Bi-Borough Consortium of Oradell and River Edge

Science Curriculum
Grade 6
2016

Mr. Paul Saxton, Superintendent, Oradell Public School

Dr. Tova Ben-Dov Superintendent, River Edge Public Schools

Ms. Megan Bozios, Principal, Oradell Public School

Ms. Denise Heitman, Principal, Cherry Hill School

Mr. Michael Henzel, Principal, Roosevelt School

Ms. Julia Diminich, Bi-Borough Supervisor of Curriculum, Instruction & Assessment

<u>2016 Science Curriculum Committee</u>
Scott Duthie, Teacher, Oradell
Michael Hagopian, Supervisor of Instruction, Oradell
Denise Kuehner, Science Teacher, Oradell
Lisa Patrocinio, Teacher, River Edge
Adrienne Spano, Supervisor of Science and Math, River Edge
Beth Unanue, Teacher

TABLE OF CONTENTS

SIXTH GRADE SCIENCE CURRICULUM

UNIT ONE - Structure and Properties of Matter

Estimated Time Frame: Approximately 40-45 days

NEW JERSEY STUDENT LEARNING STANDARDS

Science

Disciplinary Core Ideas

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 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 sub-units (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*)

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-PS1-3*) (Note: This Disciplinary Core Idea is also addressed by *MS-PS1-2* and *MS-PS1-5*.)

PS3.A: Definitions of Energy

- The term “heat” as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (*secondary to MS-PS1-4*)
- The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (*secondary to MS-PS1-4*)

Crosscutting Concepts

Cause and Effect

- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (*MS-PS1-4*)

Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. (*MS-PS1-1*)

Structure and Function

- Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (*MS-PS1-3*)

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to predict and/or describe phenomena.(*MS-PS1-1*),(*MS-PS1-4*)

Obtaining, Evaluating, and Communicating Information

Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used and describe how they are supported or not supported by evidence. (*MS-PS1-3*)

Connections to Engineering, Technology, and Applications of Science

Interdependence of Science, Engineering, and Technology

- Engineering advances have led to important discoveries in virtually every field of science, and scientific discoveries have led to the development of entire industries and engineered systems. (*MS-PS1-3*)

Influence of Science, Engineering and Technology on Society and the Natural World

- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (*MS-PS1-3*)

NEW JERSEY STUDENT LEARNING STANDARDS

Connections to:

Technology

- *8.1* Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
- *8.2* Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

ELA

Reading Standards for Science and Technical Subjects

- *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*)
    - *For example, cite specific textual evidence to support analysis of science and technical texts on the characteristic properties of pure substances. Attend to precise details of explanations or descriptions about the properties of substances before and after they undergo a chemical process.*

- *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)*
    - *Analyze quantitative properties of substances before and after a chemical process has occurred with a version of that information expressed visually, or integrate technical information about the characteristic properties of substances before and after a chemical process has occurred with a version of that information expressed visually.*

Writing- Literacy in History/SS, Science and Technical Subjects

- *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

Standards for Mathematical Practice

- *MP.2* Reason abstractly and quantitatively. (*MS-PS1-1*)
    - *Reason quantitatively with amounts, numbers, and sizes for properties like density, melting point, boiling point, solubility, flammability, and odor, and reason abstractly by assigning labels or symbols.*
- *MP.4* Model with mathematics (*MS-PS1-1*)
    - *For example, integrate quantitative or technical information about the composition of simple molecules and extended structures that is expressed in words in a text with a version of that information expressed in a model.*
    - *For example, develop a mathematical model to describe the atomic composition of simple molecules and extended structures.*

Ratios and Proportional Relationships

- *6.RP.A.3* Use ratio and rate reasoning to solve real-world and mathematical problems. (*MS-PS1-1*)
    - *For example, use ratio and rate reasoning to describe the atomic composition of simple molecules and extended structures.*
    - *For example, use ratio and rate reasoning to determine whether a chemical reaction has occurred.*

The Number System

- *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.

    - *For example, display numerical data for properties such as density, melting point, solubility, flammability, and order in plots on a number line, including dot plots, histograms, and box plots.*
    - *For example, summarize numerical data sets on the properties of substances before and after the substances interact to determine whether a chemical reaction has occurred. The summary of the numerical data sets must be in relation to their context.*

<u>21st Century Life and Careers</u>

- *9.3.12.AC.2* Use architecture and construction skills to create and manage a project.
- *9.3.12.AC-DES.1* Justify design solutions through the use of research documentation and analysis of data.
- *9.3.12.AC-DES.2* Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
- *9.3.12.AC-DES.6* Apply the techniques and skills of modern drafting, design, engineering, and construction to projects.
- *9.3.MN-HSE.3* Demonstrate a safety inspection process to assure a healthy and safe manufacturing environment.
- *9.3.MN-MIR.2* Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.

