate change. **8.2.8.ED.1:** Evaluate the function, value, and aesthetics of a technological product or system, from the perspective of the user and the producer. **8.2.8.NT.4:** Explain how a product designed for a specific demand was modified to meet a new demand and led to a new product. Example: In MakerSpace, students will be shown various innovations that environmental scientists have developed and their impact on climate change.	**9.4.8.IML.7:** Use information from a variety of sources, contexts, disciplines, and cultures for a specific purpose. Example: Students will work in lab groups during the investigative process. **9.4.8.CI.4:** Explore the role of creativity and innovation in career pathways and industries. **9.1.8.FP.6:** Compare and contrast advertising messages to understand what they are trying to accomplish. Example: In MakerSpace, students reflect on their areas of interest and develop a product that will improve an aspect of this topic. **9.1.8.FP.7:** Identify the techniques and effects of deceptive advertising. Example: In the Change of Mass of Bubble Gum Lab, students learn the actual ingredients of Dubble Bubble Gum. **9.4.8.DC.1:** Analyze the resource citations in online materials for proper use. **9.4.8.IML.1:** Critically curate multiple resources to assess the credibility of sources when searching for information. Example: In MakerSpace, students will use the SPIDER technique to evaluate credible sources and websites during their research phase, and then include citations in their annotated bibliographies.
UNIT/TOPIC ESSENTIAL QUESTIONS AND ENDURING OBJECTIVES/UNDERSTANDINGS	
How can we observe, measure, and use matter?	

<table>
<tr><td colspan="2">(Phenomenon: Baking a cake.)
How can particles combine to produce a substance with different properties?
(Phenomenon: An apple that is cut in half, turns brown.)
What happens when new materials are formed? What stays the same and what changes?
(Phenomenon: Elephant toothpaste observation.)</td></tr>
<tr><th colspan="2">STUDENT LEARNING OBJECTIVES</th></tr>
<tr><th>Key Knowledge</th><th>Process/Skills/Procedures/Application of Key Knowledge</th></tr>
<tr><td>Students will know:
Topic 1: Structures and Properties of Matter (Introduction to Matter)
matter, substance, physical property, chemical property, atom, element, molecule, compound, mixture, mass, volume, weight, density, physical change, chemical change</td><td>Students will be able to:
Topic 1: Structures and Properties of Matter (Introduction to Matter)
Students will develop and use models to explain and describe what makes up matter.
Students will carry out investigations to identify unknown substances based on their physical and chemical properties.
Students will construct explanations about why gum loses mass over a period of chewing time.
Students will qualitatively investigate different types of matter and mixtures to classify them.
Students will construct an argument to identify and describe how matter can be measured.
Students will analyze and interpret data to identify and calculate properties of matter that can be determined through measurement, specifically the proportion of density as a function of mass and volume.
Students will compare reactants and products to determine how matter is conserved during a physical and a chemical change.
Students will construct an argument to explain the difference between a physical and chemical change and how these changes affect the changes of energy in a system.
Students will be able to design a product that will be a solution to address human needs.
Students will be able to define the criteria and constraints of their product design.
Students will be able to evaluate competing design solutions for their product.</td></tr>
</table>

<table>
<tr><th colspan="2">ASSESSMENT OF LEARNING</th></tr>
<tr><td>Summative Assessment
(Assessment at the end of the learning period)</td><td>Students will analyze and develop a model and construct an argument with evidence to explain the science behind the phenomena using the Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices.</td></tr>
</table>

Formative Assessments (Ongoing assessments during the learning period to inform instruction)	Quizzes at the end of each lesson, models, claims, evidence, data and research, planning and carrying out investigations, classroom discussions, anecdotal notes
Alternative Assessments (Any learning activity or assessment that asks students to *perform* to demonstrate their knowledge, understanding and proficiency)	Gizmos (Weight and Mass, Measuring Volume, Chemical and Physical Changes STEM Case), POGILs (Building Blocks of the Stuff Around Us, What Kind of Change is Happening Here?), MakerSpace, worksheets/activities, PBL (extensions), modified assessments as per IEPs
Benchmark Assessments (used to establish baseline achievement data and measure progress towards grade level standards; given 2-3 X per year)	Grade level benchmark assessment: Evidence based short response assessments.
RESOURCES	
Core Instructional Materials: Pearson Elevate Science Textbook (Topic 1: Introduction to Matter)	
Supplemental Materials: Gizmos POGILs Colorado PhET Simulations Rutgers University: Physics Union Mathematics activities ISLE (Integrative Science Learning Environment) Cycle of Learning Physical materials for labs (ex: elements, compounds, mixtures, etc.) Diversity: Scientist of the Month	
Modifications for Learners	
See appendix	

Topic/Unit 2 Title	Structures and Properties of Matter (States of Matter)	Approximate Pacing	November

