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STAGE 1 – DESIRED RESULTS

Unit Title: Matter and Its Interactions

Grade Level: 8

Length/Timing of Unit:

Teacher(s)/Designer(s): Pascack Valley Regional Science Committee

Science State standards addressed (verbatim):

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 analysis of the following properties: density, melting point, boiling point, solubility, flammability, and odor.]

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-PS1-4. **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-PS1-5. **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-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.]

Connections to Common Core Standards (verbatim)**:**

ELA/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), (MSPS1-3)

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-PS1-1),(MS-PS1-2),(MS-PS1-4),(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)

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-PS1-2),(MS-PS1-5)

MP.4 Model with mathematics. (MS-PS1-1),(MS-PS1-5)

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1),(MS-PS1-2),(MS-PS1-5)

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.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (MS-PS1-2)

Essential Questions (3-4) in provocative, student-friendly language:

- EQ 1: How is matter structured?
- EQ 2: How does matter react?
- EQ 3: How are energy and matter connected?

A list of factual knowledge to be taught – *Students will know…*

EQ 1:

- Definitions: matter, atom, molecule, element, pure substance, compound, mixture
- Examples of physical (size, state, texture, density, etc.) and chemical properties (flammability, reactivity, etc.)
- States of matter (solid, liquid, gas, plasma)
- Arrangement and motion of particles in each state
- Definition: temperature and pressure
- Boyle's (P / V) and Charles' Law (T * V)

EQ 2:

- Definitions: chemical reaction, chemical equation, covalent bonds, ionic bonds, metallic bonds, protons, neutrons, electrons, reactants, products, endothermic, exothermic
- Atomic structure and electron configuration
- Bohr and Lewis models
- Law of conservation of mass
- Phase Changes: boiling, evaporation, freezing, melting, condensation, sublimation, and deposition

EQ 3:

- Definitions: heat, thermal energy, volume, convection, conduction, radiation
- Measurement of temperature
- The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule

A list of skills to be taught or reinforced (including habits of mind) – *Students will be able to…*

- Develop models showing the arrangement of particles in an atom
- Use evidence from data to explain the changes in the substances in reference to physical and chemical changes
- Gather and interpret data to describe that synthetic materials come from natural resources and impact society.
- 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.
- 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.
- Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

STAGE 2 – SAMPLE ASSESSMENT

Goal: Balance an equation and create a 3D model of both their reactants and products.

Role: Chemist

Audience: Interviewer

Situational: Job interview for entry level chemist job.

Product/Performance and Purpose:

1. Balancing of equations
2. Creating of 3D model to represent reactants and products of reactions
    a. Sketches of plans prior to construction.
    b. Example model: Ball and stick model using gumdrops and toothpicks. (colors can represent different atoms).
    c. Design key/legend for model.
3. Presenting to class

a. Explain the bonds and atoms used in each molecule.
b. Describe the type of reaction that is occurring. (Synthesis, Decomposition, etc.)
c. Explain when this reaction would take place or would be used in real-life situations (could be done using pictures or video of reaction).

Examples of unbalanced reactions that could be assigned:

$H_20 \rightarrow H_2 + O_2$
$H_2 + O_2 \rightarrow H_2O$
$C_6H_{12}O_6 + (heat) \rightarrow C + H_2O$
$CH_4 + O_2 \rightarrow H_2O + CO_2$
$Fe + NaBr \rightarrow FeBr_3 + Na$
$H_2O_2 \rightarrow H_2O + O_2$