BIG IDEA/COMMON THREAD

Pure substances have characteristic physical and chemical properties, and are made from a single type of atom or molecule.

ENDURING UNDERSTANDINGS

Matter is composed of atoms and molecules which can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter (Appendix E, NGSS, PS1A Structure of Matter, gr. 6-8)

ESSENTIAL QUESTIONS

- How can one explain the structure, properties, and interactions of matter?
- How can one describe and model the atomic composition of simple molecules and extended structures?
- How are synthetic materials derived from natural resources and how do they impact society?
- How can one describe and model changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed?

ASSESSMENT

- Teacher-created formative assessments, such as:
  - Develop a model of a simple structure.
  - Use the model of the simple structure to describe its atomic composition.
  - Develop a model of an extended structure.
  - Use the model of the extended structure to describe its repeating subunits.
- District-created summative assessments
- Performance assessments (presentations, posters, etc.)
- Teacher observations, conferences
- Hands-on lab experiences

UNIT OBJECTIVES

Students will be able to …

- Develop models to describe the atomic composition of simple molecules and extended structures. *(MS-PS1-1)*
  [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, three-dimensional ball and stick structures, or computer representations showing different molecules with different types of atoms.]

Disciplinary Ideas

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

Crosscutting Concepts

- Recognize that time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

Science and Engineering Practices

- Develop a model to predict and/or describe phenomena

- Gather and make sense of information to describe that synthetic materials come from natural resources and impact society. *(MS-PS1-3)*

[Clarification Statement: Emphasis is on natural resources that undergo a chemical process to form synthetic material Examples of new materials could include new medicines, foods, and alternative fuels.]

Disciplinary Ideas

- Understand that each pure substance has characteristic physical and chemical properties that can be used to identify it.
- Understand that substances react chemically in characteristic ways.
- Understand that 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.

Crosscutting Concepts

- Recognize that structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

Science and Engineering Practices

- Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods.
- Describe how these publication sources are supported or not supported by evidence.

- 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 *(MS-PS1-4)*
  [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.)

Disciplinary Ideas

- Understand that gases and liquids are made of molecules or inert atoms that are moving about relative to each other.
  - In a liquid, the molecules are constantly in contact with others.
  - In a gas, the molecules are widely spaced except when they happen to collide.
  - In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
- Describe and predict the changes of state that occur with variations in temperature or pressure using models of matter.

- Understand that the term “heat” as used in everyday language refers both to thermal energy and, in science, for the transfer of that thermal energy from one object to another.
- Explain how the relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

Crosscutting Concepts

- Understand that cause and effect relationships may be used to predict phenomena in natural or designed systems.

Science and Engineering Practices

- Develop a model to predict and/or describe phenomena.

SUGGESTED ACTIVITIES

- *Building Simple and Complex Molecules - Grade 7-8 (A. Lund): Structure and Properties of Matter; Building Models*
  http://www.resa.net/curriculum/curriculum/science/professionaldevelopment/ngss-pd/lesson-plans-exploring-ngss/
- *Properties of Matter - Grade 6 (J.Douglas)/Properties of Matter - Grade 6 (J. Douglas, attachments)*: Molecules in Motion Investigation
  http://www.resa.net/curriculum/curriculum/science/professionaldevelopment/ngss-pd/lesson-plans-exploring-ngss/

UNIT VOCABULARY

matter - anything that has mass and takes up space
atom - basic unit (building blocks) of an element
proton - positively charged part of the atom located in the nucleus
neutron - part of the atom without electrical charge with about the same mass as a proton
electron - negatively charged part of the atom with little atomic mass
nucleus - center of the atom that contains both neutrons and protons
molecule - a group of atoms bonded together, representing the smallest basic unit with particular characteristics
substance- a particular kind of matter with uniform (same) properties
physical property - observable and measurable characteristics such as color, density, texture, or state of matter that does not change the substances’ structure
chemical property - characteristics that become evident before, during or after a chemical reaction that change the substances’ identity
thermal energy - heat energy
synthetic- made by combining different substances; not naturally occurring

RESOURCES

Supplies: As per lab manuals

Websites:

www.discoveryeducation.com - videos and lesson ideas
www.opened.com - background information for teachers and lesson ideas
www.inquiryinaction.org - chemistry lab experiments
http://www.chem4kids.com - background information for students
https://phet.colorado.edu - online simulations
https://concord.org/stem-resources - online simulations (requires Java)
https://ngsschemistry.wordpress.com/ - lesson ideas
http://learningcenter.nsta.org/ - background information for teachers and lesson ideas
http://ngss.nsta.org/Classroom-Resources.aspx - lesson ideas
http://sciencespot.net/Pages/refdeskNextGen.html - lesson ideas

