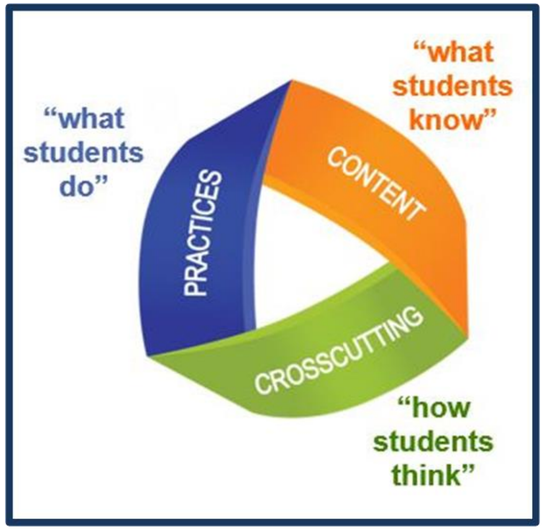
Ledyard Public Schools
Middle School NGSS Curriculum Course 2



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District Philosophy

Ledyard's vision for K-12 inquiry based science is to engage students in scientific and engineering practices as they apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

A New Vision for Science Education

Implications of the Vision of the Framework for K-12 Science Education and the Next Generation Science Standards

SCIENCE EDUCATION WILL INVOLVE LESS:	SCIENCE EDUCATION WILL INVOLVE MORE:
Rote memorization of facts and terminology.	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning.
Learning of ideas disconnected from questions about phenomena.	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned.
Teachers providing information to the whole class.	Students conducting investigations, solving problems, and engaging in discussions with teachers' guidance.
Teachers posing questions with only one right answer.	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims.
Students reading textbooks and answering questions at the end of the chapter.	Students reading multiple sources, including science-related magazine and journal articles and web-based resources; students developing summaries of information.
Pre-planned outcome for "cookbook" laboratories or hands-on activities.	Multiple investigations driven by students' questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas.
Worksheets.	Student writing of journals, reports, posters, and media presentations that explain and argue.
Oversimplification of activities for students who are perceived to be less able to do science and engineering	Provision of supports so that all students can engage in sophisticated science and engineering practices

Source: National Research Council. (2015). *Guide to Implementing the Next Generation Science Standards* (pp. 8-9). Washington, DC: National Academies Press. http://www.nap.edu/catalog/18802/guide-to-implementing-the-next-generation-science-standards

Three Dimensions of the *Next Generation Science Standards*:

SEP (appendix F), DCI (appendix E), CCC (appendix G)

Scientific and Engineering Practices Matrix

Asking Questions and Defining Problems

A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Engineering questions clarify problems to determine criteria for successful solutions and identify constraints to solve problems about the designed world. Both scientists and engineers also ask questions to clarify the ideas of others.

Planning and Carrying Out Investigations

Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters. Engineering investigations identify the effectiveness, efficiency, and durability of designs under different conditions.

Analyzing and Interpreting Data

Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Engineering investigations include analysis of data collected in the tests of designs. This allows comparison of different solutions and determines how well each meets specific design criteria—that is, which design best solves the problem within given constraints. Like scientists, engineers require a range of tools to identify patterns within data and interpret the results. Advances in science make analysis of proposed solutions more efficient and effective.

Developing and Using Models

A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations. Modeling tools are used to develop questions, predictions and explanations; analyze and identify flaws in systems; and communicate ideas. Models are used to build and revise scientific explanations and proposed engineered systems. Measurements and observations are used to revise models and designs.

Constructing Explanations and Designing Solutions

The products of science are explanations and the products of engineering are solutions. The goal of science is the construction of theories that provide explanatory accounts of the world. A theory becomes accepted when it has multiple lines of empirical evidence and greater explanatory power of phenomena than previous theories. The goal of engineering design is to find a systematic solution to problems that is based on scientific knowledge and models of the material world. Each proposed solution results from a process of balancing competing criteria of desired functions, technical feasibility, cost, safety, aesthetics, and compliance with legal requirements. The optimal choice depends on how well the proposed solutions meet criteria and constraints.

Engaging in Argument from Evidence

Argumentation is the process by which explanations and solutions are reached. In science and engineering, reasoning and argument based on evidence are essential to identifying the best explanation for a natural phenomenon or the best solution to a design problem. Scientists and engineers use argumentation to listen to, compare, and evaluate competing ideas and methods based on merits. Scientists and engineers engage in argumentation when investigating a phenomenon, testing a design solution, resolving questions about measurements, building data models, and using evidence to identify strengths and weaknesses of claims.

Using Mathematics and Computational Thinking

In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships. Mathematical and computational approaches enable scientists and engineers to predict the behavior of systems and test the validity of such predictions. Statistical methods are frequently used to identify significant patterns and establish correlational relationships.

Obtaining, Evaluating, and Communicating Information

Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity. Communicating information and ideas can be done in multiple ways: using tables, diagrams, graphs, models, and equations as well as orally, in writing, and through extended discussions. Scientists and engineers employ multiple sources to acquire information that is used to evaluate the merit and validity of claims, methods, and designs.

NGSS@ NSTA STEM STARTS HERE

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Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

Disciplinary Core Ideas Matrix Course 2 Disciplinary Core Ideas are highlighted yellow			
Physical Science	**Life Science**	**Earth and Space Science**	**Engineering, Technology, and the Application of Science**
PS1: Matter and Its Interactions PS1.A: Structure and Properties of Matter PS1.B: Chemical Reactions PS1.C: Nuclear Processes **PS2: Motion and Stability: Forces and Interactions** PS2.A: Forces and Motion PS2.B: Types of Interactions **PS3: Energy** PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces PS3.D: Energy in Chemical Processes and Everyday Life **PS4: Waves and Their Applications in Technologies for Information Transfer** PS4.A: Wave Properties PS4.B: Electromagnetic Radiation PS4.C: Information Technologies and Instrumentation	**LS1: From Molecules to Organisms: Structures and Processes** LS1.A: Structure and Function LS1.B: Growth and Development of Organisms LS1.C: Organization for Matter and Energy Flow in Organisms LS1.D: Information Processing **LS2: Ecosystems: Interactions, Energy, and Dynamics** LS2.A: Interdependent Relationships in Ecosystems LS2.B: Cycles of Matter and Energy Transfer in Ecosystems LS2.C: Ecosystem Dynamics, Functioning, and Resilience LS2.D: Social Interactions and Group Behavior **LS3: Heredity: Inheritance and Variation of Traits** LS3.A: Inheritance of Traits LS3.B: Variation of Traits **LS4: Biological Evolution: Unity and Diversity** LS4.A: Evidence of Common Ancestry and Diversity LS4.B: Natural Selection LS4.C: Adaptation LS4.D: Biodiversity and Humans	**ESS1: Earth's Place in the Universe** ESS1.A: The Universe and Its Stars ESS1.B: Earth and the Solar System ESS1.C: The History of Planet Earth **ESS2: Earth's Systems** ESS2.A: Earth Materials and Systems ESS2.B: Plate Tectonics and Large-Scale Systems ESS2.C: The Role of Water in Earth's Surface Processes ESS2.D: Weather and Climate ESS2.E: Biogeology **ESS3: Earth and Human Activity** ESS3.A: Natural Resources ESS3.B: Natural Hazards ESS3.C: Human Impacts on Earth Systems ESS3.D: Global Climate Change	**ETS1: Engineering Design** ETS1.A: Defining and Delimiting an Engineering Problem ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

Crosscutting Concepts Matrix		
Patterns Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them. Cause and Effect: Mechanism and Explanation Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	Scale, Proportion, and Quantity In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance. Systems and System Models Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.	Energy and Matter: Flows, Cycles, and Conservation Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations. Structure and Function The way in which an object or living thing is shaped and its substructure determine many of its properties and functions. Stability and Change For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.

