Audubon Public Schools

Grade 8: Physical Science

Curriculum Guide

Developed by:

Mr. Matthew Harter

Mr. Christopher Sylvester

August 15, 2018

Table of Contents

Course Description

Grade 8: Physical Science

Physical Science is a course designed to allow students to explore the basic concepts of physics and chemistry. Students will be introduced to the history and nature of science with a focus on matter and energy and their interactions. Specific topics examined during the year include, but are not limited to, kinematics, forces, gravity, different types of energy, the nature of matter, classification of matter, atomic structure, periodic table, chemical bonding, and chemical reactions. Students will be encouraged to explore the relationship between science and everyday life with hands on activities. Students enrolled in physical science need to have successfully passed 7th grade life science.

Overview / Progressions

Grade 8: Physical Science

Overview		Physical Science	Engineering Design
Unit 1 - Kinematics and Forces	**Focus standards (Objectives)**	MS-PS2-1 MS-PS2-2 MS-PS2-3 MS-PS2-4 MS-PS2-5	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4
Unit 2 - Energy	**Focus standards (Objectives)**	MS-PS3-1 MS-PS3-2 MS-PS3-5 MS-PS4-1 MS-PS4-2 MS-PS4-3	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4
Unit 3 - Matter	**Focus standards (Objectives)**	MS-PS1-1 MS-PS1-3 MS-PS1-4 MS-PS3-3 MS-PS3-4	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4
Unit 4 - Chemical Reactions	**Focus standards (Objectives)**	MS-PS1-2 MS-PS1-5 MS-PS1-6	MS-ETS1-1 MS-ETS1-2 MS-ETS1-3 MS-ETS1-4

Physical Science	Grade 8	Unit 1	Marking Period 1

Physical Science Unit 1 - Kinematics and Forces: (45 Instructional Days)

In this unit, students will develop an understanding as to why some objects will keep moving, why objects fall to the ground and why some materials are attracted to each other while others are not. Students answer the question, "How can one describe physical interactions between objects and within systems of objects?" At the middle school level, the PS2 Disciplinary Core Idea from the NRC Framework is broken down into two sub-ideas: Forces and Motion and Types of interactions. By the end of middle school, students will be able to apply Newton's Third Law of Motion to relate forces in order to explain the motion of objects. Students also apply ideas about gravitational, electrical, and magnetic forces to explain a variety of phenomena including beginning ideas about why some materials attract each other while other repe. Students also develop ideas that objects can exert forces on each other even though the objects are not in contact, through fields

Overarching Essential Questions	Overarching Enduring Understandings
• What are forces? • What causes the motion of objects to change? • Why are some objects attracted to each other while other repel each other? • What are Newton's laws of motion? • How can Newton's laws of motion be used to describe the interaction between different objects within a system?	• Forces can be pushes or pulls • Some forces only occur while objects are in contact while other forces can act even when the objects are separated by vast distances • Some forces always result in the attraction between 2 objects such as gravity while other forces such as magnetism can result in either an attractive or repellant interaction. • Newton's laws of motion can be used to mathematically calculate the forces that occur between objects and the resulting effect on motion

Student Learning Objectives	
Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.* Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.	**MS-PS2-1**

Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension	
Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units. Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.	**MS-PS2-2**
Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. Clarification Statement: Examples of devices that use electric and magnetic forces could include electromagnets, electric motors, or generators. Examples of data could include the effect of the number of turns of wire on the strength of an electromagnet, or the effect of increasing the number or strength of magnets on the speed of an electric motor. Assessment Boundary: Assessment about questions that require quantitative answers is limited to proportional reasoning and algebraic thinking.	**MS-PS2-3**
Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. Clarification Statement: Examples of evidence for arguments could include data generated from simulations or digital tools; and charts displaying mass, strength of interaction, distance from the Sun, and orbital periods of objects within the solar system. Assessment Boundary: Assessment does not include Newton's Law of Gravitation or Kepler's Laws.	**MS-PS2-4**
Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact. Clarification Statement: Examples of this phenomenon could include the interactions of magnets, electrically-charged strips of tape, and electrically-charged pith balls. Examples of investigations could include first-hand experiences or simulations.	**MS-PS2-5**

Assessment Boundary: Assessment is limited to electric and magnetic fields, and limited to qualitative evidence for the existence of fields.	
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**MS-ETS1-1**
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Ask questions that can be investigated within the scope of the classroom, outdoor environment, and museums and other public facilities with available resources and, when appropriate, frame a hypothesis based on observations and scientific principles. (MS-PS2-3) **Planning and Carrying Out Investigations** • Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are	**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	**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) **Stability and Change** • Explanations of stability and change in natural or designed systems can be constructed by examining the changes

needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2) • Conduct an investigation and evaluate the experimental design to produce data to serve as the basis for evidence that can meet the goals of the investigation. (MS-PS2-5) **Constructing Explanations and Designing Solutions** • Apply scientific ideas or principles to design an object, tool, process or system. (MS-PS2-1) **Engaging in Argument from Evidence** • Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-PS2-4) - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2),(MS-PS2-4)	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) **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)	over time and forces at different scales. (MS-PS2-2) - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. (MS-PS2-1)