STANDARDS		
Science Standards (NGSS)		
Science and Engineering Practices (Students will be able to…)	Disciplinary Core Ideas (Students will know…)	Crosscutting Concepts (Students will connect…)
MS-PS1-1. 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 depiction of all individual atoms in a complex molecule or extended structure.] **MS-PS1-2.** Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. [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	**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) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-2.)* Gases and liquids are made of molecules or inert atoms that are moving about relative to each other. (MS-PS1-4) In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations. (MS-PS1-4) The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. (MS-PS1-4) **PS1.B: Chemical Reactions**	**Patterns** Observed patterns in nature guide organization and classification and prompt questions about relations and causes underlying them. (MS-PS1-3) **Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **System and System Models** A system is an organized group of related objects of components; models can be used for understanding and predicting the behavior of a system. (MS-PS1-4) **Energy and Matter** Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. (MS-PS1-4)

analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.] **MS-PS1-4.** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [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-PS1-6.** 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.]	Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants. (MS-PS1-3) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-2 and MS-PS1-5.)* **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	**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) **Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS1-3) - ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3)

MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample. [Clarification Statement: Examples of experiments could include comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each	number of atoms in the system, and the state of the material. *(secondary to MS-PS1-4)* **ETS1.A: Defining and Delimiting Engineering Problems** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions. (MS-ETS1-1) **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution**	**Influence of Science, Engineering and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3), (MS-ETS1-1) **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)

that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	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)	

Interdisciplinary Connections:	
ELA / Literacy:	**Mathematics:**
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. <u>Example:</u> Follow procedures for analyzing and interpreting the heating curve of water. **NJSLA.R1.** Read closely to determine what the text says explicitly and to make logical inferences and relevant connections from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. <u>Example:</u> Read textbook provided resources after students have completed the labs on solids, liquids, and gases. Use this knowledge to answer questions that relate to everyday life.	**6.SP.B.4** Display numerical data in plots on a number line, including dot plots, histograms, and box plots. **(MS-PS1-2)** <u>Example:</u> Analyze and interpret data collected about the behavior of gas when volume, pressure, or temperature of the particles are manipulated. **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real world contexts, explaining the meaning of 0 in each situation. **(MS-PS1-4)** <u>Example:</u> Use both positive and negative numbers to collect the temperature of melting ice and boiling water.
Computer Science & Design Thinking:	**Career Readiness, Life Literacies, and Key Skills:**
8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose. <u>Example:</u> Use simulation to observe the motion of particles in a solid, liquid, and gas.	**9.4.8.TL.2:** Gather data and digitally represent information to communicate a real-world problem. <u>Example:</u> Use knowledge from pertinent content in order to develop a product for MakerSpace. **9.4.8.IML.12:** Use relevant tools to produce, publish, and deliver information supported

<table>
<tr><td>8.2.8.ITH.4: Identify technologies that have been designed to reduce the negative consequences of other technologies and explain the change in impact.
8.2.8.EC.2: Examine the effects of ethical and unethical practices in product design and development.
<u>Example:</u> Through discussion, students will gather feedback in regards to their product development in MakerSpace.</td><td>with evidence for an authentic audience.
<u>Example:</u> Students share their MakerSpace ideas with members of the community.
9.4.8.GCA.1: Model how to navigate cultural differences with sensitivity and respect.
9.4.8.GCA.2: Demonstrate openness to diverse ideas and perspectives through active discussions to achieve a group goal.
<u>Example:</u> Students work together to develop their MakerSpace product ideas through research.</td></tr>
<tr><td colspan="2">UNIT/TOPIC ESSENTIAL QUESTIONS AND ENDURING OBJECTIVES/UNDERSTANDINGS</td></tr>
<tr><td colspan="2">What causes matter to change from one state to another?
(Phenomenon: Ice melting in your hand.)
How does thermal energy affect particles in a substance?
(Phenomenon: Food coloring dispersed in cold water versus hot water.)</td></tr>
<tr><td colspan="2">STUDENT LEARNING OBJECTIVES</td></tr>
<tr><td>Key Knowledge</td><td>Process/Skills/Procedures/Application of Key Knowledge</td></tr>
<tr><td>Students will know:
Topic 2: Structures and Properties of Matter (States of Matter)
solid, liquid, gas, surface tension, viscosity, thermal energy, temperature, melting point, freezing point, vaporization, boiling point, evaporation, condensation, sublimation, pressure, Charles' Law, Boyle’s Law, Gay-Lussac’s Law</td><td>Students will be able to:
Topic 2: Structures and Properties of Matter (States of Matter)
Students will carry out a qualitative investigation to analyze the similarities and differences between solids, liquids, and gases.
Students will use models to determine the relationship between particle motion and the states of matter.
Students will predict particle motion in solids, liquids, and gases based on patterns.
Students will describe cause-and-effect relationships related to the role that thermal energy plays in particle motion and the role thermal energy plays in changes of state.
Students will use text information and visuals to construct a scientific investigation into how pressure affects a change from a liquid to a gas.
Students will use proportion and quantity by summarizing how Charles’ Law relates temperature and volume of gases and how Boyle’s Law relates pressure and volume in gases.
Students will collect and analyze data to interpret the directly proportional relationship between volume and temperature.</td></tr>
</table>