MODIFICATIONS

- 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.
- Restructure lesson using UDL principles
  - o http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA
- See NGSS Appendix D
  - o http://www.nextgenscience.org/sites/ngss/files/Appendix%20D%20Diversity%20and%20Equity%206-14-13.pdf

SIXTH GRADE SCIENCE CURRICULUM

UNIT TWO - Chemical Reactions

Estimated Time Frame: Approximately 40-45 days

NEW JERSEY STUDENT LEARNING STANDARDS

Disciplinary Core Ideas

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

- 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*)

Crosscutting Concepts

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*)

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop a model to describe unobservable mechanisms. (*MS-PS1-5*)

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings. (*MS-PS1-2*)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific knowledge, principles, and theories.

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. (*MS-PS1-6*)

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*)

NEW JERSEY STUDENT LEARNING STANDARDS

Connections to:

Technology

- *8.1* Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
- *8.2* Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

ELA

Reading Standards for Science and Technical Subjects

- *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*)
    - *For example, cite specific textual evidence to support analysis of science and technical texts on the design and modification of a device that controls the transfer of energy to the environment using factors such as type and concentration of a substance.*
    - *Draw evidence from informational texts to support analysis, reflection, and research on the design and modification of a device that controls the transfer of energy to the environment using factors such as type and concentration of a substance.*
- *RST.6-8.3* Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (*MS-PS1-6*)
    - *For example, follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks related to chemical reactions that release energy and some that store energy.*
    - *Conduct research on the design and modification of a device that controls the transfer of energy to the environment using factors such as type and concentration of a substance 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.

- *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)*
  - *For example, include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points on the design and modification of a device that controls the transfer of energy to the environment.*

Writing- Literacy in History/SS, Science and Technical Subjects

- *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)*
  - *For example, compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the design and modification of a device that controls the transfer of energy to the environment using factors such as type and concentration of a substance.*

<u>Mathematics</u>

Standards for Mathematical Practice

- *MP.2* Reason abstractly and quantitatively. *(MS-PS1-2),(MS-PS1-5)*
  - *For example, reason quantitatively and abstractly during communication about melting or boiling points.*
  - *For example, reason quantitatively and abstractly: Reason quantitatively using numbers to represent the criteria (amount, time, and temperature of substance) when testing a device that either releases or absorbs thermal energy by chemical processes; reason abstractly by assigning labels or symbols*
- *MP.4* Model with mathematics. *(MS-PS1-5)*
  - *For example, use mathematics to model the law of conservation of matter*

Ratios and Proportional Relationships

- *6.RP.A.3* Use ratio and rate reasoning to solve real-world and mathematical problems. *(MS-PS1-2),(MS-PS1-5)*
  - *For example, use ratio and rate reasoning to describe how the total number of atoms does not change in a chemical reaction, and thus mass is conserved.*
  - *For example, collect and analyze numerical data from tests of a device that either releases or absorbs thermal energy by chemical processes. 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. Pose problems with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate the numerical data with numbers in any form, convert between forms as*

appropriate, and assess the reasonableness of answers using mental computations and estimation strategies.

Statistics and Probability

- *6.SP.B.4* Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (*MS-PS1-2*)
    - *Develop a probability model and use it as part of an iterative process for testing to find the probability that a promising design solution will lead to an optimal solution. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy in order to ultimately develop an optimal design.*
- *6.SP.B.5* Summarize numerical data sets in relation to their context (*MS-PS1-2*)
    - *For example, integrate quantitative information expressed in words about atoms before and after a chemical process with a version of that information expressed in a physical model or drawing, including digital forms.*

<u>21st Century Life and Careers</u>

- *9.3.12.AC.2* Use architecture and construction skills to create and manage a project.
- *9.3.12.AC.6* Read, interpret and use technical drawings, documents and specifications to plan a project
- *9.3.12.AC-DES.1* Justify design solutions through the use of research documentation and analysis of data.
- *9.3.12.AC-DES.2* Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
- *9.3.12.AC-DES.6* Apply the techniques and skills of modern drafting, design, engineering, and construction to projects.
- *9.3.MN-HSE.3* Demonstrate a safety inspection process to assure a healthy and safe manufacturing environment
- *9.3.MN-MIR.2* Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.

BIG IDEA/COMMON THREAD

Chemical reactions involve regrouping of atoms to form new substances. Atoms rearrange during chemical reactions.