Embedded English Language Arts/Literacy and Mathematics	
English Language Arts/Literacy-	
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)*
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. *(MS-PS2-1),(MS-PS2-2),(MS-PS2-5)*
WHST.6-8.1	Write arguments focused on *discipline-specific content*. (MS-PS2-4)
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-PS2-1),*(MS-PS2-2),*(MS-PS2-5)*
Mathematics –	
MP.2	Reason abstractly and quantitatively. (MS-PS2-1),(MS-PS2-2),(MS-PS2-3)
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-PS2-1)
6.EE.A.2	Write, read, and evaluate expressions in which letters stand for numbers. *(MS-PS2-1),(MS-PS2-2)*
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)*
7.EE.B.4	Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. *(MS-PS2-1),(MS-PS2-2)*

Three-Dimensional Teaching and Learning
In this unit, students will transition from the chemical changes of matter to the physical forces acting upon matter. This will begin with an investigation of motion. During this time, students will design and construct experiments to demonstrate various means of changing the motion of objects. Through analysis of these experiments, students will develop the understanding that motion is the result of forces acting on the object and the matter contained within it. By comparing the effect of multiple forces acting on an object, the students will learn to solve for the net force acting on an object and predict the resulting effect on object's motion. By utilizing cause and effect relationships on stable systems, the students will engage in collaborative activities which allow them to compare various types of force interactions between objects. Using the ideas developed during these activities, students will construct arguments to debate whether or not forces between objects only occur when the objects are in direct contact with each other. At the conclusion of this debate, students will be able to cite evidence and support the claim that some forces occur when objects are in contact with each other while other forces can act through force fields. Furthermore, students will design and create demonstrations to contrast attractive and repellent forces such as electricity and magnetism. This unit will conclude with an overview of Newton's 3 Laws of Motion. Through the use of models, diagrams, and computer simulations, the students will be able summarize and explain each of Newton's laws. In addition, students will be able to algebraically solve Newton's 2nd Law: F =ma. Furthermore, students will be able to describe the action and reaction forces that occur when 2 objects exert forces on each other and explain how these forces are present in our everyday life. To conclude this unit, students will apply their understanding of Newton's laws to design, construct, test, and modify a device that is optimized by utilizing the principles described within Newton's Laws.

Prior Learning
• Mass is a measurement of the matter contained within an object • Mass and weight are related to each other, but are not the same • Gravity is a force that pulls us towards the center of the Earth • How to carry out multi-step mathematical calculations • How to add and subtract negative numbers

Part A: Forces and Motion	
Concepts	**Formative Assessment**
• Forces are pushes or pulls that occur between objects • To change the motion of an object, a force must be applied • When multiple forces are acting on an object, the net force must be calculated to determine if the object's motion will change • The motion of an object is dependent on two factors, the mass of the object and the size of the force	*Students who understand the concepts are able to:* • Explain the relationship between forces acting on an object and the relative motion of the object • Solve for the net force when multiple forces are acting on an object • Predict differences in motion for scenarios involving different masses or different magnitude of forces

Part B: Types of Interactions	
Concepts	**Formative Assessment**
• There are several different types of forces that can occur between objects • Some forces are contact forces and will only occur when the objects are in direct contact with each other • Some forces work through force fields and do not require the objects to be in contact with each other • Gravitational forces are always attractive and occur between any 2 objects with mass • Electric forces occur due to the imbalance and movement of charge • Electric and magnetic forces can be attractive or repulsive and are dependent on the magnitudes of the charges, currents, or magnetic strengths	*Students who understand the concepts are able to:* • Model and demonstrate examples to illustrate that forces can occur through contact or through force fields • Employ examples from everyday life to justify that gravitational forces are always attractive • Design an electric circuit and modify the circuit in order to explain the effect of varying the current or magnitude of charge • Construct a simple (homopolar) motor and manipulate the design to demonstrate the effect of charge, current, or varying magnetic strength

Part C: Newton's Laws of Motion	
Concepts	**Formative Assessment**
• Newton's 3 Laws of Motion are used to describe the forces and motion between objects • 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 • The overall forces and resulting motion can be mathematically calculated using Newton's Laws	*Students who understand the concepts are able to:* • Mathematically calculate the force, mass, or acceleration of an object using Newton's 3 Laws of Motion • Justify that forces always occur in pairs of equal strength but opposite direction by modeling or explaining examples such as jumping, walking, running, skateboarding, swimming, etc.. • Formulate an explanation as to why the motion of objects is different if the forces occurring between them are equal in magnitude • Design and construct a vehicle that employs Newton's 3 Laws to protect an egg (e.g., egg drop from stadium or egg car on track)

Modifications: ***Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)***

- *Restructure lesson using UDL principals (*http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA*)*
- *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.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities*

Leveraging English Language Arts/Literacy and Mathematics

English Language Arts/Literacy-

- Students will create and follow multi-step procedures which must be planned and recorded
- Students will utilize a laboratory notebook for the duration of the course

Mathematics-

- Students will employ algebraic techniques to solve for unknown variables with respect to Newton's Laws.