	Students will use proportion and quantity to interpret the inversely proportional relationship between volume and pressure. Students will design a product that will address human needs. Students will define the criteria and constraints of their product design. Students will be able to evaluate competing design solutions for their product.
ASSESSMENT OF LEARNING	
Summative Assessment (Assessment at the end of the learning period)	Students will analyze and develop a model and construct an argument with evidence to explain the science behind the phenomena using the Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices.
Formative Assessments (Ongoing assessments during the learning period to inform instruction)	Quizzes at the end of each lesson, models, claims, evidence, data and research, planning and carrying out investigations, classroom discussions, anecdotal notes
Alternative Assessments (Any learning activity or assessment that asks students to *perform* to demonstrate their knowledge, understanding and proficiency)	Gizmos (Phase Changes, Properties of Matter STEM Case), PhET Simulations (Gas Properties, States of Matter), POGILs (How are Particles Arranged in Solids, Liquids, and Gases?; How Do Particles Move in Solids, Liquids, and Gases?; How Does Temperature Change as Thermal Energy Is Added to Pure Substances?; How Much Matter is Present After a Chemical Reaction?), worksheets/activities, PBL (extensions), MakerSpace, modified assessments as per IEPs
Benchmark Assessments (used to establish baseline achievement data and measure progress towards grade level standards; given 2-3 X per year)	Grade level benchmark assessment: Evidence based short response assessments.
RESOURCES	
Core Instructional Materials: Pearson Elevate Science Textbook (Topic 2: Solids, Liquids, and Gases, and Topic 9: Chemical Reactions)	
Supplemental Materials: Gizmos POGILs Colorado PhET Simulations Rutgers University: Physics Union Mathematics activities ISLE (Integrative Science Learning Environment) Cycle of Learning Physical materials for labs (ex: water, dry ice, balloons, etc.)	

Diversity: Scientist of the Month
Modifications for Learners
See appendix

Topic/Unit 3 Title	Elements and the Periodic Table	Approximate Pacing	December - January

STANDARDS		
Science Standards (NGSS)		
Science and Engineering Practices (Students will be able to…)	Disciplinary Core Ideas (Students will know…)	Crosscutting Concepts (Students will connect…)
MS-PS1-3. 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-PS1-5.** Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved. [Clarification Statement: Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms that represent atoms.] [Assessment Boundary: Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.] **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible	**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),(MS-PS1-3) **PS1.B: Chemical Reactions** Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS1-4) **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) **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) **Systems and System Models** Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. (MS-LS1-3)

solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	(MS-PS1-2),(MS-PS1-5) *(Note: This Disciplinary Core Idea is also addressed by MS-PS1-3.)* The total number of each type of atom is conserved, and thus the mass does not change. (MS-PS1-5) **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), (MS-ETS1-3) A solution needs to be tested, and then modified on the basis of the test results, in order to improve it (secondary to MS- PS1-6)	- ***Connections to Engineering, Technology, and Applications of Science*** **Interdependence of Science, Engineering, and Technology** Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (MS-PS1-3) **Influence of Science, Engineering and Technology on Society and the Natural World** The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3) **Patterns** Macroscopic patterns are related to the nature of microscopic and atomic-level structure. (MS-PS1-2)

		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)

Interdisciplinary Connections:	
ELA / Literacy:	**Mathematics:**
RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **(MS-PS1-1),(MS-PS1-4)** <u>Example:</u> Students will construct a periodic table that incorporates the symbol, atomic number, atomic mass, Bohr Model, and how elements are used in everyday life. **WHST.6- 8.7** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. **(MS-PS1-6)** <u>Example:</u> Students will collect information about the atomic theory and piecing together a timeline of events.	**6.RP.A.3** Use ratio and rate reasoning to solve real-world and mathematical problems. **(MS-PS1-2), (MS-PS1-5)** <u>Example:</u> Use atomic information to determine if an atom is electrically charged. **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real world contexts, explaining the meaning of 0 in each situation. **(MS-PS1-4)** <u>Example:</u> Determine the charge of protons, neutrons, and electrons to determine the charge of an atom.
Computer Science & Design Thinking:	**Career Readiness, Life Literacies, and Key Skills:**

8.2.8.ETW.2: Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital). **8.2.8.ED.3:** Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch). Example: Students will construct a morphological chart and then a prototype for MakerSpace. **8.2.8.EC.2:** Examine the effects of ethical and unethical practices in product design and development. **8.2.8.ED.6:** Analyze how trade-offs can impact the design of a product. **8.2.8.ED.7:** Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches). Example: Students will plan and carry out an investigation pertaining to the product created for MakerSpace in order to determine pros and cons of their invention.	**9.2.8.CAP.10:** Evaluate how careers have evolved regionally, nationally, and globally. Example: Students research the history of the atomic theory and learn about the evolution of modern science. Example: A webquest including articles, videos, and simulations are used in order for students to understand the development of the atom. **9.4.8.CT.1:** Evaluate diverse solutions proposed by a variety of individuals, organizations, and/or agencies to a local or global problem, such as climate change, and use critical thinking skills to predict which one(s) are likely to be effective. Example: Throughout MakerSpace, students will develop and revise prototypes of their MakerSpace product.
UNIT/TOPIC ESSENTIAL QUESTIONS AND ENDURING OBJECTIVES/UNDERSTANDINGS	
How do atoms combine to form extended structures? (Phenomenon: Sodium and Chlorine atoms combine to form table salt.) **How is the periodic table organized?** (Phenomenon: Observe Alkali Metals and Halogens. What are their similarities, what are their differences? How does their location compare on the periodic table?)	
STUDENT LEARNING OBJECTIVES	
Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: **Topic 3: Elements and the Periodic Table**	***Students will be able to:*** **Topic 3: Elements and the Periodic Table**