ENDURING UNDERSTANDINGS

Reacting substances rearrange to form different molecules, but the number of atoms is conserved. Some reactions release energy and others absorb energy.
(Appendix E, NGSS, PS1.B, Chemical Reactions, gr. 6-8)

ESSENTIAL QUESTIONS

- How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?
- How can we analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred?
- How can we develop and create models to describe how the total number of atoms does not change in a chemical reaction, thus conserving mass?
- How can we design a project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes?

ASSESSMENT

- Teacher-created formative assessments
- District-created summative assessments
- Performance assessments (presentations, posters, etc.)
- Teacher observations, conferences
- Hands-on lab experiences

UNIT OBJECTIVES

Students will be able to …

- 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 HCl.]*

Disciplinary Ideas

- ○ Understand that each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
- ○ Understand that substances react chemically in characteristic ways.

- Understand that 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.

Crosscutting Concepts

- Understand that macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Science and Engineering Practices

- Analyze and interpret data to determine similarities and differences in findings.
- Understand that scientific knowledge is based on logical and conceptual connections between evidence and evaluations.

- 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. *(MS-PS1-5)* *[Clarification Statement: Emphasis is on law of conservation of matter, and on physical models or drawings, including digital forms, that represent atoms.]*

Disciplinary Ideas

- Understand that substances react chemically in characteristic ways.
- Understand that the total number of each type of atom is conserved and thus the mass does not change (the law of conservation of matter).

Crosscutting Concepts

- Understand that matter is conserved because atoms are conserved in physical and chemical processes.

Science and Engineering Practices

- Develop a model to describe unobservable mechanisms.
- Understand that laws are regularities or mathematical descriptions of natural phenomena.

- Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.* *(MS-PS1-6)* *[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.]*

Disciplinary Ideas

- Understand that some chemical reactions release energy, while others store energy.
- Understand that models of all kinds are important for testing solutions.
- Understand that there are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.

- Understand that a solution needs to be tested and then modified on the basis of the test results in order to improve it.
- Understand that 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.
- Understand that 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.
- Understand that some of the characteristics identified as having the best performance may be incorporated into the new design.

Crosscutting Concepts

- Understand that the transfer of energy can be tracked as energy flows through a designed or natural system.

Science and Engineering Practices

- Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints.

SUGGESTED ACTIVITIES

- *http://www.cfep.uci.edu/cspi/docs/lessons_secondary/Mystery%20Powder.pdf* - Mystery powder lab activity
- http://www.stevespanglerscience.com/lab/experiments/elephants-toothpaste/ - elephant toothpaste lab activity
- http://www.inquiryinaction.org/classroomactivities/activity.php?id=26 - Calcium chloride exothermic reaction lab activity

UNIT VOCABULARY

chemical reaction - process that involves the changing of the molecular structure of a substance (something new is formed)
density - the degree of compactness of a substance/how tightly packed a substance is
melting point - temperature at which a solid changes to a liquid
boiling point - temperature at which a liquid changes to a gas
solubility - the ability to be dissolved especially in water
flammability - how easily something is set afire
mass - the quantity of matter a substance contains

RESOURCES

Supplies: As per lab manuals

Websites:

www.discoveryeducation.com - videos and lesson ideas
www.opened.com - background information for teachers and lesson ideas
www.inquiryinaction.org - chemistry lab experiments
http://www.chem4kids.com - background information for students
https://phet.colorado.edu - online simulations
https://concord.org/stem-resources - online simulations (requires Java)
https://ngsschemistry.wordpress.com/ - lesson ideas
http://learningcenter.nsta.org/ - background information for teachers and lesson ideas
http://ngss.nsta.org/Classroom-Resources.aspx - lesson ideas
http://sciencespot.net/Pages/refdeskNextGen.html - lesson ideas

MODIFICATIONS

- 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.
- Restructure lesson using UDL principles
    - o http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA
- See NGSS Appendix D
    - o http://www.nextgenscience.org/sites/ngss/files/Appendix%20D%20Diversity%20and%20Equity%206-14-13.pdf

SIXTH GRADE SCIENCE CURRICULUM

UNIT THREE - Forces and Interactions

Estimated Time Frame: Approximately 40-45 days

NEW JERSEY STUDENT LEARNING STANDARDS

Disciplinary Core Ideas

PS2.A: Forces and Motion

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law). *(MS-PS2-1)*
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change.The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. *(MS-PS2-2)*
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. *(MS-PS2-2)*

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 magnet, or a ball respectively). *(MS-PS2-5)*

Crosscutting Concepts

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 over time and forces at different scales. *(MS-PS2-2)*

Science and Engineering Practices

Asking Questions and Defining Problems

Asking questions and defining problems in grades 6–8 builds from grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- 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

Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.