Lesson idea:
http://sciencespot.net/Media/candycompounds.pdf

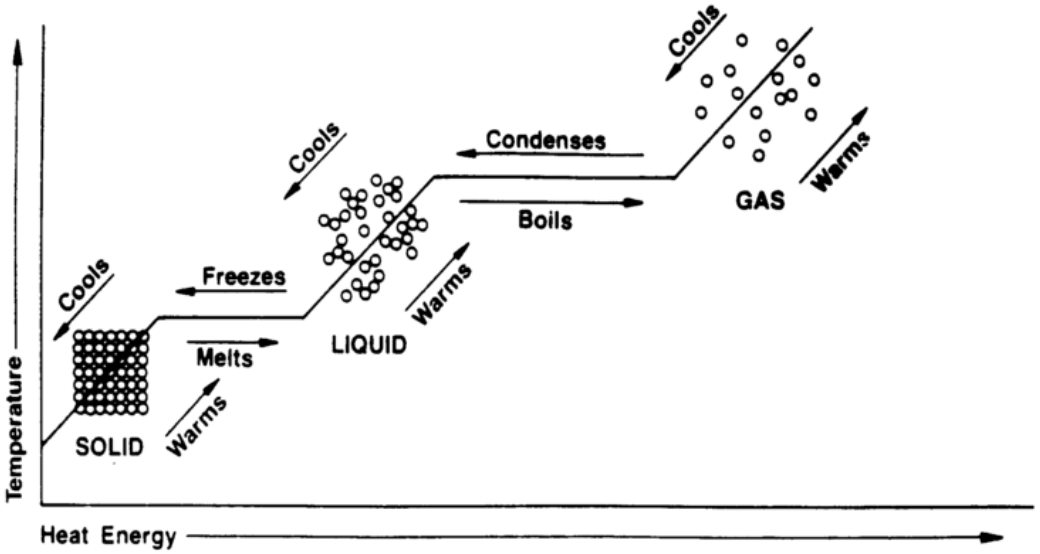
STAGE 3 – LEARNING PLAN

Summary of Learning Activities (Lectures, mini-lessons, read alouds, independent reading, films, website exploration, discussions, dialogues, debates, partner or small-group work, student presentations, reports, journals, reflections, in-class assessments, written reports, essays, research, and homework):

EQ 1: How is matter structured?

- Discoverylearning.com video “Properties of Matter”
- T-chart comparing physical and chemical changes of matter
- Brainpop.com “Properties of matter” with quiz and activity
- Particle Clings Activity https://www.wardsci.com/store/catalog/product.jsp?catalog_number=6730708 https://www.wardsci.com/store/catalog/product.jsp?catalog_number=176460
- Chemical and Physical Changes Lab: Students perform lab experiments and use evidence from their observations to decide if it is a physical or chemical change
- Brainpop - States of Matter & Matter Changing States

Heating and Cooling Curve Graphic



- Hot vs. Cold Demo
- Boyle & Charles' Law Video Clips
- Classifying Matter Identification Activity: Students will view pictures of elements compounds and mixtures and they will have to identify which classification the picture falls under
- Classifying Matter Labs - Mystery Colors (Chromatography) Mystery Bags (Percent Composition)

EQ 2: How does matter react?

- Brainpop on Atoms and Brainpop of Periodic Table
- Hunting Elements Video and Interactive App
- Bohr Model Lab
- Lewis Structure Practice (Dot diagrams)
- Periodic Table Basics
- Formation of Ions Activity
- Brainpop - Chemical Bonds
- Bonding Basics - Ionic and Covalent Bonds http://sciencespot.net/Pages/classchem.html#Anchor-49575
- Bond with a classmate http://sciencespot.net/Pages/classchem.html#Anchor-49575
- Balancing Act
- Types of Reactions Activity
- Poster Scavenger hunt - Law of Conservation of Mass
- Dehydration of Sucrose Video Clip and discussion

EQ 3: How are energy and matter connected?

STAGE 1 – DESIRED RESULTS

Unit Title: Motion and Stability: Forces and Interactions

Grade Level: 8

Length/Timing of Unit:

Teacher(s)/Designer(s): Pascack Valley Regional Science Committee

Science State standards addressed (verbatim):

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

Connections to Common Core Standards (verbatim)**:**

ELA/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),(MSPS2-3)

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)

Essential Questions (3-4) in provocative, student-friendly language:

- EQ 1. How can forces be used to explain the motion of objects?
- EQ 2. How can forces help to explain why some materials attract while others repel?

Big Ideas/ Enduring Understandings: ***Students will understand that…***

EQ 1.

- 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)

EQ 2.

- 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)

A list of factual knowledge to be taught – *Students will know…*

EQ 1:

- Definitions: Force, motion, mass, weight, speed, velocity, acceleration, inertia, gravity, friction, momentum, centripetal force
- Unbalanced forces cause motion in an object.
- Newton's 1st Law of Motion: Inertia
- Newton's 3rd Law of Motion: Action and Reaction.

EQ 2:

- Definitions: Forces, attract, repel, magnetism, poles, gravity, charges, currents
- Relationship between strength of magnetic field and distance
- Gravity is related to the mass of the objects and distance between the objects.

A list of skills to be taught or reinforced (including habits of mind) – *Students will be able to…*

- Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- 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.
- Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.
- Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
- 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.

STAGE 2 – SAMPLE ASSESSMENT

Laws of Motion Application Lab

Goal: Explain how forces relate to the motion of objects through a series of application labs

Role: NHTSA (National Highway and Traffic Safety Administration) Engineer

Audience: Prospective Car Buyers

Situation: Tesla Motor Company has developed a new car, and it needs to be tested for safety. You are responsible for analyzing crash test data and suspension components.