atom, electron, nucleus, proton, neutron, atomic number, isotope, mass number, atomic mass, periodic table, chemical symbol, period, group, compound, valence electron, reactivity, malleable, ductile, luster, semiconductor, ion, polyatomic ion, ionic bond, covalent bond, molecule, corrosive, salt	Students will develop and use models to identify and describe the properties of electrons, protons, and neutrons. Students will apply scientific reasoning to show the development of atomic theory, including the historical atomic models of Dalton, Thompson, Rutherford, and Bohr, how data from experiments caused the theory to change, and the basics of modern atomic theory. Students will construct an argument that supports the modern model of the atom. Students will identify and describe the organization used to create the periodic table. Students will gather, read, and synthesize information surrounding the development of the periodic table. Students will interpret and use the periodic table for locating important information pertaining to the elements and to describe the elements. Students will cite evidence and interpret data to explain the role of valence electrons in the bonding of atoms. Students will cite evidence and interpret data to compare the properties of metals and nonmetals. Students will develop and use models to describe and compare the properties of atoms, and explain the role of valence electrons in the structure and function of atoms. Students will be able to design a product that will address human needs. Students will be able to define the criteria and constraints of their product design. Students will be able to evaluate competing design solutions for their product.

ASSESSMENT OF LEARNING	
Summative Assessment (Assessment at the end of the learning period)	Students will analyze and develop a model and construct an argument with evidence to explain the science behind the phenomena using the Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices.
Formative Assessments (Ongoing assessments during the learning period to inform instruction)	Quizzes at the end of each lesson, models, claims, evidence, data and research, planning and carrying out investigations, classroom discussions, anecdotal notes
Alternative Assessments (Any learning activity or assessment that asks students to *perform* to	Gizmos (Electrons and Chemical Reactions STEM Case), PhET Simulations (Build an Atom), worksheets/activities, PBL (extensions: Electron Configuration Gizmos), MakerSpace, modified assessments as per IEPs

demonstrate their knowledge, understanding and proficiency)	
Benchmark Assessments (used to establish baseline achievement data and measure progress towards grade level standards; given 2-3 X per year)	Grade level benchmark assessment: Evidence based short response assessments.
RESOURCES	
Core Instructional Materials: Pearson Elevate Science Textbook (Topic 8: Atoms and the Periodic Table)	
Supplemental Materials: Gizmos POGILs Colorado PhET Simulations Rutgers University: Physics Union Mathematics activities ISLE (Integrative Science Learning Environment) Cycle of Learning Physical materials for labs (ex: magnetic Bohr Model board, “build an atom” manipulatives, assorted metals and battery, etc.) Periodic Table of Elements Diversity: Scientist of the Month	
Modifications for Learners	
See appendix	

Topic/Unit 4 Title	Energy	Approximate Pacing	January - February

STANDARDS		
Science Standards (NGSS)		
Science and Engineering Practices (Students will be able to…)	Disciplinary Core Ideas (Students will know…)	Crosscutting Concepts (Students will connect…)
MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object to the speed of an object. [Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.] **MS-PS3-2.** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. [Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster car at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems.] [Assessment	**PS3.A: Definitions of Energy** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2) Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)	**Scale, Proportion, and Quantity** Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1),(MS-PS3-4) **Systems and System Models** Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-PS3-2) **Energy and Matter** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3-5) The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) -

Boundary: Assessment is limited to qualitative information.] **MS-PS3-3.** Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer. [Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup.] [Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.] **MS-PS3-5.** Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. [Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of an object.] [Assessment Boundary: Assessment does not include calculations of energy.] **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well	The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4) Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **PS3.C: Relationship Between Energy and Forces** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2) **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 is likely to limit possible solutions. (secondary to MS-PS3-3) **ETS1.B: Developing Possible Solutions** A solution needs to be tested, and then modified on the basis of the test results in	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-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)

they meet the criteria and constraints of the problem. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3) 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) Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** 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)	

Interdisciplinary Connections:	
ELA / Literacy:	**Mathematics:**
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. **(MS-PS3-3),(MS-PS3-4)** Example: Carry out investigations pertaining to potential and kinetic energy. **SL.8.5** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. **(MS-PS3-2)**	**MP.2** Reason abstractly and quantitatively. **(MS-PS3-1),(MS-PS3-4),(MS-PS3-5)** Example: Determine how work and energy are related in a system. **7.RP.A.2** Recognize and represent proportional relationships between quantities. **(MS-PS3-1),(MS-PS3-5)** Example: Students determine the relationship between mass velocity and kinetic energy through an investigation.