Samples of Open Education Resources for this unit:

Phet-Forces and Motion-This site provides students with a simulation to investigate the relationship between the forces acting on an object and the motion of that object

BrainPop-Forces-This site provides an overview of forces and how they can cause changes in motion

Khan Academy-Forces-This site provides free online lessons on forces and Newton's laws of motion

Phet-Gravity-This online simulation will provide students with an overview of the gravitational force and what factors affect the strength of this force

Your Weight on Other Worlds - See what you and other objects would weigh on various planets, moon, and stars.

Physical Science	Grade 8	Unit 2	Marking Period 2

Physical Science Unit 2-Energy, Waves, and Electromagnetic Radiation: (45 Instructional Days)

In this unit, students will formulate an answer to the question, "How can energy be transferred from one object or system to another?" At the middle school level, the PS3 Disciplinary Core Idea from the NRC Framework is broken down into sub-core ideas: Definitions of Energy, Conservation of Energy and Energy Transfer, and the Relationship between Energy and Forces. Students develop their understanding of important qualitative ideas about energy including that the interactions of objects can be explained and predicted using the concept of transfer of energy from one object or system of objects to another, and that that the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students understand that objects that are moving have kinetic energy and that objects may also contain stored (potential) energy, depending on their relative positions. Students will also come to develop an understanding of the relationship between force and energy.

Also in this unit, students will formulate an answer to the question, "What are the characteristic properties of waves and how can they be used?" At the middle school level, the PS4 Disciplinary Core Idea from the NRC Framework is broken down into Wave Properties, Electromagnetic Radiation, and Information Technologies and Instrumentation. Students are able to describe and predict characteristic properties and behaviors of waves when the waves interact with matter. Students can apply an understanding of waves as a means to send digital information

Overarching Essential Questions	Overarching Enduring Understandings
• How can energy be transferred between objects in a system? • What is the difference between kinetic and potential energy? • What factors affect the energy of an object? • What happens to the total energy of a system when objects interact? • What are the characteristic properties of waves?	• Energy is transferred from one object to another through forces • Kinetic energy is the energy of motion and depends only on an object's mass and velocity • Potential energy is the stored energy of an object • Potential energy varies based on the relative position of the object to a reference point

• How can the characteristic properties of waves be used? • What is the relationship between waves and electromagnetic radiation? • What happens when waves interact with other materials?	• Although energy can be transferred between objects in a system, the total amount of energy in the system must remain constant • Waves have 3 characteristic properties: wavelength, frequency, and amplitude • Most waves require a medium through which to travel • Digital information can be sent using wave pulses • Electromagnetic radiation is a wave that does not need a medium in order to travel • When waves interact with other materials, they can be transmitted, bent, absorbed, or reflected depending on the material they come in contact with

Student Learning Objectives	
Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. Clarification Statement: Emphasis is on descriptive relationships between kinetic energy and mass separately from kinetic energy and speed. Examples could include riding a bicycle at different speeds, rolling different sizes of rocks downhill, and getting hit by a wiffle ball versus a tennis ball.	**MS-PS3-1**
Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. Clarification Statement: Emphasis is on relative amounts of potential energy, not on calculations of potential energy. Examples of objects within systems interacting at varying distances could include: the Earth and either a roller coaster cart at varying positions on a hill or objects at varying heights on shelves, changing the direction/orientation of a magnet, and a balloon with static electrical charge being brought closer to a classmate's hair. Examples of models could include representations, diagrams, pictures, and written descriptions of systems. Assessment Boundary: Assessment is limited to two objects and electric, magnetic, and gravitational interactions.	**MS-PS3-2**

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object. Clarification Statement: Examples of empirical evidence used in arguments could include an inventory or other representation of the energy before and after the transfer in the form of temperature changes or motion of object. Assessment Boundary: Assessment does not include calculations of energy.	**MS-PS3-5**
Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. Clarification Statement: Emphasis is on describing waves with both qualitative and quantitative thinking. Assessment Boundary: Assessment does not include electromagnetic waves and is limited to standard repeating waves.	**MS-PS4-1**
Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials. Clarification Statement: Emphasis is on both light and mechanical waves. Examples of models could include drawings, simulations, and written descriptions. Assessment Boundary: Assessment is limited to qualitative applications pertaining to light and mechanical waves.	**MS-PS4-2**
Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. Clarification Statement: Emphasis is on a basic understanding that waves can be used for communication purposes. Examples could include using fiber optic cable to transmit light pulses, radio wave pulses in wifi devices, and conversion of stored binary patterns to make sound or text on a computer screen. Assessment Boundary: Assessment does not include binary counting. Assessment does not include the specific mechanism of any given device.	**MS-PS4-3**
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**MS-ETS1-1**