Product/ Performance and Purpose:

1. Collect data for each part of laws of motion lab
    a. Station 1: Inertia Crash Test Dummies: Using a car on a ramp and a simulated "person" (i.e. ping pong ball, penny, etc.), students will measure the impact of a crash.
    b. Station 2: Elastic Force Spring: Using different masses on a spring, students will calculate the force exerted by the mass using the spring constant.
    c. Station 3: Action Reaction: Using a Newton's cradle, similar device or online simulation, students will predict and explain the action-reaction between two objects.
2. Graph and analyze data.
3. Write a conclusion relating the force explored in the lab to the motion of the objects involved and communicate findings to advise the Tesla motor company on the design and safety of their new car.

Standards and Criteria:
Students will be required to complete lab procedures and collect the necessary data. Students should be consistently making qualitative and quantitative observations as they perform these lab activities. A conclusion must be written for each experiment relating the force and motion involved in the lab activity.

STAGE 3 – LEARNING PLAN

EQ 1. How can forces be used to explain the motion of objects?
Commander of the Nautilus - velocity
http://www.nautiluslive.org/kids

Forces and Movement
http://www.bbc.co.uk/schools/scienceclips/ages/6_7/forces_movement.shtml

Force and Mass
http://www.bbc.co.uk/schools/scienceclips/ages/10_11/forces_action.shtml

Force and Friction
http://www.bbc.co.uk/schools/scienceclips/ages/8_9/friction.shtml

Balloon Car Technology Learning Activity(rf): Student design and create a vehicle that is powered from the air from a 12" balloon.
Goal#1 - vehicle must travel at least 10' from a stopped position averaging 1m/sec.
Goal#2 - Redesign your vehicle to go farther and faster than it did.

EQ 2. How can forces help to explain why some materials attract while others repel?
Determine weight on other planets: http://www.factmonster.com/ipka/A0875450.html
Discussion on Balanced/Unbalanced force, center of gravity: Tug-o-war (sumo vs orangutan)
https://www.youtube.com/watch?v=QfDxg0pJAX4
Discussion on inertia, momentum:Train vs Tornado
https://www.youtube.com/watch?v=azV5bC2br-Q

EQ 1:

- Definitions: Force, motion, mass, weight, speed, velocity, acceleration, inertia, gravity, friction, momentum, centripetal force
- Unbalanced forces cause motion in an object.
- Newton's 1st Law of Motion: Inertia
- Newton's 2nd Law of Motion: F=ma
- Newton's 3rd Law of Motion: Action and Reaction.

EQ 2:

- Definitions: Forces, attract, repel, magnetism, poles, gravity, charges, currents
- Relationship between strength of magnetic field and distance
- Gravity is related to the mass of the objects and distance between the objects.

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STAGE 1 – DESIRED RESULTS

Unit Title: Energy

Grade Level: 8

Length/Timing of Unit:

Teacher(s)/Designer(s): Pascack Valley Regional Science Committee

Science State standards addressed (verbatim):

MS-PS3-1. **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-PS3-2. **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 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-PS3-3. **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-PS3-4. **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-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 object.] [Assessment Boundary: Assessment does not include calculations of energy.]

Connections to Common Core Standards (verbatim)**:**

ELA/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.6-8.3 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-PS3-1)

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

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-PS3-3),(MS-PS3-4)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)

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 $b \neq 0$, 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 $\sqrt{2}$ 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)

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

Essential Questions (3-4) in provocative, student-friendly language:

- EQ1: What is energy?
- EQ 2: How is energy conserved and transferred?
- EQ 3: What is the relationship between energy and forces?

Big Ideas/ Enduring Understandings: Students will understand that…

EQ 1:

- Kinetic energy is the energy of motion and it is proportional to the mass of the moving object and grows with the square of its speed. (PS3-1)
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (PS3-2)
- Temperature is a measure of the average kinetic energy of particles of matter. (PS3-3)(PS3-4)
- The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (PS3-3)(PS3-4)

EQ 2:

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (PS3-5)
- 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. (PS3-4)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (PS3-3)

EQ 3: 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. (PS3-2)

A list of factual knowledge to be taught – *Students will know…*

EQ 1:

- Definitions: energy, kinetic energy, potential energy, temperature, matter, mass, heat, work, mass, speed, gravitational potential energy, velocity, acceleration
- Formulas: kinetic energy and potential energy
- kinetic molecular model of particles
- the transformation between kinetic and potential

EQ 2:

- Definitions: conduction, convection, radiation, exothermic, endothermic
- Law of energy conservation
- Dynamics of equilibrium

EQ 3:

- Definitions: gravity, force, inertia, electric, magnetic, polarity
- relationships between two objects colliding (conservation of momentum)
- mechanical vs. chemical energy
- Formula: f = ma

A list of skills to be taught or reinforced (including habits of mind) – *Students will be able to…*

- 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.
- 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.
- Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.
- 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.
- 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.