<u>Example:</u> Videos used to show how energy is transferred from one object to another.	
Computer Science & Design Thinking:	**Career Readiness, Life Literacies, and Key Skills:**
8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose. <u>Example:</u> Graph the relationship between height and potential energy. **8.2.8.ETW.2:** Analyze the impact of modifying resources in a product or system (e.g., materials, energy, information, time, tools, people, capital). **8.2.8.ETW.3:** Analyze the design of a product that negatively impacts the environment or society and develop possible solutions to lessen its impact. **8.2.8.ETW.4:** Compare the environmental effects of two alternative technologies devised to address climate change issues and use data to justify which choice is best. **8.2.8.ITH.2:** Compare how technologies have influenced society over time. **8.2.8.ITH.3:** Evaluate the impact of sustainability on the development of a designed product or system. **8.2.8.ITH.4:** Identify technologies that have been designed to reduce the negative consequences of other technologies and explain the change in impact. **8.2.8.EC.1:** Explain ethical issues that may arise from the use of new technologies. <u>Example:</u> Research renewable energy systems and sources, and compare across the United States (climate change).	**9.4.8.IML.5:** Analyze and interpret local or public data sets to summarize and effectively communicate the data. **9.4.8.CT.3:** Compare past problem-solving solutions to local, national, or global issues and analyze the factors that led to a positive or negative outcome. **9.4.8.CI.1:** Assess data gathered on varying perspectives on causes of climate change (e.g., cross-cultural, gender-specific, generational), and determine how the data can best be used to design multiple potential solutions. <u>Example:</u> Research the impact of how nonrenewable energy sources are impacting the environment (climate change). **9.2.8.CAP.20:** Identify the items to consider when estimating the cost of funding a business. <u>Example:</u> Students research the cost of materials and calculate an estimated price for their product in order to make a profit, including costs of taxes and labor.

UNIT/TOPIC ESSENTIAL QUESTIONS AND ENDURING OBJECTIVES/UNDERSTANDINGS	
How are work and energy related? (Phenomenon: Lifting a box to a specific height.) **How does energy change in a given system?** (Phenomenon: A pendulum swinging back and forth.) **How does heat flow from one object to another?** (Phenomenon: A ball bouncing on the ground.)	
STUDENT LEARNING OBJECTIVES	
Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: **Topic 4: Energy** energy, motion, force, work, power, kinetic energy, potential energy, gravitational potential energy, elastic potential energy, mechanical energy, nuclear energy, thermal energy, chemical energy, electrical energy, electromagnetic radiation, law of conservation of energy, thermal energy, heat, temperature	***Students will be able to:*** **Topic 4: Energy** Students will make and use models to define and determine the relationship between energy, motion, force, and work. Students will analyze and interpret the relationship between mass, height, velocity and energy. Students will calculate the amount of work done and the amount of power used. Students will use visual representations to identify factors related to kinetic energy and factors that affect potential energy. Students will integrate quantitative information to explain the relationship between potential and kinetic energy. Students will evaluate the expressions to identify the linear relationship of gravitational potential energy and the nonlinear relationship of kinetic energy. Students will use scientific reasoning to classify, quantify, and measure different forms of energy. Students will use models to represent relationships among different forms of energy. Students will construct explanations to explain how energy changes from one form to another. Students will use models to demonstrate how energy transfers between objects. Students will use proportional relationships to explain how energy is conserved in a system. Students will make and use models to describe and explain how the total thermal energy of a system depends on the types, states, and amounts of matter present.

	Students will gather data and analyze the relationship among thermal energy, temperature, and heat. Students will provide peer feedback to optimize their solutions. Students will revise their designs based on feedback and testing of effectiveness. Students will create a pitch and logo to advertise and "sell" their product. Students will prepare a presentation to pitch their final product.
ASSESSMENT OF LEARNING	
Summative Assessment (Assessment at the end of the learning period)	Students will analyze and develop a model and construct an argument with evidence to explain the science behind the phenomena using the Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices.
Formative Assessments (Ongoing assessments during the learning period to inform instruction)	Quizzes at the end of each lesson, models, claims, evidence, data and research, planning and carrying out investigations, classroom discussions, anecdotal notes
Alternative Assessments (Any learning activity or assessment that asks students to *perform* to demonstrate their knowledge, understanding and proficiency)	PhET Simulations (Energy Skate Park, Energy Conversions), POGILs (What Happens When Marbles Collide?; Energy of Motion: The Effect of Mass and Speed; Potential Energy: Three Examples; When Potential Energy is Transformed), worksheets/activities, PBL (extensions), MakerSpace, modified assessments as per IEPs
Benchmark Assessments (used to establish baseline achievement data and measure progress towards grade level standards; given 2-3 X per year)	Grade level benchmark assessment: Evidence based short response assessments.
RESOURCES	
Core Instructional Materials: Pearson Elevate Science Textbook (Topic 3: Energy)	
Supplemental Materials: Gizmos POGILs Colorado PhET Simulations Rutgers University: Physics Union Mathematics activities ISLE (Integrative Science Learning Environment) Cycle of Learning	