- Plan an investigation individually and collaboratively, and in the design identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. *(MS-PS2-2)*
- 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

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas or principles to design an object, tool, process or system. *(MS-PS2-1)*

Engaging in Argument from Evidence

Engaging in argument from evidence in 6–8 builds from K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.

- 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 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)*

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)*

NEW JERSEY STUDENT LEARNING STANDARDS

Connections to:

Technology

- *8.1* Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
- *8.2* Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

ELA

Reading Standards for Science and Technical Subjects

- *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)*
    - *For example, cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions of the application of Newton's third law involving the motion of two colliding objects.*
    - *For example, draw evidence from informational texts to support analysis, reflection, and research about the application of Newton's third law when designing a solution to a problem involving the motion of two colliding objects.*
- *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)*
    - *For example, follow precisely a multistep procedure when carrying out experiments to apply Newton's third law when designing a solution to a problem involving the motion of two colliding objects, taking measurements, or performing technical tasks.*
    - *For example, follow precisely a multistep procedure when performing an investigation that provides 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, taking measurements or performing technical tasks.*

Writing- Literacy in History/SS, Science and Technical Subjects

- *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)*
    - *For example, compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading texts about the application of Newton's third law to the motion of two colliding objects Conduct a short research project to answer a question about the application of Newton's third law when designing a solution to a problem involving the motion of two colliding objects, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.*
    - *For example, conduct a short research project to answer a question about how the sum of the forces on the object and the mass of the object change an object's motion, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.*

- *For example, gather relevant information from multiple print and digital sources that provide information about the application of Newton's third law when designing a solution to a problem involving the motion of two colliding objects; assess the credibility of each source and quote or paraphrase the data and conclusions of others while avoiding plagiarism and providing basic bibliographic information for sources*

Mathematics

Standards for Mathematical Practice

- *MP.2* Reason abstractly and quantitatively. *(MS-PS1-2),(MS-PS2-2),(MS-PS2-3)*
  - For example, reason abstractly and quantitatively when collecting and analyzing data about the application of Newton's third law in the course of designing a solution to a problem involving the motion of two colliding objects.

The Number System

- *6.NS.C.5* Understand that positive and negative 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)*
  - *For example, analyze data in the form of numbers and symbols to draw conclusions about how the sum of the forces on an object and the mass of an object change the object's motion.*
  - *For example, 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 a design that applies Newton's third law to a problem involving the motion of two colliding objects.*

Expressions and Equations

- *6.EE.A.2* Write, read, and evaluate expressions in which letters stand for numbers. *(MS-PS2-1),(MS-PS2-2)*
  - *For example, when collecting and analyzing data from investigations about how the sum of the forces on an object and the mass of the object changes the object's motion, write, read, and evaluate expressions in which letters stand for numbers.*

21st Century Life and Careers

- *9.3.12.AC.2* Use architecture and construction skills to create and manage a project.
- *9.3.12.AC.6* Read, interpret and use technical drawings, documents and specifications to plan a project
- *9.3.12.AC-DES.1* Justify design solutions through the use of research documentation and analysis of data.
- *9.3.12.AC-DES.2* Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
- *9.3.12.AC-DES.6* Apply the techniques and skills of modern drafting, design, engineering, and construction to projects.
- *9.3.MN-HSE.3* Demonstrate a safety inspection process to assure a healthy and safe manufacturing environment
- *9.3.MN-MIR.2* Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.

BIG IDEAS/COMMON THREAD

Interactions between objects affect how objects move, and whether they are attracted to or repel each other. Different kinds of forces affect objects in different ways.

ENDURING UNDERSTANDINGS

- The role of the mass of an object must be qualitatively accounted for in any change of motion due to the application of a force. (Appendix E, NGSS, PS2.A, Forces and Motion, gr. 6-8)
- Forces that act at a distance involve fields that can be mapped by their relative strength and effect on an object. (Appendix E, NGSS, PS2.B, Types of Interactions, gr. 6-8)

ESSENTIAL QUESTIONS

- How does data help determine factors that affect the strength of electric and magnetic forces?
- How could you plan an investigation to provide evidence that changes an object's motion depended upon the sum of the forces?
- How could you apply Newton's Third Law to design a solution to a problem involving two colliding objects?

ASSESSMENT

- Teacher-created formative assessments, such as:
  - Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.
  - Plan an investigation individually and collaboratively to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- District-created summative assessments
- Performance assessments (presentations, posters, etc.)
- Teacher observations, conferences
- Hands-on lab experiences

UNIT OBJECTIVES

Students will be able to …

- Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.* (*MS-PS2-1)*
  [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.]

Disciplinary Ideas

- Understand that 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.