Developed by NSTA based on content from the *Framework for K-12 Science Education* and supporting documents for the *May 2012 Public Draft of the NGSS*

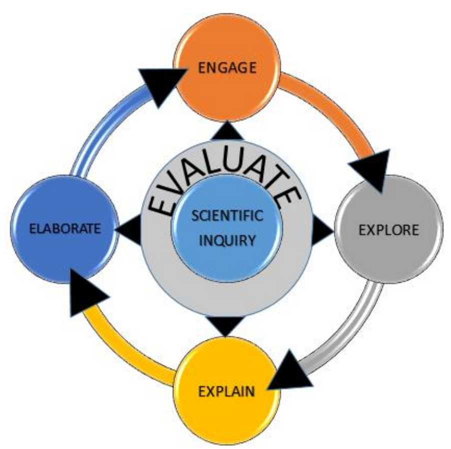
Connections to the Nature of Science

Nature of Science Practices	Nature of Science Crosscutting Concepts
These understandings about the nature of science are closely associated with the science and engineering practices, and are found in that section of the foundation box on a standards page. More information about the Connections to Engineering, Technology and Applications of Science can be found in Appendix H.	These understandings about the nature of science are closely associated with the crosscutting concepts, and are found in that section of the foundation box on a standards page. More information about the Connections to Engineering, Technology and Applications of Science can be found in Appendix H.
Scientific Investigations Use a Variety of Methods	Science is a Way of Knowing
Science Knowledge is Based on Empirical Evidence	Scientific Knowledge Assumes and Order and Consistency in Natural Systems
Scientific Knowledge is Open to Revision in Light of New Evidence	Science is a Human Endeavor
Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena.	Science Addresses Questions About the Natural and Material World

How does Ledyard Define Inquiry?

Inquiry is defined as a way of seeking information, knowledge, or truth through questioning. Inquiry is a way for a learner to acquire new information and data and turn it into useful knowledge. Inquiry involves asking good questions and developing robust investigations from them. Inquiry also involves considering possible solutions and consequences. A third component of inquiry is separating evidence based claims from common opinion, and communicating claims with others, and acting upon these claims when appropriate. Questions lead to gathering information through research, study, experimentation, observation, or interviews. During this time, the original question may be revised, a line of research refined, or an entirely new path may be pursued. As more information is gathered, it becomes possible to make connections and allows individuals to construct their own understanding to form new knowledge. Sharing this knowledge with others develops the relevance of the learning for both the student and a greater community. Sharing is followed by reflection and potentially more questions, bringing the inquiry process full circle.

Inquiry 5 Science Teaching Model



Engagement	Object, event or question used to engage students. Connections facilitated between what students know and can do.
Exploration	Objects and phenomena are explored. Hands-on activities, with guidance.
Explanation	Students explain their understanding of concepts and processes. New concepts and skills are introduced as conceptual clarity and cohesion are sought.
Elaboration	Activities allow students to apply concepts in contexts, and build on or extend understanding and skill.
Evaluation	Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness.

Ledyard Next Generation Science Standards Grade 7

Unit 1: The Study of Ecology

August-November

Anchoring Phenomenon	
When various species of cichlid fish are combined in aquariums, some stop eating to the point of dying.	
Compelling Questions	**Supporting Questions**
How do organisms and ecosystems interact?	• *How do resources affect ecosystems?* • *Are there patterns in predation?* • *How can we classify the interactions amongst living things?* • *How do biological and physical changes affect ecosystems?* • *How do organisms carry out photosynthesis?* • *How does an organism get energy from stored resources?* • *How does energy flow through an ecosystem?* • *What causes changes in biodiversity in an ecosystem?* • *Why is biodiversity important to the health of an ecosystem?*
Unit 1 Storyline	**Unit 1 Possible Student Misconceptions:**
Students will discover the way abiotic (water, soil) and biotic (cells, organisms) resources contribute to the function of living organisms. Students will study photosynthesis and matter/energy flow among interacting organisms in an ecosystem.	• *Energy flow can only be seen as activity and not stored in organisms.* • *Energy is not just electricity.* • *Energy is not stored.*

Unit 1: The Study of Interactions Between Organisms and Ecosystems
Standards and 3-D Learning Overview

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-LS2-1** • **MS-LS2-2** • **MS-ETS1-1** • **MS-LS2-4** • **MS-LS1-6** • **MS-LS1-7** • **MS-LS2-3** • **MS-LS2-5** *Teacher Note: All the Performance Expectations above will be covered this unit and can be worked on concurrently. All Science and Engineering Practices and Crosscutting Concepts in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• *1: Asking Questions and Defining Problems* • **2: Developing and Using Models (MS-LS1-2)** • **3: Planning and Carrying Out Investigations (MS-LS1-1)** • 4: Analyzing and Interpreting Data • 5: Using Mathematical Computational Thinking • 6: Constructing Explanations and Designing Solutions • **7: Engaging in Argument from Evidence (MS-LS1-3)** • **8: Obtaining, Evaluating, and Communicating Information (MS-LS1-8)**	**ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE** • **ETS1 Engineering Design** -ETS1.C: Optimizing the Design Solution **LIFE SCIENCE** • **LS1: From Molecules to Organisms: Structures and Processes** -LS1.C: Organization for Matter and Energy Flow in Organisms • **LS2: Ecosystems: Interactions, Energy, Dynamics** -LS2.A: Interdependent Relationships in Ecosystems -LS2.B: Cycles of Matter and Energy Transfer -LS2.C: Ecosystem Dynamics, Functioning and Resilience -LS2.D: Social Interactions and Group Behavior **LIFE SCIENCE** • **PS3: Energy** -PS3.D: Energy in Chemical Processes and Everyday Life	• 1: Patterns • **2: Cause and Effect (MS-LS1-8)** • **3: Scale, Proportion and Quantity (MS-LS1-1)** • **4: Systems and System Models (MS-LS1-3)** • *5: Energy and Matter* • **6: Structure and Function (MS-LS1-2)** • *7: Stability and Change*

Performance Expectation
MS-LS2-1 Ecosystems: Interactions, Energy, Dynamics

Students who demonstrate understanding can:

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

Clarification Statement: *Emphasis is on cause and effect relationships between resources and growth of individual organisms and the numbers of organisms in ecosystems during periods of abundant and scarce resources.*

Assessment Boundary: *N/A*

Lesson Level Phenomenon: A poison dart frog loses its toxicity during captivity.

note: all photo and video above links to suggested activities below

MS-LS2-1 Suggested Activities	MS-LS2-1 Recommended Formative Assessments
Resources in Living Systems (*TCI Ecosystems: Unit 1 Resources in Ecosystems, Lesson 1 Resources in Living Systems*) Students will investigate how resources impact organisms, populations, ecosystems and biomes through engagement in analyzing graphs, composing charts, and modeling a simple pond ecosystem. (LS2-1; LS2-2) (4-5 class periods) *Terrarium- students will explore mini ecosystems using leaf litter and invertebrates gathered outside of school during this unit.	• Analyze and organize data using tables, charts or graphs concerning how resources affects organisms and populations. • Make claims using a CER about the relationship(s) between resources and populations. • Model resource needs within ecosystems and biomes using a terrarium or the like.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to provide evidence to support explanations or solutions. **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.**	**LS2.A: Interdependent Relationships in Ecosystems** • Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors. • In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. • Growth of organisms and population increases are limited by access to resources.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Performance Expectation
MS-LS2-1 Ecosystems: Interactions, Energy, Dynamics