Physical materials for labs (ex: carts, chalk, thermometers, ramps, Newtonian Demonstrators, etc.) Diversity: Scientist of the Month, Black History Month Scientists
Modifications for Learners
See appendix

Topic/Unit 5 Title	Waves	Approximate Pacing	February - March

STANDARDS

Science Standards (NGSS)

Science and Engineering Practices (Students will be able to…)	Disciplinary Core Ideas (Students will know…)	Crosscutting Concepts (Students will connect…)
MS-PS4-1. Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. [Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking.] [Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.] **MS-PS4-2.** Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. [Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions.] [Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.] **MS-PS4-3.** Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. [Clarification Statement: Emphasis is on a basic understanding that waves can be used for	**PS4.A: Wave Properties** A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (MS-PS4-1) A sound wave needs a medium through which it is transmitted. (MS-PS4-2) **PS4.B: Electromagnetic Radiation** When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. (MS-PS4-2) The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2)	**Patterns** Graphs and charts can be used to identify patterns in data. (MS-PS4- 1) **Structure and Function** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2) Structures can be designed to serve particular functions. (MS-PS4-3) **Systems and System Models** Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. **Cause and Effect**

communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen.] [Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device. **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) **PS4.C: Information Technologies and Instrumentation** Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3) **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)	Cause and effect relationships may be used to predict phenomena in natural systems. (MS-LS1-8) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) 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) -

	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)	***Connections to Nature of Science*** **Science is a Human Endeavor** Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

Interdisciplinary Connections:	
ELA / Literacy:	**Mathematics:**
RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic. **(MS-PS4-3)** <u>Example:</u> Students will conduct waves on a string simulation to determine how different variables affect characteristics of waves.	**MP.4** Model with mathematics. **(MS-PS4-1)** <u>Example:</u> Determine the relationship between height and amplitude of a wave. **8.F.A.3** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. **(MS-PS4-1)** <u>Example:</u> Find the slope of a line on a graph representing the relationship between energy and height of a wave.

NJSLA.R7. Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. Example: Students will analyze and interpret data to determine the relationship between height and energy of a wave.	
Computer Science & Design Thinking:	**Career Readiness, Life Literacies, and Key Skills:**
8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team. Example: Use a simulation to investigate the properties of a wave. (Example: Early Tsunami warning system) **8.2.8.ITH.2:** Compare how technologies have influenced society over time. Example: Determine how digital waves are more reliable than analog waves.	**9.4.8.TL.2:** Gather data and digitally represent information to communicate a real-world problem. Example: In Makerspace, students will collect data on their climate change-related project to determine its effectiveness. **9.1.8.FP.6:** Compare and contrast advertising messages to understand what they are trying to accomplish. Example: Use technology to promote and advertise MakerSpace products. **9.1.8.CP.1:** Compare prices for the same goods or services. **9.1.8.CR.4:** Examine the implications of legal and ethical behaviors when making financial decisions. Example: Students will analyze the intended and unintended consequences of climate-related innovations, and apply that thinking to their own project development. **9.1.8.PB.1:** Predict future expenses or opportunities that should be included in the budget planning process. Example: Students will reflect on the added costs and cost savings that climate-related products impact (for example, solar panels on roofs have startup costs but eventually save money on power usage).
UNIT/TOPIC ESSENTIAL QUESTIONS AND ENDURING OBJECTIVES/UNDERSTANDINGS	
What are the properties of mechanical and electromagnetic waves? (Phenomenon: Boats in a harbor bob gently up and down due to the motion of water waves. Compare these waves to laser beams.) **How do waves interact with different types of matter?** (Phenomenon: A pencil in a cup of water looks bent.) **How are digital waves different from analog waves?** (Phenomenon: A digital clock is easier to read than an analog clock.)	
STUDENT LEARNING OBJECTIVES	

Key Knowledge	Process/Skills/Procedures/Application of Key Knowledge
Students will know: **Topic 5: Waves** wave, mechanical wave, medium, electromagnetic radiation, transverse wave, amplitude, longitudinal wave, wavelength, frequency, reflection, refraction, diffraction, absorption, interference, standing wave, resonance, loudness, intensity, decibel, pitch, Doppler effect, electromagnetic wave, electromagnetic spectrum, radio waves, microwaves, visible light, ultraviolet rays, infrared rays, x-rays, gamma rays, transparent, translucent, opaque, diffuse reflection, convex, focal point, concave	***Students will be able to:*** **Topic 5: Waves** Students will evaluate evidence and claims that different types of waves transmit energy in different ways, and waves share common properties that influence the waves' behavior. Students will analyze cause-and-effect relationships and determine how frequency, wavelength, and speed are related. Students will use patterns described in a simple mathematical model of waves to predict the behavior of a wave as it travels from one medium to another. Students will make predictions based on models for how waves change direction and how waves interact with other waves. Students will explain the concepts of diffraction, refraction, and reflection and the ways that waves interact, including constructive and destructive interference. Students will develop and use models to explain how sound waves interact with matter by process of reflection, absorption, transmittal, and diffraction. Students will describe how stiffness, density, and temperature of materials affect the speed of sound. Students will use patterns to identify the characteristics of electromagnetic waves and analyze how the length of the wave impacts the frequency. Students will compare models of electromagnetic wave behavior. Students will explore the waves that make up the electromagnetic spectrum and how models describe the way that frequency and amplitude are related in waves. Students will develop a model of light-matter interactions that explains that transparent and translucent materials transmit light, opaque materials reflect and absorb light, and an object reflects light that is the color of the object. Students will provide peer feedback to optimize their solutions. Students will revise their designs based on feedback and testing of effectiveness. Students will create a pitch and logo to advertise and "sell" their product. Students will prepare a presentation to pitch their final product.
ASSESSMENT OF LEARNING	