STAGE 2 – SAMPLE ASSESSMENT

Assessments (Quizzes, tests, and a performance task to assess student mastery formatively and summatively, including an exemplar of proficient student work and a scoring guide for the performance task):

Goal: Create a product that shows the relationship between energy and force.

Role: Roller Coaster Designer

Audience: Theme park director, theme park visitors

Situation: You are hired to design and build a model of a rollercoaster for a theme park.

Product/ Performance and Purpose:

1. Create a graph that shows relationship between potential, kinetic energy, mass, and speed of the roller coaster at different points along its path.
2. Create Rollercoaster
    - Create a theme for your roller coaster.
    - Design a layout for your coaster with at least 3 special features (loop, corkscrew, bend, twist, etc.) with appropriate names that relate to the theme
    - List design materials for coaster using recyclable materials.
    - Construct a roller coaster that is safe (test marble doesn't fall off), has a start and stop, includes all three features, and has a cohesive theme.
3. Write a lab report that addresses the connection between energy and forces involved in testing the roller coaster.

Standards and Criteria:

Students will create a model of their roller coaster and write a lab report containing the following standards:

- Explain why it is important for engineers to understand how roller coasters work.
- Explain in physics terms how their model roller coasters work.
- Discuss the effects of gravity and friction in the context of their roller coaster designs.
- Use the principle of conservation of energy to explain the design and layout of roller coasters.
- Identify points in a roller coaster track at which a car has maximum kinetic and potential energy.
- Identify points in a roller coaster track where a car experiences more or less than 1 g-force.
- Identify points in a roller coaster track where a car accelerates and decelerates.

STAGE 3 – LEARNING PLAN

Summary of Learning Activities (Lectures, mini-lessons, read-alouds, independent reading, films, website exploration, discussions, dialogues, debates, partner or small-group work, student presentations, reports, journals, reflections, in-class assessments, written reports, essays, research, and homework)

EQ1: What is energy?

- Brain Pop: Forms of Energy
- Brain Pop: Potential Energy, Kinetic Energy
- Spinner Lab: Students manipulate set amounts of weight and analyzing the difference in the number of spins the arms make with more or less weight on the arm
- Roller Coaster Challenge: Student use pipe insulation tubes to create a roller coaster track. THe goal is to get the marble

from one end to the other without helping it along - thus re. Starting with groups of four, then half class, then full class, then adding hills, turns, loops, etc to make it more challenging

- Coaster Creator http://content3.jason.org/resource_content/content/digitallab/4859/misc_content/public/coaster.html
- Roller Coaster Web Quest (rf): Questions asked using this web site http://science.howstuffworks.com/engineering/structural/roller-coaster.htm
- Brain Pop: Heat
- Heat and Temperature http://www.wonderville.ca/asset/DSAHeatandTemperature
- Corn Starch and Water clip https://www.youtube.com/watch?v=1UVjOoJaWGo , https://www.youtube.com/watch?v=f2XQ97XHjVw

EQ 2: How is energy conserved and transferred?

- Brain Pop: Law of Conservation of Mass
- Pasta Lab (rf): Students boil water and cook pasta and measure expansion rates
- Marshmallow Lab (rf): Students heat marshmallows at certain heights above a burner flame and measure the expansion rates
- Flame Test Lab (rf): Students heat various metal salts (sodium chloride, copper chloride, etc) over a burner flame and observe/analyze the color that is produced
- Elephant Toothpaste Demo (rf): St. observe a reaction between 27% H^2O^2 and Potassium or Sodium Iodine
- Boiling Water Lab (myths covered vs not covered) (rf):St. Heat water or ice cubes and investigate if liquid will boil faster if it is covered or uncovered
- Physical / Chemical Properties Labs (with sugar cubes) (rf)

EQ 3: What is the relationship between energy and forces?