Connections to other DCIs in Middle School:
MS.ESS3.A ; MS.ESS3.C

Articulation of DCIs across grade-levels:
3.LS2.C ; 3.LS4.D ; 5.LS2.A ; HS.LS2.A ; HS.LS4.C ; HS.LS4.D ; HS.ESS3.A

Common Core State Standards Connections*:*
ELA/Literacy

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-1)

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-LS2-1)

Mathematics- N/A

Lesson Level Vocabulary: *species, organism, resource, population, competition, ecosystem, biome, biosphere*

DCI Domain Vocabulary:
Domains are bold:
- **Ecosystems: Interactions, Energy, Dynamics→Interdependent Relationships in Ecosystems (LS2)**
  disperse, ecological rule, evolve, genetic, host, infection, interdependent, mutualism, mutually beneficial, parasite, relative

Performance Expectation
MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Clarification Statement: *Emphasis is on predicting consistent patterns of interactions in different ecosystems in terms of the relationships among and between organisms and abiotic components of ecosystems. Examples of types of interactions could include competitive, predatory, and mutually beneficial.*

Assessment Boundary: N/*A*

Lesson Level Phenomenon: Observe the relationship between an ant and an acacia tree.

note: all photo and video above links to suggested activities below

MS-LS2-2 Suggested Activities	MS-LS2-2 Recommended Formative Assessments
Interactions Among Organisms (*TCI Ecosystems: Unit 1 Resources in Ecosystems, Lesson 2 Interactions Among Organisms*) Students will investigate predation patterns and their cycles of time and students will classify interactions of living things. (5-6 class periods)	• Write cause and effect scenarios identifying patterns in different ecosystems for one or more of the following: wolves in Yellowstone Park, jaguars in Central America, invasive snakes in Guam, or deer in Washington D.C.; also bobcat and cottontail in New Engand. • Create a group google slide show depicting one relationship between organisms: mutualism, commensalism, predation, parasitism, or competition.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Construct an explanation that includes qualitative or quantitative relationships between variables that predict phenomena. **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.**	LS2.A: Interdependent Relationships in Ecosystems • Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Mutually beneficial interactions, in contrast, may become so interdependent that each organism requires the other for survival. Although the species involved in these competitive, predatory, and mutually beneficial interactions vary across ecosystems, the patterns of interactions of organisms with their environments, both living and nonliving, are shared.	Patterns • Patterns can be used to identify cause and effect relationships.

Performance Expectation
MS-LS2-2 Ecosystems: Interactions, Energy, and Dynamics

Connections to other DCIs Middle School:
MS.LS1.B

Articulation of DCIs across grade-level bands:
1.LS1.B ; HS.LS2.A ; HS.LS2.B ; HS.LS2.D

Common Core State Standards Connections:
ELA/Literacy

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-2)
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS2-2)
WHST.6-8.9	Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS2-2)
SL.8.1	Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. *(MS-LS2-2)*
SL.8.4	Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. *(MS-LS2-2)*

Mathematics

6.SP.B.5	Summarize numerical data sets in relation to their context. *(MS-LS2-2)*

Lesson Level Vocabulary: *omnivore, herbivore, carnivore, predation, constraint, criteria, mutualism, parasitism, commensalism*

DCI Domain Vocabulary:
Domains are bold:

- **Ecosystems: Interactions, Energy, Dynamics→Interdependent Relationships in Ecosystems (LS2)**
  disperse, ecological rule, evolve, genetic, host, infection, interdependent, mutualism, mutually beneficial, parasite, relative

<table>
<tr><th colspan="6">Performance Expectation
MS-LS2-4 Ecosystems: Interactions, Energy, and Dynamics</th></tr>
<tr><td colspan="6">Students who demonstrate understanding can:
Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.
Clarification Statement: Emphasis is on recognizing patterns in data and making warranted inferences about changes in populations, and on evaluating empirical evidence supporting arguments about changes to ecosystems.
Assessment Boundary: N/A</td></tr>
<tr><td colspan="6">Lesson Level Phenomenon: Although the 1980 eruption of Mt. St. Helens destroyed all life near the eruption, the area is now covered in green and full of life.
*note: all photo and video above links to suggested activities below</td></tr>
<tr><th colspan="3">MS-LS2-4 Suggested Activities</th><th colspan="3">MS-LS2-4 Recommended Formative Assessments</th></tr>
<tr><td colspan="3">Changing Ecosystems (TCI Ecosystems: Unit 1, Lesson 3) Students will investigate how the many interactions of an ecosystem cause even small changes to lead to other large changes. These observations will be in their model ecosystems, and then study the impact of biological and physical changes that can occur in some specific natural ecosystems. (5-6 class periods)</td><td colspan="3">• Make a claim about how the specified change will affect the ecosystem.
• Observe, record, and analyze data (e.g. temperature, dissolved oxygen, activity level of organism, location of organisms, etc.) by creating a graph, and writing conclusions based on the data.</td></tr>
<tr><th colspan="2">Science and Engineering Practices</th><th colspan="2">Disciplinary Core Ideas</th><th colspan="2">Crosscutting Concepts</th></tr>
<tr><td colspan="2">Engaging in Argument from Evidence
• Construct an oral and written argument 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.

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

Connections to Nature of Science
Scientific Knowledge is Based on Empirical Evidence
• Science disciplines share common rules of obtaining and evaluating empirical evidence.</td><td colspan="2">LS2.C: Ecosystem Dynamics, Functioning, and Resilience
• Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations.</td><td colspan="2">Stability and Change
• Small changes in one part of a system might cause large changes in another part.</td></tr>
</table>

Performance Expectation
LS2-4 Ecosystems: Interactions, Energy, and Dynamics

Connections to other DCIs Middle School:
MS.LS4.C ; MS.LS4.D ; MS.ESS2.A ; MS.ESS3.A ; MS.ESS3.C

Articulation of DCIs across grade-levels:
3.LS2.C ; 3.LS4.D ; HS.LS2.C ; HS.LS4.C ; HS.LS4.D ; HS.ESS2.E ; HS.ESS3.B ; HS.ESS3.C

Common Core State Standards Connections:
ELA /Literacy -

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-LS2-4)

RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-4)

WHST.6-8.1 Write arguments to support claims with clear reasons and relevant evidence. (MS-LS2-4)

WHST.6-8.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (MS-LS2-4)

Mathematics —
N/A

Lesson Level Vocabulary: *ecological succession, dynamic system, evidence*

DCI Domain Vocabulary:
Domains are bold:

- **Ecosystems: Interactions, Energy, Dynamics→Interdependent Relationships in Ecosystems (LS2)**
  disperse, ecological rule, evolve, genetic, host, infection, interdependent, mutualism, mutually beneficial, parasite, relative

Performance Expectation
MS-ETS1-1 Engineering Design

Students who demonstrate understanding can:
Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Clarification Statement: *N/A*
Assessment Boundary: *N/A*