Summative Assessment (Assessment at the end of the learning period)	Students will analyze and develop a model and construct an argument with evidence to explain the science behind the phenomena using the Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices.
Formative Assessments (Ongoing assessments during the learning period to inform instruction)	Quizzes at the end of each lesson, models, claims, evidence, data and research, planning and carrying out investigations, classroom discussions, anecdotal notes
Alternative Assessments (Any learning activity or assessment that asks students to *perform* to demonstrate their knowledge, understanding and proficiency)	Gizmos (Waves), PhET Simulations (Wave on a String), POGILs (Exploring Predictable, Repeating Patterns of Data; How Does the Amplitude of a Water Wave Relate to the Wave's Energy?; More Properties of Waves; Waves Everywhere! Water, Sound, and Light; What Happens When Waves Hit Different Kinds of Materials?), worksheets/activities, PBL (extensions), MakerSpace, modified assessments as per IEPs
Benchmark Assessments (used to establish baseline achievement data and measure progress towards grade level standards; given 2-3 X per year)	Grade level benchmark assessment: Evidence based claim assessment
RESOURCES	
Core Instructional Materials: Pearson Elevate Science Textbook (Topic 5: Waves and Electromagnetic Radiation)	
Supplemental Materials: Gizmos POGILs Colorado PhET Simulations Rutgers University: Physics Union Mathematics activities ISLE (Integrative Science Learning Environment) Cycle of Learning Physical materials for labs (ex: slinkies, ropes, wave tank, mirrors, kaleidoscope, etc.) Diversity: Scientist of the Month, Black History Month Scientists, Women History Month Scientists	
Modifications for Learners	
See appendix	

Topic/Unit 6 Title	Motion and Stability; Forces and Interactions	Approximate Pacing	March - June
STANDARDS			
Science Standards (NGSS)			

Science and Engineering Practices (Students will be able to…)	Disciplinary Core Ideas (Students will know…)	Crosscutting Concepts (Students will connect…)
MS-PS2-1. 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-PS2-2.** Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [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.	**PS2.A: Forces and Motion** For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). (MS-PS2-1) The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2) All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)	**Cause and Effect** Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-PS2-3),(MS-PS2- 5) **Systems and System Models** Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems. (MS-PS2-1),(MS-PS2-4) **Energy and Matter** Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior. (MS-PS2-1) **Stability and Change**

Assessment does not include the use of trigonometry.] **MS-PS2-3.** 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-PS2-4.** 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-PS2-5.** Conduct an investigation and evaluate the experimental design to provide	**PS2.B: Types of Interactions** Electric and magnetic (electromagnetic) forces can be attractive or repulsive, and their sizes depend on the magnitudes of the charges, currents, or magnetic strengths involved and on the distances between the interacting objects. (MS-PS2-3) Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small, except when one or both of the objects have large mass—e.g., Earth and the sun. (MS-PS2-4) Forces that act at a distance (electric, magnetic, and gravitational) can be explained by fields that extend through space and can be mapped by their effect on a test object (a charged object, or a ball, respectively). (MS-PS2-5) **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**	Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ETS1-1) The uses of technologies and 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), (MS-EST1-1)

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 limited to qualitative evidence for the existence of fields.] **MS-ETS1-1.** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. **MS-ETS1-2.** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. **MS-ETS1-3.** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. **MS-ETS1-4.** Develop a model to generate data	A solution needs to be tested, and then modified on the basis of the test results, in order to improve it. (MS-ETS1-4) There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. (MS-ETS1-2), (MS-ETS1-3) Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) Models of all kinds are important for testing solutions. (MS-ETS1-4) **ETS1.C: Optimizing the Design Solution** Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution. (MS-ETS1-4)	

for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.		