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**

Developing and Using Models • Develop a model to describe unobservable mechanisms. (MS-PS3-2) • Develop and use a model to describe phenomena. (MS-PS4-2) **Analyzing and Interpreting Data** • Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1) **Engaging in Argument from Evidence** • Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5) **Using Mathematics and Computational Thinking** • Use mathematical representations to describe and/or support scientific conclusions and design solutions. (MS-PS4-1) **Obtaining, Evaluating, and Communicating Information** • Integrate qualitative scientific and technical information in written text with that contained in media and visual displays to clarify claims and findings. (MS-PS4-3) - ***Connections to Nature of Science***	**PS3.A: Definitions of Energy** • Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1) • A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2) **PS3.B: Conservation of Energy and Energy Transfer** • When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5) **PS3.C: Relationship Between Energy and Forces** • When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2) **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)	**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) **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) -

Scientific Knowledge is Based on Empirical Evidence • Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4),(MS-PS3-5),(MS-PS4-1)	• The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. (MS-PS4-2) • A wave model of light is useful for explaining brightness, color, and the frequency-dependent bending of light at a surface between media. (MS-PS4-2) • However, because light can travel through space, it cannot be a matter wave, like sound or water waves. (MS-PS4-2) **PS4.C: Information Technologies and Instrumentation** • Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (MS-PS4-3)	***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • Technologies extend the measurement, exploration, modeling, and computational capacity of scientific investigations. (MS-PS4-3) - ***Connections to Nature of Science*** **Science is a Human Endeavor** • Advances in technology influence the progress of science and science has influenced advances in technology. (MS-PS4-3)

Embedded English Language Arts/Literacy and Mathematics

English Language Arts/Literacy –

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-PS3-1),(MS-PS3-5)*

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-PS3-1)

WHST.6-8.1 Write arguments focused on discipline content. *(MS-PS3-5)*

SL.8.5	Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-PS3-2)*
RST.6-8.2	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. *(MS-PS4-3)*
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)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-PS4-3)
Mathematics – **MP.2**	Reason abstractly and quantitatively. (MS-PS3-1),(MS-PS3-4),(MS-PS3-5)
6.RP.A.1	Understand the concept of ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS3-1),*(MS-PS3-5)*
6.RP.A.2	Understand the concept of a unit rate a/b associated with a ratio a:b with b ≠ 0, and use rate language in the context of a ratio relationship. *(MS-PS3-1)*
7.RP.A.2	Recognize and represent proportional relationships between quantities. (MS-PS3-1),*(MS-PS3-5)*
8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
8.EE.A.2	Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. *(MS-PS3-1)*
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-PS3-1),*(MS-PS3-5)*
MP.4	Model with mathematics. (MS-PS4-1)

6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)

Three-Dimensional Teaching and Learning

In this unit, students will expand their understanding of motion by investigating the energy associated with the motion of objects. After using models, diagrams, and computer simulations, students will be able to summarize and explain the concept of kinetic energy. In addition, students will conduct and analyze the results of collaborative activities to determine and justify the relationship between mass and speed with respect to kinetic energy.

After students are able to accurately explain the concept and factors affecting the kinetic energy of an object, the focus will shift towards energy of non-moving objects. Students will analyze everyday scenarios to debate whether or not objects at rest contain energy. At the conclusion of this debate, students will be able to support the claim that objects at rest contain energy known as potential energy and that the amount of potential energy is related to the position of the object.

Students will temporarily transition from the motion of object to the motion of waves and wave properties. Through the use of models and simulations, students will develop an understanding for the various properties of waves and how waves propagate. The focus will begin with traditional waves such as sound and water and progress to electromagnetic waves such as light. During these investigations, students will design and construct experiments to formulate explanations regarding the ability of waves to be transmitted, absorbed, bent, or reflected when coming into contact with different materials. Students will then present and cite evidence to support the claim that interactions between waves and other materials can be structurally designed to take advantage of

these properties (such as stealth technology to absorb radio waves). This will then be applied to the idea of communicating via digital pulse waves.

This unit concludes with an investigation into energy transfer and the conversion of energy between kinetic and potential energy. Students will design, test, and optimize a Rube Goldberg Machine to perform a menial task such as watering a plant or popping a balloon using what they learned about the principles of forces, energy, and the interaction of objects.