Lesson Level Phenomenon: Frogs need to hear each other's calls in order to attract a mate. Bats listen for frog calls to find food.
note: all photo and video above links to suggested activities below

MS-ETS1-1 Suggested Activities	MS-ETS1-1 Recommended Formative Assessments
Engineering Challenge: Preserving Frog-Bat Interactions (*TCI Ecosystems: Unit 1)* Students will build a sound shield to protect local animal interactions. (3-4 class periods)	• Design a sound shield to prevent local nesting birds from nest abandonment during construction.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Asking Questions and Defining Problems • Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions. **Asking questions and defining problems in grades 6–8 builds on grades K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.**	ETS1.A: Defining and Delimiting Engineering Problems • The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that are likely to limit possible solutions.	Influence of Science, Engineering, and Technology on Society and the Natural World • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. • The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Performance Expectation
MS-EST1-1 Engineering Design

Connections to other DCIs Middle School:
Physical Science: MS-PS3-3

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; 3-5.ETS1.C ; HS.ETS1.A ; HS.ETS1.B

Common Core State Standards Connections:

ELA /Literacy -

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ETS1-1)

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-ETS1-1)

Mathematics —

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-1)*

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), 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-ETS1-1)*

Lesson Level Vocabulary: *evidence, dynamic system, ecological succession, commensalism, parasitism, mutualism, criteria, constraint, predation, carnivore, herbivore, omnivore, biosphere, ecosystem, competition, population, resource, organism, species*

DCI Domain Vocabulary:

Domains are bold:

- **Biological Evolution: Engineering Design→Defining and Delimiting Engineering Problems(ETS1)**
  consequence, consideration, criteria, design task, development, economic, humanity, impact, limitation, long-term, negative, positive, potential, precise, qualitative, quantitative, real-world, requirement, short-term, societal, specification, supply, testable

Performance Expectation
LS1-6 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:
Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.
Clarification Statement: *Emphasis is on tracing movement of matter and flow of energy.*
Assessment Boundary: *Assessment does not include the biochemical mechanisms of photosynthesis.*

Lesson Level Phenomenon: Epiphytes, plants that can live high in trees, grow and flower in spite of having no roots that touch the ground.
note: all photo and video above links to suggested activities below

MS-LS1-6 Suggested Activities	MS-LS1-6 Recommended Formative Assessments
Capturing the Sun's Energy (*TCI Ecosystems: Unit 2, Lesson 4*) Students will explore the process of photosynthesis and experiment to test whether plants in the sun truly remove carbon dioxide from their environment. (4-5 class periods)	• Draw a model (poster, google slide, etc.) illustrating and explaining the interactions of atoms, molecules, and cell structures in their role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **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.** -- ***Connections to Nature of Science*** **Scientific Knowledge is Based on Empirical Evidence** • Science knowledge is based upon logical connections between evidence and explanations.	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. **PS3.D: Energy in Chemical Processes and Everyday Life** • The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. *(secondary)*	**Energy and Matter** • Within a natural system, the transfer of energy drives the motion and/or cycling of matter.

Performance Expectation
LS1-6 From Molecules to Organisms: Structures and Processes

Connections to other DCIs in Middle School:
MS.PS1.B ; MS.ESS2.A

Articulation of DCIs across grade-levels:
5.PS3.D ; 5.LS1.C ; 5.LS2.A ; 5.LS2.B ; HS.PS1.B ; HS.LS1.C ; HS.LS2.B ; HS.ESS2.D

Common Core State Standards Connections:
ELA /Literacy -

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-LS1-6)
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-LS1-6)*
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-LS1-6)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-LS1-6)

Mathematics —

6.EE.C.9	Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS1-6)*

Lesson Level Vocabulary: *producer, matter, chlorophyll, chloroplast, photosynthesis, biomass, cellulose, biofuel*

DCI Domain Vocabulary:
Domains are bold:

- **From Molecules to Organisms: Structures and Processes→ Organization for Matter and Energy Flow in Organisms (LS1)**
  aquatic, atom, carbon, carbon dioxide, chemical, chemical process, chemical reaction, conservation, conserve, convert, cycle, decomposer, element, energy flow, flow chart, interdependent, Louis Pasteur, microorganism, molecule, nutrient, organic, oxygen, photosynthesis, phytoplankton, producer, protein, react, reaction, store, terrestrial, transfer

Performance Expectation
MS-LS1-7 From Molecules to Organisms: Structures and Processes

Students who demonstrate understanding can:
Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.
Clarification Statement: Emphasis is on describing that molecules are broken apart and put back together and that in this process, energy is released
Assessment Boundary: *Assessment does not include details of the chemical reactions for photosynthesis or respiration.*

Lesson Level Phenomenon: **Antlions use a lot of energy to build sandy pits and then lie in wait until an ant falls in, at which point an antlion pegs the ant with sand until it falls to the very bottom of the pit.**

note: all photo and video above links to suggested activities below

MS-LS1-7 Suggested Activities	MS-LS1-7 Recommended Formative Assessments
Using Stored Energy (*TCI Ecosystems: Unit 2, Lesson 5*) Students will investigate how organisms use food and oxygen to get energy through cellular respiration. (4-5 class periods)	• Make a claim about how exercise affects cellular respiration. • Analyze, discuss, and display recorded data. • Write a conclusion based on gathered data.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to describe unobservable mechanisms. **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.**	**LS1.C: Organization for Matter and Energy Flow in Organisms** • Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. **PS3.D: Energy in Chemical Processes and Everyday Life** • Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. *(secondary)*	**Energy and Matter** • Matter is conserved because atoms are conserved in physical and chemical processes.

Performance Expectation
MS-LS1-7 From Molecules to Organisms: Structures and Processes

Connections to other DCIs in Middle School:
MS.PS1.B

Articulation of DCIs across grade-levels:
5.PS3.D ; 5.LS1.C ; 5.LS2.B ; HS.PS1.B ; HS.LS1.C ; HS.LS2.B

Common Core State Standards Connections:
ELA /Literacy –

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-LS1-7)*

Mathematics —
N/A

Lesson Level Vocabulary: *Consumer, mitochondria, cellular respiration, protein, fat, carbohydrate*

DCI Domain Vocabulary:
Domains are bold:

- **From Molecules to Organisms: Structures and Processes→ Organization for Matter and Energy Flow in Organisms (LS1)**
  aquatic, atom, carbon, carbon dioxide, chemical, chemical process, chemical reaction, conservation, conserve, convert, cycle, decomposer, element, energy flow, flow chart, interdependent, Louis Pasteur, microorganism, molecule, nutrient, organic, oxygen, photosynthesis, phytoplankton, producer, protein, react, reaction, store, terrestrial, transfer

Performance Expectation
MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

Students who demonstrate understanding can:
Develop a model to describe the cycling of matter and flow of energy among living and non-living parts of an ecosystem.
Clarification Statement: *Emphasis is on describing the conservation of matter and flow of energy into and out of various ecosystems, and on defining the boundaries of the system.*
Assessment Boundary: *Assessment does not include the use of chemical reactions to describe the processes.*

Lesson Level Phenomenon: In Yellowstone National Park, it is very easy to observe hundreds of types of plants but nearly impossible to spot a wolf.
note: all photo and video above links to suggested activities below

MS-LS2-3 Suggested Activities	MS-LS2-3 Recommended Formative Assessments
Food Webs and Trophic Pyramids (*TCI Ecosystems: Unit 2, Lesson 6*) Students will track matter and energy moving through a food web and model energy transfer through trophic pyramids. Observe trophic interactions in aquatic microbes. (4-5 class periods)	• Create a model of a food web showing the energy transfer relationships. • Create a model of the microbial trophic interactions.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to describe phenomena. **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.**	LS2.B: Cycle of Matter and Energy Transfer in Ecosystems • Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.	Energy and Matter • The transfer of energy can be tracked as energy flows through a natural system. -- ***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.