Interdisciplinary Connections:	
ELA / Literacy:	**Mathematics:**
RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions **(MS-PS2-1),(MS-PS2-3)** Example: Students will use information to pitch their MakerSpace idea to a panel of judges.	**MP.2** Reason abstractly and quantitatively**. (MS-PS2-1),(MS-PS2-2),(MS-PS2-3)** Example: Students determine the relationship between forces, mass, and acceleration in the Newton's Laws investigation. **6.NS.C.5** Understand that positive and negative numbers are used together to describe quantities having opposite directions or values; use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. **(MS-PS2-)** Example: Students discuss velocity and direction of motion with positive and negative signs. **7.EE.B.3** Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. **(MS-PS2-1),(MS-PS2-2)** Example: Students will solve for the momentum, mass or velocity, through a real life momentum problem.
Computer Science & Design Thinking:	**Career Readiness, Life Literacies, and Key Skills:**
8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose. Example: Students will analyze and interpret a distance vs time graph to determine the velocity of an object. **8.2.8.ED.5:** Explain the need for optimization in a design process. **8.2.8.ED.6:** Analyze how trade-offs can impact the	**9.4.8.TL.3:** Select appropriate tools to organize and present information digitally. Example: Students create videos and digital advertising to promote MakerSpace products. **9.2.8.CAP.12:** Assess personal strengths, talents, values, and interests to appropriate jobs and careers to maximize career potential. Example: Creating a solution to their MakerSpace challenge allows students to find strengths in different types of career opportunities. **9.4.8.TL.5:** Compare the process and effectiveness of synchronous collaboration and asynchronous collaboration.

design of a product. **8.2.8.ED.7:** Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches). Example: Students create a prototype for their MakerSpace products.	Example: Students will evaluate and provide feedback to students during their pitch presentations, and examine the benefits and pitfalls to synchronous versus asynchronous learning.
UNIT/TOPIC ESSENTIAL QUESTIONS AND ENDURING OBJECTIVES/UNDERSTANDINGS	
How can we predict the motion of an object? (Phenomenon: Falling skydivers.) **How is the motion of an object affected by forces that act on it?** (Phenomenon: Blowing up a balloon and letting it go.)	
STUDENT LEARNING OBJECTIVES	
Key Knowledge	**Process/Skills/Procedures/Application of Key Knowledge**
Students will know: **Topic 6: Motion and Stability; Forces and Interactions** motion, reference point, force, Newton, friction, gravity, net force, speed, slope, velocity, acceleration, inertia, weight, pivot point	***Students will be able to:*** **Topic 6: Motion and Stability; Forces and Interactions** Students will construct an explanation using reasoning that motion is a change in position relative to a reference point. Students will communicate how balanced and unbalanced forces cause the motion of an object to change. Students will use mathematics and computational thinking to determine the average speed of an object from calculation, and analyze distance-versus-time graphs. Students will engage in argument from evidence to compare the quantities of velocity, speed, and acceleration. Students will analyze and interpret data from graphs to determine acceleration. Students will identify and describe evidence that an object's motion remains the same if forces on it are balanced and an object's motion changes if forces on it are unbalanced. Students will model how factors affect an object's motion to predict the relationship between force, mass, and acceleration. Students will construct explanations using reasoning to describe the effect of action and reaction forces on an object's motion.

	Students will analyze and interpret data to explain how surface texture and the amount of force used to push surfaces together affects the amount of friction. Students will analyze and interpret data to predict how the mass and distance between two objects affect the gravitational force they exert on each other. Students will develop a model to demonstrate the relationship between gravitational potential energy and kinetic energy. Students will provide peer feedback to optimize their solutions. Students will revise their designs based on feedback and testing of effectiveness. Students will create a pitch and logo to advertise and “sell” their product. Students will prepare a presentation to pitch their final product. Students will communicate their final product design to a panel of judges.
ASSESSMENT OF LEARNING	
Summative Assessment (Assessment at the end of the learning period)	Students will analyze and develop a model and construct an argument with evidence to explain the science behind the phenomena using the Disciplinary Core Ideas, Cross Cutting Concepts, and Science and Engineering Practices.
Formative Assessments (Ongoing assessments during the learning period to inform instruction)	Quizzes at the end of each lesson, models, claims, evidence, data and research, planning and carrying out investigations, classroom discussions, anecdotal notes
Alternative Assessments (Any learning activity or assessment that asks students to *perform* to demonstrate their knowledge, understanding and proficiency)	Gizmos (Force and Fan Cars), PhET Simulations (Forces and Motion), POGILs (What Happens When Marbles Collide?; Energy of Motion: The Effect of Mass and Speed; Potential Energy: Three Examples; When Potential Energy is Transformed), worksheets/activities, PBL (extensions), MakerSpace, modified assessments as per IEPs
Benchmark Assessments (used to establish baseline achievement data and measure progress towards grade level standards; given 2-3 X per year)	Grade level benchmark assessment: Evidence based claim responses.
RESOURCES	
Core Instructional Materials: Pearson Elevate Science Textbook (Topic 10: Forces and Motion)	
Supplemental Materials: Gizmos	

POGILs Colorado PhET Simulations Rutgers University: Physics Union Mathematics activities ISLE (Integrative Science Learning Environment) Cycle of Learning Physical materials for labs (ex: carts, ramps, balloons, Newtonian Demonstrator, soccer balls, scooters, etc.) Diversity: Scientist of the Month, Women History Month Scientists
Modifications for Learners
See appendix