Crosscutting Concepts

- Understand that models can be used to represent the motion of objects in colliding systems and their interactions - such as inputs, processes, and outputs - and energy and matter flows within systems.
- Understand that 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 the differences in such factors as climate, natural resources, and economic conditions.

Science and Engineering Practices

- Apply scientific ideas or principles to design an object, tool, process, or system.

- 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. (*MS-PS2-2)*

[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.]

Disciplinary Ideas

- Understand that 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.
- Understand that the greater the mass of the object, the greater the force needed to achieve the same change in motion.
- Understand that for any given object, a larger force causes a larger change in motion.
- Understand that all positions of objects and the directions of forces and motions must be described in a chosen reference frame and chosen units of size.

Crosscutting Concepts

- Understand that explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

Science and Engineering Practices

- Plan an investigation individually and collaboratively and in the design identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Understand that scientific knowledge is based on logical and conceptual connections between evidence and explanations.

- Ask questions about data to determine the factors that affect the strength of electric and magnetic forces. (*MS-PS2-3)*

[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.]

Disciplinary Ideas

- Understand that electrical 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.

Crosscutting Concepts

- Understand that cause and effect relationships may be used to predict phenomena in natural or designed systems.

Science and Engineering Practices

- 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.

- Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. (*MS-PS2-4)*
[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.]

Disciplinary Ideas
- Understand that gravitational forces are always attractive. There is a gravitational force between two masses, but it is very small except when one or both of the objects have a large mass (e.g., Earth and the sun).

Crosscutting Concepts
- Understand that models can be used to represent systems and their interactions - such as inputs, processes, and outputs - and energy and matter flows within systems.

Science and Engineering Practices
- 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.
- Understand that scientific knowledge is based on logical and conceptual connections between evidence and explanations.

- 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. (*MS-PS2-5)*
[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.]

Disciplinary Ideas
- Understand that forces that act at a distance (electrical, 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, a magnet, or a ball, respectively).

Crosscutting Concepts
- Understand that cause and effect relationships may be used to predict phenomena in natural or designed systems.

Science and Engineering Practices

- 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.

SUGGESTED ACTIVITIES

- PHET (Forces and Motion: Basics) - https://phet.colorado.edu/en/simulation/forces-and-motion-basics
- Inertia Crash Dummies kit - https://www.wardsci.com/store/product/8877645/inertia-crash-dummies
- Building straw rockets - http://mars.nasa.gov/participate/marsforeducators/soi/MarsSOI2012_Lesson5.pdf

UNIT VOCABULARY

energy - the ability to do work (the use of a force to move an object over a distance)
kinetic energy - energy that matter has due to its motion.
potential energy- the energy of a particle (or system of particles) derived from position, or condition, rather than motion. *Example: height of an object above the ground*.
force - a push or pull upon an object resulting from the object's interaction with another object. If it is unopposed, it will change the motion of an object.
balanced forces - forces acting in opposite directions on an object, and equal in size. When the forces on an object are balanced, the object stays still or continues to move at the same speed and in the same direction.
unbalanced forces - forces not acting in opposite directions on an object, and/or unequal in size. When the forces on an object are unbalanced, the object changes speed and/or direction.
Newton's First Law - An object at rest stays at rest, and an object in motion stays in motion with the same speed and in the same direction, unless acted upon by an unbalanced force.
Newton's Second Law - The change in motion of an object due to an unbalanced force is proportional to the magnitude of the force, in the same direction as the force, and inversely proportional to the mass of the object.
Newton's Third Law - 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.

RESOURCES

Supplies:As per lab manuals

Websites:
www.discoveryeducation.com - videos and lesson ideas
www.opened.com - background information for teachers and lesson ideas
https://phet.colorado.edu - online simulations
https://concord.org/stem-resources - online simulations (requires Java)
http://learningcenter.nsta.org/ - background information for teachers and lesson ideas
http://ngss.nsta.org/Classroom-Resources.aspx - lesson ideas
http://sciencespot.net/Pages/refdeskNextGen.html - lesson ideas
https://drive.google.com/drive/folders/0B62XPnDvYwvWRC10cW44dUo4MlU - NASA guide to Adventures in Rocket Science
https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html - NASA Rockets Educator Guide - activities in which students build rockets
https://drive.google.com/drive/folders/0B62XPnDvYwvWRC10cW44dUo4MlU - Estes Educator guide to Science and Model Rockets
http://www.nasa.gov/pdf/630754main_NASAsBESTActivityGuide6-8.pdf - NASA's Educator Guide to the Engineering Design Process

MODIFICATIONS

- 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.