Performance Expectation
MS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics

Connections to other DCIs in Middle School:
MS.PS1.B

Articulation of DCIs across grade-levels:
5.LS2.A ; 5.LS2.B ; HS.PS3.B ; HS.LS1.C ; HS.LS2.B ; HS.ESS2.A

Common Core State Standards Connections:
ELA/Literacy –
SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-LS2-3)*

Mathematics -
6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *(MS-LS2-3)*

Lesson Level Vocabulary: *indirect effect, direct effect, food chain, food web, decomposer, trophic pyramid*

DCI Domain Vocabulary:
Domains are bold:

- **Biological Evolution: Ecosystems: Interactions, Energy, and Dynamics→Cycle of Matter and Energy Transfer in Ecosystems (LS2)**
  aerobic, anaerobic, atom, biological, biosphere, carbon, chemical, chemical process, conserve, cycle, decompose, decomposer, decomposition, element, energy transfer, field, fungi, geological, geosphere, hydrosphere, interdependent, linear, microbe, molecule, non-linear, oxygen, photosynthesis, react, recycling of matter, restore, store, transfer

Performance Expectation MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics
Students who demonstrate understanding can: **Evaluate competing design solutions for maintaining biodiversity and ecosystem services.** **Clarification Statement:** *Examples of ecosystem services could include water purification, nutrient recycling, and prevention of soil erosion. Examples of design solution constraints could include scientific, economic, and social considerations.* **Assessment Boundary:** *N/A*
Lesson Level Phenomenon: **The kakapo is a flightless parrot that lives in New Zealand. In the 1970s, only 18 individuals were left alive; now there are about 160 living individuals.** ***note: all photo and video above links to suggested activities below***

MS-LS2-5 Suggested Activities	MS-LS2-5 Recommended Formative Assessments
Biodiversity (*TCI Ecosystems: Unit 3, Lesson 8*) Students will calculate the biodiversity of different ecosystems and examine the impacts of changes to biodiversity over time. (3-4 class periods)	• Write a persuasive argument writing for invasive species from Ledyard including but not limited to mute swans, barberry, bittersweet, Asian crab, Gypsy moth, emerald ashborer, etc.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).**	**LS2.C: Ecosystem Dynamics, Functioning, and Resilience** • Biodiversity describes the variety of species found in Earth's terrestrial and oceanic ecosystems. The completeness or integrity of an ecosystem's biodiversity is often used as a measure of its health. **LS4.D: Biodiversity and Humans** • Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. *(secondary)* **ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. *(secondary)*	**Stability and Change** • Small changes in one part of a system might cause large changes in another part. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • The use 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. --- ***Connections to Nature of Science*** **Science Addresses Questions About the Natural and Material World** • Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes.

Performance Expectation
MS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics

Connections to other DCIs in Middle School:
MS.ESS3.C

Articulation of DCIs across grade-levels:
HS.LS2.A ; HS.LS2.C ; HS.LS4.D ; HS.ESS3.A ; HS.ESS3.C ; HS.ESS3.D

Common Core State Standards Connections:
ELA/Literacy –

RST.6-8.8 Distinguish among facts, reasoned judgment based on research findings, and speculation in a text. (MS-LS2-5)

RI.8.8 Trace and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient to support the claims. (MS-LS2-5)

Mathematics --
MP.4 Model with mathematics. *(MS-LS2-5)*

6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems. *(MS-LS2-5)*

Lesson Level Vocabulary: *proportion, biodiversity, niche, keystone species, extirpation, extinction*

DCI Domain Vocabulary:
Domains are bold:

- **Ecosystems: Interactions, Energy and Dynamics→ Ecosystem Dynamics, Functioning, and Resilience (LS2)**
  abundance, abundant, average, biological, capacity, constrain, disruption, diversity, diversity of life, dynamic, extreme, interdependent, limited, oxygen, predation, relative, requirement, resilient, status, support, trend

Ledyard Next Generation Science Standards Grade 7

Unit 2: The Study of the Composition of Matter

December-January

Anchoring Phenomenon
Materials have properties that make them suited for specific uses Ice eventually melts when it is left out; boiling water seems to disappear Survival gear includes items like hot packs that can be activated at a moment's notice

Compelling Questions	Supporting Questions
What is the composition of matter?	• *What are the smallest particles of matter?* • *How are atoms combined to form different molecules and extended structures?* • *How can you tell one substance from another?*

Unit 2 Storyline	Unit 2 Possible Student Misconceptions:
Students will discover everything is made of matter. The periodic table will be used to investigate the elements. Students will also investigate the unique properties of matter.	*All matter can be seen with the naked eye.*

Unit 2 Overview: The Study of Matter

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-PS1-1** • **MS-PS1-2** • **MS-ETS1-2** *Teacher Note: All the <u>Performance Expectations</u> above will be covered this unit and can be worked on concurrently. All <u>Science and Engineering Practices</u> and <u>Crosscutting Concepts</u> in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• 1: Asking Questions and Defining Problems • **2: Developing and Using Models** • *3: Planning and Carrying Out Investigations* • ***4: Analyzing and Interpreting Data*** • *5: Using Mathematical Computational Thinking* • 6: Constructing Explanations and Designing Solutions • *7: Engaging in Argument from Evidence* • 8: Obtaining, Evaluating, and Communicating Information	**<u>PHYSICAL SCIENCE</u>** • **PS1 Matter and its Interactions** -PS1.A: Structure and Propertes of Matter -PS1.B: Chemical Reactions **<u>ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE</u>** • **ETS1 Engineering Design** -ETS1.B: Developing Possible Solutions	• **1: Patterns** • 2: Cause and Effect • ***3: Scale, Proportion and Quantity*** • *4: Systems and System Models* • *5: Energy and Matter* • *6: Structure and Function* • 7: Stability and Change

Performance Expectation
MS-PS1-1 Matter and its Interactions

Students who demonstrate understanding can:
Develop models to describe the atomic composition of simple molecules and extended structures.

Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms
Assessment Boundary: *Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.*

Lesson Level Phenomenon: Balloons have more mass when filled with air; All the materials in the world are composed of combinations of 92 types of atoms
note: all photo and video above links to suggested activities below

MS- PS1-1 Suggested Activities	MS- PS1-1 Recommended Formative Assessments
Atoms and Elements (*TCI Matter: Unit 1 The Composition of Matter, Lesson 1*) Students will investigate the fact that everything is made up of matter and investigate the atomic scale/periodic table. Students will then use their understanding of the periodic table to create their own periodic table of an object.(155 minutes) Molecules and Extended Structures (*TCI Matter: Unit 1 The Composition of Matter, Lesson 2*) Students model simple and more complex molecular structures. (135 minutes)	• Identify the best material to use a base for a make-up pen to be used for humans- TCI Performance Assessment. • Write a persuasive essay supporting your claim about the best base for a make-up pen based on student-gathered evidence during performance assesment.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to predict and/or describe phenomena. **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.**	**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. • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).	**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.