Prior Learning
• The motion of objects changes as the result of forces • When two objects interact, forces occur between them resulting in a change in motion • Gravitational forces are always attractive • Objects are pulled towards the center of the Earth due to the gravitational interaction between the Earth and the object • Sound and water travel in waves • Our ears have evolved to convert sound waves into electrical signals • Since waves are in motion, they carry energy • Mathematical properties such as proportionality and inverse relationships • Basic mathematical skills necessary for constructing and interpreting graphs

Part A: Kinetic and Potential Energy	
Concepts	**Formative Assessment**
• The motion energy of an object is known as kinetic energy • Kinetic energy is proportional to the mass of the moving object and grows with the square of its speed	*Students who understand the concepts are able to:* ● Explain what is meant by kinetic and potential energy

• The stored energy of an object in a system is known as potential energy, and can take on many forms • The amount of potential energy is determined by the relative position of an object to a reference point	• Design and construct an experiment to compare the effect of mass and speed on an object's energy and decide which factor affects an object's kinetic energy more • Design and construct an experiment to identify the relationship between potential energy and position • Compare different amounts of kinetic and potential energies in different systems by calculating given characteristics of the system

Part B: Transfer of Energy	
Concepts	**Formative Assessment**
• The total energy of the system must remain constant; this is known as the "Law of Conservation of Energy" • Any change in motion results in a change in energy • When forces occur between objects, energy is transferred • Waves have 3 characteristic properties: wavelength, frequency, and amplitude • The amplitude of a wave is related to the energy it contains • Sound and water waves require a medium to pass through in order to travel	*Students who understand the concepts are able to:* • Model examples to demonstrate the conversion of potential energy into kinetic energy • Summarize the "Law of Conservation of Energy" • Design and construct an experiment to illustrate the transfer of energy between objects • Defend, mathematically, that the total amount of energy in a system remains constant • Explain the 3 properties of waves and the relationship between those properties • Justify that the larger the amplitude of a wave, the more energy it carries • Cite evidence to defend the claim that sound and water waves require a medium to pass through in order to travel

Part C: Information Transfer and Technology	
Concepts	**Formative Assessment**
• Electromagnetic waves are self-propagating and can travel through the vacuum of space • Electromagnetic radiation can be broken down into categories based on the frequency of the wave. • The path of wave can be traced as a straight line except at the surfaces of different materials • Waves can be transmitted, bent, absorbed, or reflected based on the material they encounter • Waves can be used to transmit information • Digitized signals sent as wave pulses are a more reliable method to transmit information	*Students who understand the concepts are able to:* • Compare and contrast analog and digital methods of transmitting information • Devise and implement a method to transmit messages to other students using wave pulses • Compare and contrast matter dependent waves with electromagnetic waves. • Categorize electromagnetic waves based on their frequency • Model the ability of a light wave to be transmitted, bent, absorbed, or reflected by constructing demonstrations using classroom materials

Modifications: ***Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)***

- *Restructure lesson using UDL principals (*http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA*)*
- *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.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities*

Leveraging English Language Arts/Literacy and Mathematics
English Language Arts/Literacy- • Students will be writing procedures, recording data, and presenting conclusions • Integration of data sets to strengthen arguments • Students will be required to compare and contrast different sources of information • Students will be citing specific forms of evidence ***Mathematics-*** • Students will create data tables and incorporate graphs to represent the data • Students will apply graphical analysis to strengthen their conclusions • Students will be solving algebraic problems to determine the kinetic, potential, and total energy of objects in a system • Students will be working with proportional and inverse relationships

Samples of Open Education Resources for this unit:
Phet-Energy Skate Park-This simulation provides students with the ability to investigate kinetic and potential energy BrainPop-Kinetic Energy-This site provides an overview of kinetic energy and the factors that influence the kinetic energy of an object

BrainPop-Potential Energy-This site provides an overview of potential energy and the factors that influence the potential energy of an object

Khan Academy-Energy-This online tutorial has sections devoted to the conservation of energy

Phet-Wave on a String- This simulation allows students to investigate the various properties of waves

Phet-Sound Waves-This simulation allows students to get a visual representation of sound waves and their properties

Phet-Bending Light- This simulation provides a method to investigate the ability of light to be bent by various materials

BrainPop-Electromagnetic Spectrum- This site provides an overview of the electromagnetic spectrum including visual light

Khan Academy-Binary-This tutorial provides an introduction to the binary system used to transmit digital information

Physical Science	Grade 8	Unit 3	Marking Period 3

Physical Science Unit 1-Structures and Properties of Matter: (45 Instructional Days)

In this unit, students will learn to formulate an answer to the questions: "How can particles combine to produce a substance with different properties? How does thermal energy affect particles?" by building understanding of what occurs at the atomic and molecular scale. By the end of middle school, students will be able to apply understanding that pure substances have characteristic properties and are made from a single type of atom or molecule. They will be able to provide molecular level accounts to explain states of matters and changes between states.