- Cookie Drop Project (rf)
- Mythbusters - episode “Penny Drop”
  - part 1 https://www.youtube.com/watch?v=kY15tu2V4GA
  - part 2 https://www.youtube.com/watch?v=HB7E_t0ldRA
- Determine your weight and age on other planets b/c of gravity and revolutional period http://www.factmonster.com/ipka/A0875450.html
- Pool Practice http://www.knowledgeadventure.com/games/pool-practice.aspx
- Launching Projectiles Planet Projectile Game
- Lunar Lander http://phet.colorado.edu/en/simulation/lunar-lander

EQ 1:

- Definitions: energy, kinetic energy, potential energy, temperature, matter, mass, heat, work, mass, speed, gravitational potential energy, velocity, acceleration
- Formulas: kinetic energy and potential energy
- kinetic molecular model of particles
- the transformation between kinetic and potential

EQ 2:

- Definitions: conduction, convection, radiation, exothermic, endothermic
- Law of energy conservation
- Dynamics of equilibrium

EQ 3:

- Definitions: gravity, force, inertia, electric, magnetic, polarity
- Relationships between two objects colliding (conservation of momentum)
- Mechanical vs. chemical energy

STAGE 1 – DESIRED RESULTS

Unit Title: Waves and Electromagnetic Radiation

Grade Level: 8

Length/Timing of Unit:

Teacher(s)/Designer(s): Pascack Valley Regional Science Committee

Science State standards addressed (verbatim):

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 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.*]

Connections to Common Core Standards (verbatim)**:**

ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-PS4-3)

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)
SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS4-1),(MS-PS4-2)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-PS4-1)

MP.4 Model with mathematics. (MS-PS4-1)

6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (MS-PS4-1)

6.RP.A.2 Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS4-1)

7.RP.A.2 Recognize and represent proportional relationships between quantities. (MS-PS4-1)

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-PS4-1)

Essential Questions (3-4) in provocative, student-friendly language:

- EQ 1: What are the common properties of different types of waves?
- EQ 2: How are waves used in society?

Big Ideas/ Enduring Understandings: Students will understand that…

EQ 1:

- A simple wave has a repeating pattern with a specific wavelength, frequency, and amplitude. (PS4-1)
- A sound wave needs a medium through which it is transmitted. (PS4-2)
- 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. (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. (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. (PS4-2)

EQ 2:

- Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information. (PS4-3)

A list of factual knowledge to be taught – Students will know…

EQ 1:

- Definition: wavelength, frequency, amplitude, wave, sound, medium, transmission
- Parts of a wave
- Formula: wavelength & frequency
- Types of mediums
- Definitions: light, reflection, refraction, absorption, color, transparency, opacity, translucent, brightness, concave, convex, lens
- Angle of incidence
- Angle of reflection
- Types of waves

EQ 2:

- Definitions: pulse, encoding, transmitting
- fiber optics, computer binary code/systems, radar systems, sonar systems, nuclear power, x-rays, microwaves, radio waves, light waves, Wi Fi devices
- graphic of the electromagnetic spectrum

A list of skills to be taught or reinforced (including habits of mind) – Students will be able to…

- 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.
- Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.
- 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.

STAGE 2 – SAMPLE ASSESSMENT

Goal: Support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals. (*Clarification*: While most forms of communication depend on EM waves, some forms may be more dependable than others.)

Role: Communications Engineer

Audience: Communication User

Situation: You are a communications engineer for SkyNet and need to make a presentation to investors to back your method of digital encryption.

Product/ Performance and Purpose: Presentation arguing the reliability of digital vs. analog encryption.

Standards and Criteria:

Students need to create a presentation with the following criteria:

1. Provide a brief history of telecommunication through the ages. (Examples could include such elements as Morse code, radio waves, binary patterns, etc.)
2. Compare and contrast digital and analog EM signals (e.g. visual models of digital and analog waves).
3. Based on the research, choose a method of digital encryption and construct an argument as to why your method will be more reliable than analog information transmittance. Provide evidence and examples to support this claim.

STAGE 3 – LEARNING PLAN

Summary of Learning Activities (Lectures, mini-lessons, readalouds, independent reading, films, website exploration, discussions, dialogues, debates, partner or small-group work, student presentations, reports, journals, reflections, in-class assessments, written reports, essays, research, and homework):

EQ 1: What are the common properties of different types of waves?

- Brainpop - Waves & Electromagnetic Spectrum
- Phet simulation waves on a string https://phet.colorado.edu/en/simulation/wave-on-a-string
- Diagram parts of a wave - http://www.physicsclassroom.com/Class/waves/u10l2a.cfm
- Slinky Lab - simulate waves
- Use models

EQ 2: How are waves used in society?

- Electromagnetic spectrum
    - Diagram 1843437_orig.png
- http://educade.org/lesson_plans/investigate-wave-properties-and-the-electromagnetic-spectrum-with-wave-blaster - *ThermBot: Wave Blaster* is a digital science simulation game that shows students how radiation waves, its properties (medium, wavelength, frequency, and thermal energy), and the electromagnetic (EM) spectrum are associated with everyday objects.
- http://www2.gsu.edu/~mstjrh/waves.html - Webquest exploring the electromagnetic spectrum