Performance Expectation
MS- PS1-1 Matter and its Interactions

Connections to other DCIs in Middle School:
MS.ESS2.C

Articulation of DCIs across grade-levels:
5.PS1.A ; HS.PS1.A ; HS.ESS1.A

Common Core State Standards Connections*:*
ELA/Literacy

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)*

Mathematics-

MP.2 Reason abstractly and quantitatively. (MS-PS1-1)

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

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

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)*

Lesson Level Vocabulary: *element, atom, criteria, constraint, atomic mass, periodic table of elements, chemical symbol, chemical bond, molecule, model, atomic composition, chemical structure, crystal, polymer, extended structure*

DCI Domain Vocabulary:
Domains are bold:

- **Matter and its Interactions→The Structure and Properties of Matter (PS1)**
  actual mass, ammonia, atom, atomic, atomic arrangement, atomic theory, atomic weight, attractive, boiling point, charged, compress, condensation, conduction, conductive, conductivity, detect, dissolve, electrical charge, electrical conductivity, element, evaporation, extended structure, filtering, function, matter particle, melting point, methanol, mineral, molecular level, molecule, nucleus, oxygen, particle, precision, pressure, properties of elements, reaction, receptor, relative, repulsive, separation method (for mixtures), simple molecule., sodium chloride, solubility, substance, thermal conductivity, vapor

Performance Expectation
MS-PS1-2 Matter and its Interactions

Students who demonstrate understanding can:

Analyze and interpret data on the properties and 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.*

Lesson Level Phenomenon: Liquids do not mix with all liquids; some liquids form distinct layers when poured in a bottle

note: all photo and video above links to suggested activities below

MS- PS1-2 Suggested Activities	MS- PS1-2 Recommended Formative Assessments
Substances and Their Properties (*TCI Matter: Unit 1 The Composition of Matter, Lesson 3*) Students will investigate the properties used to identify a substance and then identify an unknown substance that have different properties by experimentation. (180 minutes)	• Identify the best material to use a base for a make-up pen to be used for humans- TCI Performance Assessment. • Write a persuasive essay supporting your claim about the best base for a make-up pen based on student-gathered evidence during performance assessment.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to determine similarities and differences in findings. **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.** --- ***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.	**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. **PS1.B: Chemical Reactions** • Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.	**Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure.

Performance Expectation
MS-PS1-2 Matter and Its Interactions

Connections to other DCIs Middle School:
MS.PS3.D ; MS.LS1.C ; MS.ESS2.A

Articulation of DCIs across grade-level bands:
5.PS1.B ; HS.PS1.B

Common Core State Standards Connections:
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)*

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)

Mathematics

MP.2 Reason abstractly and quantitatively. (MS-PS1-2)

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

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

6.SP.B.5 Summarize numerical data sets in relation to their context. (MS-PS1-2)

Lesson Level Vocabulary: substance, macroscopic, mass, property, density, solubility

DCI Domain Vocabulary:
Domains are bold:

- **Matter and its Interactions→The Structure and Properties of Matter (PS1)**
  actual mass, ammonia, atom, atomic, atomic arrangement, atomic theory, atomic weight, attractive, boiling point, charged, compress, condensation, conduction, conductive, conductivity, detect, dissolve, electrical charge, electrical conductivity, element, evaporation, extended structure, filtering, function, matter particle, melting point, methanol, mineral, molecular level, molecule, nucleus, oxygen, particle, precision, pressure, properties of elements, reaction, receptor, relative, repulsive, separation method (for mixtures), simple molecule., sodium chloride, solubility, substance, thermal conductivity, vapor

Performance Expectation
MS-ETS1-2 Engineering Design

Students who demonstrate understanding can:
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria the contraints of the problem.
Clarification Statement: *N/A*
Assessment Boundary: *N/A*

Lesson Level Phenomenon: N/A

MS-ETS1-2 Suggested Activities	MS-ETS1-2 Recommended Formative Assessments
Determining the Best Material for a Makeup Pen Base (TCI Matter, Unit 1 Performance Assessment) Students will test and evaluate three substances that could be used as a base for a make-up pen by analyzing and interpreting data.	• Identify the best material to use a base for a make-up pen to be used for humans- TCI Performance Assessment. • Write a persuasive essay supporting your claim about the best base for a make-up pen based on student-gathered evidence during performance assessment.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Engaging in Argument from Evidence • Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. **Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world.**	**ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem.	**N/A**

Performance Expectation
MS-EST1-2 Engineering Design

Connections to other DCIs Middle School:
Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: MS-PS1-6

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; **3-5.ETS1.B** ; **3-5.ETS1.C** ; **HS.ETS1.B** ; **HS.ETS1.C**

Common Core State Standards Connections:

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. *(MS-ETS1-2)*

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-ETS1-2)

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-ETS1-2)

WHST.6-8.9 Draw evidence from informational texts to support analysis, reflection, and research. *(MS-ETS1-2)*

Mathematics —

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-2)*

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), 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-ETS1-2)*

Lesson Level Vocabulary: N/A

DCI Domain Vocabulary:

Domains are bold:

- **Biological Evolution: Engineering Design→Developing Possible Solutions(ETS1)**
  abstract, agreed-upon, break down, concrete, consideration, convincing, criteria, jointly, mathematical model, physical replica, priority, real-world, representation, societal, systematic , theoretical model

Ledyard Next Generation Science Standards Grade 7

Unit 3: The Study of the States of Matter

February-March

Anchoring Phenomenon	
Materials have properties that make them suited for specific uses Ice eventually melts when it is left out; boiling water seems to disappear Survival gear includes items like hot packs that can be activated at a moment's notice	
Compelling Questions	**Supporting Questions**
What causes changes in matter?	• *How do atoms and molecules move in solids, liquids, and gases?* • *How does energy affect state changes in matter?* • *How do you know when a new substance forms?* • *What happens to atoms during chemical reactions?* • *What role does energy play in chemical reactions?* • *Why are chemical reactions important to society?*
Unit 2 Storyline	**Unit 2 Possible Student Misconceptions:**
Students will discover how pure substances have physical and chemical properties. They will investigate states of matter and changes between the states of matter. Further investigations include changes in matter where atoms rearrange during chemical reactions involving absorption/release of energy to form new substances with new properties.	*Chemical reactions are limited to test tubes during an experiment.* *Properties of substances do not change.*

Unit 2 Overview: The Study of Matter

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-PS1-4** • **MS-PS1-5** • **MS-ETS1-3** • **MS-PS1-6** • **MS-PS1-3** *Teacher Note: All the <u>Performance Expectations</u> above will be covered this unit and can be worked on concurrently. All <u>Science and Engineering Practices</u> and <u>Crosscutting Concepts</u> in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• 1: Asking Questions and Defining Problems • **2: Developing and Using Models** • *3: Planning and Carrying Out Investigations* • ***4: Analyzing and Interpreting Data*** • *5: Using Mathematical Computational Thinking* • **6: Constructing Explanations and Designing Solutions** • ***7: Engaging in Argument from Evidence*** • 8: Obtaining, Evaluating, and Communicating Information	**<u>PHYSICAL SCIENCE</u>** • **PS1 Matter and its Interactions** -PS1.A: Structure and Propertes of Matter -PS1.B: Chemical Reactions **<u>ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE</u>** • **ETS1 Engineering Design** -ETS1.B: Developing Possible Solutions -ETS1.C: Optimizing the Design Solution	• 1: Patterns • **2: Cause and Effect** • *3: Scale, Proportion and Quantity* • *4: Systems and System Models* • ***5: Energy and Matter*** • *6: Structure and Function* • 7: Stability and Change