Overarching Essential Questions	Overarching Enduring Understandings
• How can particles combine to produce a substance with different properties? • What are the different properties of matter and how can these be used to identify different substances? • How can matter be classified and what are the different classifications? • How can thermal energy affect particles? • What accounts for the differences between solids, liquids, and gases?	• Matter can have both physical and chemical properties. • Characteristic properties such as density can be used to identify different substances • Matter can be classified as a pure substance or mixture and then further classified as an element, compounds, heterogeneous mixture or homogeneous mixture • Adding or removing thermal energy affects the motion and interaction of particles which accounts for their physical state (solid, liquid, or gas)

Student Learning Objectives	
Develop models to describe the atomic composition of simple molecules and extended structures. Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or	**MS-PS1-1**

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.	
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 drawing 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**
Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.* Clarification Statement: Examples of devices could include an insulated box, a solar cooker, and a Styrofoam cup. Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.	**MS-PS3-3**
Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of that 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.	**MS-PS3-4**

Assessment Boundary: Assessment does not include calculating the total amount of thermal energy transferred.	
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**MS-ETS1-1**
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

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

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to predict and/or describe phenomena. (MS-PS1-1),(MS-PS1-4) **Obtaining, Evaluating, and Communicating Information** • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or now supported by evidence. (MS-PS1-3) **Planning and Carrying Out Investigations**	**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.)* • Gases and liquids are made of molecules or inert atoms that are	**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) • Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-4) **Structure and Function**

• Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support the claim. (MS-PS3-4) **Constructing Explanations and Designing Solutions** • Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process, or system. (MS-PS3-3) - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4)	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) • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). (MS-PS1-1) • 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) **PS3.A: Definitions of Energy** • Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of the system depends on the types, states, and amounts of matter present. (MS-PS3-3),(MS-PS3-4) **PS3.B: Conservation of Energy and Energy Transfer** • The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of	• 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) **Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system. (MS-PS3-3) ***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 limitation on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-PS1-3)

	the matter, the size of the sample, and the environment.(MS-PS3-4) • Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3) **ETS1.A: Defining and Delimiting 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 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)*	

Embedded English Language Arts/Literacy and Mathematics

English Language Arts/Literacy-

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-PS1-3)
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)
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)
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-PS3-3),(MS-PS3-4)
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. (MS-PS1-3)

Mathematics-

MP.2	Reason abstractly and quantitatively. (MS-PS1-1),(MS-PS3-4)
MP.4	Model with mathematics. (MS-PS1-1)
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1)
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)

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)
6.SP.B.5	Summarize numerical data sets in relation to their context. (MS-PS3-4)

Three-Dimensional Teaching and Learning

In this unit, students will expand their understanding of matter and its properties. Through the use of models, drawings, and computer simulations, the students will conclude that different substances are composed from different arrangement of atoms.In addition, students will develop an understanding that different substances have different properties.

Students will then use the differences in properties to create a classification system for different types of substances. By employing this classification system, the students will be able to categorize materials as pure substances or mixtures and then further organize the substances as elements, compounds, heterogeneous mixtures, or homogeneous mixtures.

Besides classifying substances by composition, scientists also categorize substances by their physical state (solid, liquid, or gas). Through the use of experiments (such as generating and analyzing a phase diagram by melting ice), models, diagrams, and computer simulations, students will be able to explain that the state of matter is related to the kinetic energy of the particles within the system and that during phase changes the energy is associated with forming or breaking the forces that occur between particles (intermolecular forces).

By employing cause and effect relationships, models to represent the atomic scale, and the relationship between molecular structure and material function, the students will be able to collaboratively obtain, evaluate, summarize, and communicate information using the scientific process.

Prior Learning
• Matter is anything that has mass and volume • An understanding of ratios and how to interpret a ratio • Observations are made using our senses • Energy can be transferred between objects and substances • Kinetic energy is the energy of motion

Part A: Kinetic Molecular Theory	
Concepts	**Formative Assessment**
• The motion of particles is affected by the amount of energy contained in the system • Temperature is a measurement of the average kinetic energy of the particles • Adding thermal energy increases the kinetic energy of the particles • Removing thermal energy decreases the kinetic energy of the particles • Solids are composed of particles with low energy that are in contact with each other; the particles in a solid vibrate in place • Liquids are composed of particles that have more energy than a solid, these particles have the ability to move around freely, but are still bound to one another	*Students who understand the concepts are able to:* • Relate the motion of a particle to the temperature of the system • Develop models and describe what occurs on the particle level when thermal energy is added or removed and during phase changes • Analyze and interpret a phase diagram to describe the structural changes to the particles and their relative motion throughout

• Gases are composed of particles with a large amount of kinetic energy; the particles in a gas are spread out and rarely come in contact with one another • Phase changes occur when the intermolecular forces between particles can or cannot overcome the kinetic energy of the particles	