- Restructure lesson using UDL principles
    - http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA
- See NGSS Appendix D
    - http://www.nextgenscience.org/sites/ngss/files/Appendix%20D%20Diversity%20and%20Equity%206-14-13.pdf

SIXTH GRADE SCIENCE CURRICULUM

UNIT FOUR - Space Systems

Estimated Time Frame: Approximately 30-35 days

NEW JERSEY STUDENT LEARNING STANDARDS

Disciplinary Core Ideas

ESS1.A:The Universe and Its Stars

- Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. *(MS-ESS1-1)*
- Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. *(MS-ESS1-2)*

ESS1.B: Earth and the Solar System

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

Crosscutting Concepts

Patterns

- Patterns can be used to identify cause and effect relationships. *(MS-ESS1-1)*

Scale, Proportion, and Quantity

- Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. *(MS-ESS1-3)*

Systems and System Models

- Models can be used to represent systems and their interactions. *(MS-ESS1-2)*

Science and Engineering Practices

Developing and Using Models

Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.

- Develop and use a model to describe phenomena. *(MS-ESS1-1),(MS-ESS1-2)*

Analyzing and Interpreting Data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis

- Analyze and interpret data to determine similarities and differences in findings. *(MS-ESS1-3)*

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-ESS1-3)*

Connections to Nature of Science

Scientific Knowledge Assumes an Order and Consistency in Natural Systems

- Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation. *(MS-ESS1-1), (MS-ESS1-2)*

NEW JERSEY STUDENT LEARNING STANDARDS

Connections to:

Technology

- *8.1* Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
- *8.2* Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

ELA

Reading Standards for Science and Technical Subjects

- *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-ESS1-3)*
    - *For example, cite specific textual evidence to support analysis of science and technical text about scale properties of objects in the solar system.*
- *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-ESS1-3)*
    - *For example, include multimedia components and visual displays in presentations to describe the cyclical patterns of lunar phases, eclipses of the sun and moon, seasons, and the role of gravity in the motions within galaxies and the solar system. The presentation needs to clarify claims and findings and emphasize salient points.*
    - *For example, integrate quantitative or technical information expressed in words in a text about scale properties of objects in the solar system with a version of that information expressed visually in a flowchart, diagram, model, graph, or table.*

Mathematics

Standards for Mathematical Practice

- *MP.2* Reason abstractly and quantitatively. *(MS-ESS1-3)*
    - *For example, reason quantitatively and abstractly about the sizes of an object's layers, surface features, and orbital radius where appropriate.*
- *MP.4* Model with mathematics. *(MS-ESS1-1),(MS-ESS1-2)*
    - *For example, use mathematics to model the motion of the sun, moon, and stars in the sky and the role of gravity in the motions within galaxies and the solar system.*

Ratios and Proportional Relationships

- *6.RP.A.1* Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. (*MS-ESS1-1*),(*MS-ESS1-2*),(*MS-ESS1-3*)
    - *For example, understand the concept of a ratio and use ratio language to describe a ratio relationship between the measurements of the cyclical motion between at least two bodies in the solar system and the relative sizes of objects and/or distances between objects and the impact of gravity on the motion of these objects.*
    - *For example, recognize and represent proportional relationships between the measurement of patterns in the cyclical motion of the sun, moon, and stars in the sky and mathematical proportions relative to the sizes of objects and the effect of gravity on the motion of these objects.*

Expressions and Equations

- *6.EE.B.6* Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. (*MS-ESS1-2*)
    - *Use variables to represent numbers and write expressions when solving a problem involving the role of gravity in the motions within galaxies and within the solar system. Understand that a variable can represent an unknown number, or depending on the problem, any number in a specified set.*

21st Century Life and Careers

- *9.3.12.AC.2* Use architecture and construction skills to create and manage a project.
- *9.3.12.AC.6* Read, interpret and use technical drawings, documents and specifications to plan a project
- *9.3.12.AC-DES.1* Justify design solutions through the use of research documentation and analysis of data.
- *9.3.12.AC-DES.2* Use effective communication skills and strategies (listening, speaking, reading, writing and graphic communications) to work with clients and colleagues.
- *9.3.12.AC-DES.6* Apply the techniques and skills of modern drafting, design, engineering, and construction to projects.
- *9.3.MN-HSE.3* Demonstrate a safety inspection process to assure a healthy and safe manufacturing environment
- *9.3.MN-MIR.2* Demonstrate the safe use of manufacturing equipment to ensure a safe and healthy environment.

BIG IDEAS/COMMON THREAD

Models of the solar system can explain astronomical and other observations of the cyclic patterns of eclipses, tides, and seasons.