Performance Expectation
MS-PS1-4 Matter and its Interactions

Students who demonstrate understanding can:
Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.
Clarification Statement: *Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawing and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.*
Assessment Boundary: *N/A*

Lesson Level Phenomenon: Food coloring drops dissolve at different rates at different water temperatures; water droplets form on the outside of a can or glass
note: all photo and video above links to suggested activities below

MS-PS1-4 Suggested Activities	MS-PS1-4 Recommended Formative Assessments
The Motion of Particles (*TCI Matter: Unit 2 States of Matter, Lesson 4)* Students will create and revise models depicting relationship between particle motion and states of matter based on temperature and pressure. (165 minutes) Heat, Temperature, and State Change (*TCI Matter: Unit 2 States of Matter, Lesson 5)* Students will compare heat, thermal energy, and temperature to explore six types of state changes with video and experimentation. (140 minutes)	• Write a letter to your alien pen pal that explains the states of matter on Earth- Performance Assessment TCI.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to predict and/or describe phenomena. **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.**	**PS1.A: Structure and Properties of Matter** • 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, 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. • The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter. **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	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

	temperature difference between two objects. *(secondary)* • The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. *(secondary)*	

Performance Expectation PS1-4
Matter and its Interactions

Connections to other DCIs Middle School:
MS.ESS2.C

Articulation of DCIs across grade-levels:
HS.PS1.A ; HS.PS1.B ; HS.PS3.A

Common Core State Standards Connections:
ELA /Literacy -

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-PS1-4)*

Mathematics —
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)

Lesson Level Vocabulary:
State of matter, solid, liquid, gas, melting point, boiling point, pressure, thermal energy, temperature, heat, evaporate, sublime, condense, deposit

DCI Domain Vocabulary:
Domains are bold:
- **Matter and Its Interactions→Structure and Properties of Matter (PS1)**
  actual mass, ammonia, atom, atomic, atomic arrangement, atomic theory, atomic weight, attractive, boiling point, charged, compress, condensation, conduction, conductive, conductivity, detect, dissolve, electrical charge, electrical conductivity, element, evaporation, extended structure, filtering, function, matter particle, melting point, methanol, mineral, molecular level, molecule, nucleus, oxygen, particle, precision, pressure, properties of elements, reaction, receptor, relative, repulsive, separation method (for mixtures), simple molecule., sodium chloride, solubility, substance, thermal conductivity, vapor

Performance Expectation MS-PS1-5 From Molecules to Organisms: Structures and Processes		
Students who demonstrate understanding can: **Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.** **Clarification Statement:** Emphasis is on law of conservation of matter and on physical models or drawings, including digital forms, that represent atoms. **Assessment Boundary:** *Assessment does not include the use of atomic masses, balancing symbolic equations, or intermolecular forces.*		
Lesson Level Phenomenon: The mass of steel wool increases as it burns. ***note: all photo and video above links to suggested activities below***		

MS-PS1-5 Suggested Activities	MS-PS1-5 Recommended Formative Assessments
Atoms in Chemical Reactions (*TCI Matter: Unit 3 Chemical Reactions, Lesson 7*) Students will observe changes in substances and draw a model of atoms before and after a chemical reaction. (200 minutes)	• In a Venn diagram, describe the similarities and differences between the two models you used to investigate atoms in chemical reactions.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to describe unobservable mechanisms. . **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.**	**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. • The total number of each type of atom is conserved, and thus the mass does not change.	**Energy and Matter** • Matter is conserved because atoms are conserved in physical and chemical processes.

Performance Expectation
MS-PS1-5 Matter and its Interactions

Connections to other DCIs in Middle School:
MS.LS1.C ; MS.LS2.B ; MS.ESS2.A

Articulation of DCIs across grade-levels:
5.PS1.B ; HS.PS1.B

Common Core State Standards Connections:

ELA /Literacy –

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-PS1-5)*

Mathematics —

MP.2 Reason abstractly and quantitatively. (MS-PS1-5)

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

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

Lesson Level Vocabulary: *chemical equation, law of conservation of matter, scientific law*

DCI Domain Vocabulary:

Domains are bold:

- **Matter and its Interactions→Chemical Reactions (PS1)**
  accuracy, alternative, ammonium chloride, atom, atomic level, carbon, chemical, chemical , chemical energy, chemical process, chemical reaction, chlorine, compound, concentration of reactants, conserve, dissolve, dynamic, element, energy, food oxidation, interdependence, iterative process, Kelvin, kinetic energy, macroscopic, macroscopic level, metal reactivity, microscopic, molecule,, nonmetal reactivity, nonreactive gas, nucleus, optimal, oxidation, oxygen, particle, physical properties, pure substance, react, reactant, reaction, reaction rate, refinement, sodium, sodium hydroxide, store, substance, surface area of reactants, synthetic, test results, thermal , transfer, zinc

Performance Expectation
MS-ETS1-3 Engineering Design

Students who demonstrate understanding can:
Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
Clarification Statement: *N/A*
Assessment Boundary: *N/A*

Lesson Level Phenomenon: The mass of steel wool increases as it burns
note: all photo and video above links to suggested activities below

MS-ETS1-3 Suggested Activities	MS-ETS1-3 Recommended Formative Assessments
Atoms in Chemical Reactions (*TCI Matter: Unit 3 Chemical Reactions, Lesson 7*) Students will observe changes in substances and draw a model of atoms before and after a chemical reaction. (200 minutes) Energy in Chemical Reactions (*TCI Matter: Unit 3 Chemical Reactions, Lesson 8*) Students will investigate exothermic and endothermic reactions that can be used for a chemical cold pack or hand warmer. (200 minutes)	• Describe the similarities and differences between the two models you used to investigate atoms in chemical reactions using a Venn diagram. • Complete lesson game (TCI) "Budding Wisdom". • Identify a specific problem you would like to solve with a hot pack. Design solutions to the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to determine similarities and differences in findings. **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.**	**ETS1.B: Developing Possible Solutions** • There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. • Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. **ETS1.C: Optimizing the Design Solution** • Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design.	**N/A**

Performance Expectation
MS-EST1-3 Engineering Design

Connections to other DCIs Middle School:
Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5
Connections to MS-ETS1.C: Optimizing the Design Solution include:
Physical Science: MS-PS1-6

Articulation of DCIs across grade-levels:
3-5.ETS1.A ; 3-5.ETS1.B ; 3-5.ETS1.C ; HS.ETS1.B ; HS.ETS1.C

Common Core State Standards Connections:
ELA/Literacy —

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. *(MS-ETS1-3)*

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-ETS1-3)*

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-ETS1-3)

Mathematics —

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-3)*

7.EE.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), 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-ETS1-3)*

Lesson Level Vocabulary:
chemical equation, law of conservation of matter, scientific law

DCI Domain Vocabulary:
Domains are bold:

- **Biological Evolution: Engineering Design→Developing Possible Solutions, Optimizing the Design Solution(ETS1)**
  abstract, agreed-upon, collaboratively, computational, concrete, consideration, control of variables, controlled experiment, convincing, criteria, cultural, data analysis, data interpretation, data presentation, design system, element, impact, iterative process, jointly, linear, mathematical model, nonlinear, optimal, physical replica, priority, prototype, quantitative, real-world, redesign process, representation, societal, break down, statistical, systematic, systematic, test results, theoretical model, trial

Performance Expectation
PS1-6 Matter and its Interactions

Students who demonstrate understanding can:

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.*

Lesson Level Phenomenon: When magnesium is lit on fire, it burns bright—when chicken is lit on fire it changes color from pink to white

note: all photo and video above links to suggested activities below

MS-PS1-6 Suggested Activities	MS-PS1-6 Recommended Formative Assessments
Energy in Chemical Reactions (*TCI Matter: Unit 3 Chemical Reactions, Lesson 8*) Students will investigate exothermic and endothermic reactions that can be used for a chemical cold pack or hand warmer. (200 minutes)	• Identify a specific problem you would like to solve with a hot pack. Design solutions to the problem.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. **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.**	**PS1.B: Chemical Reactions** • Some chemical reactions release energy, others store energy. **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)* **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)* • 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)*	**Energy and Matter** • The transfer of energy can be tracked as energy flows through a designed or natural system.