Part B: Properties and Changes in Matter	
Concepts	**Formative Assessment**
• Physical properties are characteristics of a material that can be observed or measured without changing the composition of the substances of the material • Chemical properties are any property that produces a change in the composition of matter • Physical changes occur when some properties of a material change, but the substances in the material stay the same • Chemical changes occur when a substance reacts and forms one or more new substances	*Students who understand the concepts are able to:* • Contrast physical and chemical properties for substances • Contrast between physical and chemical changes for substances • Categorize substances based on their properties • Solve for the density of various objects by measuring their mass and volume and predict the type of matter for these objects through comparison to known densities

Part C: Classification of Matter	
Concepts	**Formative Assessment**
• Matter can be classified as either a pure substance or a mixture • Pure substances are either elements or compounds. Elements are composed of only 1 type of atom and cannot be broken down into simpler substances. Compounds are composed of 2 or more different types of atoms chemically	*Students who understand the concepts are able to:* • Categorize substances as either pure or mixture. • Develop a method to categorize pure substances as either an element or compound

combined; compounds can only be broken down by chemical means. • Mixtures can be classified as either heterogeneous or homogeneous. For heterogeneous mixtures, the substances comprising the mixture are not evenly distributed throughout. For homogeneous mixtures, the substances comprising the mixture are evenly distributed throughout; in liquid form, these are often called solutions.	• Develop a method to categorize mixtures as either heterogeneous or homogeneous • Create models to represent these substances on the atomic level

Modifications: ***Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)***
• *Restructure lesson using UDL principals (*http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA*)* • *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.* • *Provide ELL students with multiple literacy strategies.*

- *Collaborate with after-school programs or clubs to extend learning opportunities*

Leveraging English Language Arts/Literacy and Mathematics
English Language Arts/Literacy- • Create and present written descriptions to accompany the models developed • Develop flow charts to assist in classification of substances ***Mathematics-*** • Calculate density after measuring mass and volume • Apply graphical analysis to determine the relationship between energy, temperature, and the phase of substances

Samples of Open Education Resources for this unit:
States of matter simulation-an online simulation to reinforce the relationship between energy, temperature, and the phases of matter
Density simulation-an online simulation to investigate the physical property of density
Brainpop-properties of matter-videos and online activities for students related to physical and chemical properties
Brainpop-compounds and mixtures-videos and online activities that help students practice classifying matter

Physical Science	Grade 8	Unit 4	Marking Period 4

Physical Science Unit 4-Chemical Reactions: (45 Instructional Days)

In this unit, students will formulate an answer to the questions: "What happens when new materials are formed? What stays the same and what changes?" by building understanding of what occurs at the atomic and molecular scale during chemical reactions. By the end of middle school, students will be able to provide molecular level accounts to explain that chemical reactions involve regrouping of atoms to form new substances, and that atoms rearrange during chemical reactions.

Overarching Essential Questions	Overarching Enduring Understandings
• What happens when new materials are formed? • What observations can be used to identify chemical reactions • What is the conservation of mass and how does it apply to chemical reactions? • What happens to the energy of a system when a chemical reaction occurs?	• New materials are formed when substances undergo a chemical change. • Observations that can be made to support that a chemical reaction occurred include changes in color, changes in the energy of the system, production of a gas, and production of a precipitate • During chemical reactions, the total mass of the system must remain the same; therefore, chemical equations must be balanced • During chemical reactions, the thermal energy of the system can change; exothermic reactions release thermal energy while endothermic reactions absorb thermal energy

Student Learning Objectives	
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.	**MS-PS1-2**

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.	
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-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**
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	**MS-ETS1-1**
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	**MS-ETS1-2**
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success	**MS-ETS1-3**
Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	**MS-ETS1-4**

The Student Learning Objectives above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*:		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**

Developing and Using Models • Develop a model to predict and/or describe phenomena. (MS-PS1-1),(MS-PS1-4) • Develop a model to describe unobservable mechanisms. (MS-PS1-5) **Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. (MS-PS1-2) **Constructing Explanations and Designing Solutions** • 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) - ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS1-2) **Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena** • Laws are regularities or mathematical descriptions of natural phenomena. (MS-PS1-5)	**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-PS1-2) *(Note: This Disciplinary Core Idea is also addressed by 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. (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.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 to MS-PS1-6)* **ETS1.C: Optimizing the Design Solution**	**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)

	• 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 to 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 to MS-PS1-6)*	

Embedded English Language Arts/Literacy and Mathematics	
English Language Arts/Literacy –	
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)*
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)
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-PS1-2),*(MS-PS1-5)*
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)

Mathematics –	
MP.2	Reason abstractly and quantitatively. (MS-PS1-2),(MS-PS1-5)
MP.4	Model with mathematics. (MS-PS1-5)
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems. *(MS-PS1-2)*,(MS-PS1-5)
6.SP.B.4	Display numerical data in plots on a number line, including dot plots, histograms, and box plots. *(MS-PS1-2)*
6.SP.B.5	Summarize numerical data sets in relation to their context. (MS-PS1-2)

Three-Dimensional Teaching and Learning

In this unit, students will investigate the difference between physical changes and chemical changes in order to explain the chemical processes involved in reactions. To start, the students will evaluate observational evidence to predict when a chemical reaction has occurred. These predictions should include the production of a gas, a change in color, the release of light, the formation of a precipitate, and a change in thermal energy. During this time, students will work collaboratively to design simple chemical reactions to justify that thermal energy can be absorbed or released during reactions depending on substances reacting. In addition, students will compare the starting reactants with the final products to conclude that chemical reactions result in substances with different properties than the original materials.