ENDURING UNDERSTANDINGS

- The solar system is part of the Milky Way, which is one of many billions of galaxies. (Appendix E. NGSS, ESS1.A, The Universe and its starts, gr 6-8)
- The solar system contains many varied objects held together by gravity. Solar system models explain and predict eclipses, lunar phases, and seasons. (Appendix E. NGSS, ESS1.B, Earth and the solar systems, gr 6-8)

ESSENTIAL QUESTIONS

- How can one describe and model the of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons?
- How can one describe and model the role of gravity in the motions within galaxies and the solar system?

ASSESSMENT

- Teacher-created formative assessments, such as:
    - Students develop and use a physical, graphical, or conceptual model to describe patterns in the apparent motion of the sun, moon, and stars in the sky.
    - Students develop and use models to explain the relationship between the tilt of Earth's axis and seasons.
- District-created summative assessments
- Performance assessments (presentations, posters, etc.)
- Teacher observations, conferences
- Hands-on lab experiences

UNIT OBJECTIVES

Students will be able to …

- Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons. *(MS-ESS1-1)*

  [Clarification Statement: Examples of models can be physical, graphical, or conceptual.]

Disciplinary Ideas

- Understand that patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.
- Understand that the Earth and solar system model can explain eclipses of the sun and the moon.
- Understand that Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun.
- Understand that the seasons are a result of Earth's tilt and are caused by the differential intensity of sunlight on different areas of Earth throughout the year.

Crosscutting Concepts

- Understand that patterns can be used to identify cause-and-effect relationships that exist in the apparent motion of the sun, moon, and stars in the sky.

Science and Engineering Practices

- Develop and use a model to describe patterns in the apparent motion of the sun, moon, and stars in the sky.

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

Disciplinary Ideas

- Understand that gravity plays a role in the motions within galaxies and the solar system.
- Understand that gravity is the force that holds together the solar system and Milky Way galaxy and controls orbital motions within them.
- Understand that the earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe.
- Understand that the solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them.
- Understand that the solar system appears to have formed from a disk of dust and gas, drawn together by gravity.

Crosscutting Concepts

- Models can be used to represent the role of gravity in the motions and interactions within galaxies and the solar system.

Science and Engineering Practices

- Develop and use a model to describe phenomena.

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

Disciplinary Ideas

- Understand that the solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids, that are held in orbit around the sun by its gravitational pull on them.

Crosscutting Concepts

- Objects in the solar system have scale properties.
- Time, space, and energy phenomena in the solar system can be observed at various scales, using models to study systems that are too large.

Science and Engineering Practices

- Analyze and interpret data to determine similarities and differences among objects in the solar system.
- Data from Earth-based instruments, space-based telescopes, and spacecraft can be used to determine similarities and differences among solar system objects.

SUGGESTED ACTIVITIES

- Bring the students into the Starlab portable planetarium.
  See http://starlab.com/classic-starlab-old/classic-starlab-cylinders/ for ideas.

UNIT VOCABULARY

Orbit - the path followed by an object revolving around another object, under the influence of gravity
Gravity - a force which tries to pull two objects toward each other. Anything which has mass also has a gravitational pull. The more massive an object is, the stronger its gravitational pull is
Solar System - the collection of eight planets and their moons in orbit around the sun, together with smaller bodies such as asteroids, meteoroids, and comets
Galaxy - a system of millions or billions of stars, together with gas and dust, held together by gravitational attraction
Eclipse - the partial or total blocking of light of one celestial object by another
Solar eclipse - an eclipse in which the sun is partially or completely blocked from Earth's view by the moon passing between the sun and the earth
Lunar eclipse - an eclipse in which earth's view of the moon is partially or completely darkened when the moon passes into the earth's shadow
Axis - an imaginary line that passes through a planet or other object, that the object rotates around
Rotation - the spinning of a planet or other object on its axis
Revolution - the movement of a planet or other object around another object

RESOURCES

Supplies:As per lab manuals

Websites:
www.discoveryeducation.com - videos and lesson ideas
www.opened.com - background information for teachers and lesson ideas
https://phet.colorado.edu - online simulations
https://concord.org/stem-resources - online simulations (requires Java)
http://learningcenter.nsta.org/ - background information for teachers and lesson ideas
http://ngss.nsta.org/Classroom-Resources.aspx - lesson ideas
http://sciencespot.net/Pages/refdeskNextGen.html - lesson ideas
http://www.moonconnection.com/ - lesson ideas

MODIFICATIONS

- 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.
- Restructure lesson using UDL principles
    - http://www.cast.org/our-work/about-udl.html#.VXmoXcfD_UA
- See NGSS Appendix D
    - http://www.nextgenscience.org/sites/ngss/files/Appendix%20D%20Diversity%20and%20Equity%206-14-13.pdf