By utilizing models, diagrams, experiments, and computer simulations, the students will conclude the unit by investigating the "Law of Conservation of Mass." Careful analysis of chemical reactions in a closed system will allow students to develop an understanding that the total mass of substances in a chemical reaction does not change. Interpretation of these results will lead students to conclude that if mass does not change, the total number of atoms cannot change. Finally, students will practice balancing chemical reactions using models and through the algebraic process of adding coefficients to chemical equations.

Prior Learning

- Chemical changes result in substances with new properties
- Observations are made using the senses
- Atoms are the simplest pure substance and make up elements, molecules, and compounds
- Energy can be transferred into and out of a system
- Certain properties of systems can be measured and compared to establish change in a system

Part A: Identifying Chemical Reactions	
Concepts	**Formative Assessment**
• Chemical reactions occur when the atoms for 2 or more different substances re-combine to produce new substances • Chemical reactions are often accompanied by observable signs that provide the scientist with evidence that a reaction has occurred • Chemical reactions often involve a change in thermal energy; some reactions absorb thermal energy and some reactions release thermal energy	*Students who understand the concepts are able to:* ● Compare and contrast various observations for signs of a chemical reaction ● Categorize reactions based on observable evidence and the unique characteristics associated with each ● Design at least 2 different chemical reactions to justify that thermal energy can be absorbed or released during a chemical reaction

Part B: Modeling the Law of Conservation of MAss	
Concepts	**Formative Assessment**
• At the particle level, a chemical reaction is simply a rearrangement of particles to create different substances • The same type and number of particles must be present before and after the reaction occurs	*Students who understand the concepts are able to:* ● Create a particle model and use it to model a chemical reaction at the particle level ● Design an experiment to prove the law of conservation of mass

• Chemical reactions that occur in a closed system can be measured for their adherence to the law of conservation of mass	

Modifications: ***Teachers identify the modifications that they will use in the unit. The unneeded modifications can then be deleted from the list.(See NGSS Appendix D)***

- *Restructure lesson using UDL principles (*http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA*)*
- *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.*
- *Provide ELL students with multiple literacy strategies.*
- *Collaborate with after-school programs or clubs to extend learning opportunities*

Leveraging English Language Arts/Literacy and Mathematics

English Language Arts/Literacy-

- Students will utilize a laboratory notebook for the recording and organization of real-time data

Mathematics-

- Students will integrate basic algebraic skill to mathematically balance the total number of atoms involved in a chemical reaction
- Students will utilize the metric system to measure and calculate to the correct precision

Samples of Open Education Resources for this unit:
Brainpop Chemical Reactions-Provides students with an overview of chemical reactions and why equations need to be balanced
Chemistry Video Lesson-Writing and Balancing Equations-This free video lesson gives students an overview related to writing chemical reactions and balancing reactions
Phet-Balancing Chemical Reactions- This computer simulation gives students the ability to practice balancing chemical reactions
Crash Course-Recognizing Chemical Reactions-This video gives an overview on recognizing chemical reactions

Appendix

Differentiation

Enrichment	● Utilize collaborative media tools ● Provide differentiated feedback ● Opportunities for reflection ● Encourage student voice and input ● Model close reading ● Distinguish long term and short term goals
Intervention & Modification	● Utilize “skeleton notes” where some required information is already filled in for the student ● Provide access to a variety of tools for responses ● Provide opportunities to build familiarity and to practice with multiple media tools ● Leveled text and activities that adapt as students build skills ● Provide multiple means of action and expression ● Consider learning styles and interests ● Provide differentiated mentors ● Graphic organizers
ELLs	● Pre-teach new vocabulary and meaning of symbols ● Embed glossaries or definitions ● Provide translations ● Connect new vocabulary to background knowledge ● Provide flash cards ● Incorporate as many learning senses as possible ● Portray structure, relationships, and associations through concept webs ● Graphic organizers
21st Century Skills	

- Creativity
- Innovation
- Critical Thinking
- Problem Solving
- Communication
- Collaboration

Integrating Technology

- Chromebooks
- Internet research
- Online programs
- Virtual collaboration and projects
- Presentations using presentation hardware and software