Performance Expectation
PS1-6 Matter and its Interactions

Connections to other DCIs in Middle School:
MS.PS3.D

Articulation of DCIs across grade-levels:
HS.PS1.A ; HS.PS1.B ; HS.PS3.A ; HS.PS3.B ; HS.PS3.D

Common Core State Standards Connections:
ELA /Literacy –

RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS1-6)

WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS1-6)

Mathematics —

N/A

Lesson Level Vocabulary: *exothermic reaction, endothermic reaction, prototype*

DCI Domain Vocabulary:
Domains are bold:

- **Matter and its Interactions→Chemical Reactions (PS1)**
  accuracy, alternative, ammonium chloride, atom, atomic level, carbon, chemical, chemical compound, chemical energy, chemical process, chemical reaction, chlorine, concentration of reactants, conserve, dissolve, dynamic, element, food oxidation, interdependence, iterative process, Kelvin, kinetic energy, macroscopic, macroscopic level, metal reactivity, microscopic, molecule,, nonmetal reactivity, nonreactive gas, nucleus, optimal, oxidation, oxygen, particle, physical properties, pure substance, react, reactant, reaction, reaction rate, refinement, sodium, sodium hydroxide, store, substance, surface area of reactants, synthetic, test results, thermal energy, transfer, zinc

Performance Expectation
MS-PS1-3 Matter and its Interactions

Students who demonstrate understanding can:

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

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

Assessment Boundary: *Assessment is limited to qualitative information.*

Lesson Level Phenomenon: Faux leather is made from synthetic materials that serve the same function as real leather

note: all photo and video above links to suggested activities below

MS-PS1-3 Suggested Activities	MS-PS1-3 Recommended Formative Assessments
Chemical Engineering and Society (*TCI Matter: Unit 3 Chemical Reactions, Lesson 9*) Students will research and investigate substances that have a lasting impact on society.	• Complete performance Assessment (TCI) "Modifying and Explaining Survival Gear".

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Obtaining, Evaluating, and Communicating Information • Gather, read, and synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication and methods used, and describe how they are supported or now supported by evidence. **Obtaining, evaluating, and communicating information in 6–8 builds on K–5 and progresses to evaluating the merit and validity of ideas and methods.**	**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. **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.	**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. -- ***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. **Influence of Science, Engineering and Technology on Society and the Natural World** • The uses of technologies and any limitation on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time.

Performance Expectation
MS-PS1-3 Matter and its Interactions

Connections to other DCIs in Middle School:
MS.LS2.A ; MS.LS4.D ; MS.ESS3.A ; MS.ESS3.C

Articulation of DCIs across grade-levels:
HS.PS1.A ; HS.LS2.A ; HS.LS4.D ; HS.ESS3.A

Common Core State Standards Connections:

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-PS1-3)

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 -
N/A

Lesson Level Vocabulary: *natural resource, synthetic material, food additive, biodegradable*

DCI Domain Vocabulary:

Domains are bold:

- **Matter and its Interactions→Chemical Reactions (PS1)**
  chemical, microscopic, particle, store, test results, transfer, accuracy, alternative, atom, conserve, dissolve, Kelvin, react, substance, ammonium chloride, chemical compound, chemical energy, chlorine, concentration of reactants, element, food oxidation, kinetic energy, metal reactivity, nonmetal reactivity, nonreactive gas, nucleus, physical properties, pure substance, reactant, reaction, reaction rate, refinement, sodium, sodium hydroxide, surface area of reactants, synthetic, thermal energy, zinc, atomic level, carbon, chemical process, chemical reaction, dynamic, interdependence, iterative process, macroscopic, macroscopic level, molecule, optimal, oxidation, oxygen

Unit 4: The Study of How Earth Changes

April-June

Anchoring Phenomenon	
The Himalayas Forming: 70 million years in 2 minutes	
Compelling Questions	**Supporting Questions**
How has the Earth changed over time?	• *What kinds of fossils would you expect to find at the top of the tallest mountains in the world?* • *What Earth's processes occur on similar time and space scales?* • *What are some different ways the Earth's surface changes?*
Unit 4 Storyline	**Unit 4 Possible Student Misconceptions:**
Students will study geological changes that take place on Earth.	• *All Earth's processes occur on the same time scale.* • *Earth's surface does not change over time.*

Unit 4 Overview: The Study of How Earth Changes

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **MS-ESS2-1** • **MS-ETS1-4** • **MS-ESS2-2** • **MS-ESS2-3** • **MS-ESS3-1** • **MS-ESS3-2** *Teacher Note: All the Performance Expectations above will be covered this unit and can be worked on concurrently. All Science and Engineering Practices and Crosscutting Concepts in bold are written in the Performance Expectations above. The italicized practices and crosscutting concepts, although not mentioned specifically, may be incorporated additionally in any science lesson at any time.*	• 1: Asking Questions and Defining Problems • 2: **Developing and Using Models** • *3: Planning and Carrying Out Investigations* • **4: Analyzing and Interpreting Data** • *5: Using Mathematical Computational Thinking* • **6: Constructing Explanations and Designing Solutions** • *7: Engaging in Argument from Evidence* • 8: Obtaining, Evaluating, and Communicating Information	**EARTH AND SPACE SCIENCE** • **ESS1 The History of Planet Earth** -ESS1.C: The History of Planet Earth • **ESS2 Earth's Systems** -ESS2.A: Earth's Materials and Systems -ESS2.B: Plate Tectonics and Large-Scale System Interactions -ESS2.C: The Roles of Water in Earth's Processes • **ESS3 Earth and Human Activity** -ESS3.A: Natural Resources -ESS3.B: Natural Hazards **ENGINEERING, TECHNOLOGY AND THE APPLICATION OF SCIENCE** • **ETS1 Engineering Design** -ETS1.B: Developing Possible Solutions -ETS1.C: Optimizing the Design Solution	• **1: Patterns** • 2: Cause and Effect • **3: Scale, Proportion and Quantity** • *4: Systems and System Models* • *5: Energy and Matter* • *6: Structure and Function* • **7: Stability and Change**

Performance Expectation MS-ESS2-1 Earth's Systems
Students who demonstrate understanding can: **Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.** **Clarification Statement:** *Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.* **Assessment Boundary:** *Assessment does not include the identification and naming of minerals.*
Lesson Level Phenomenon: **When the bottom of a tank of water is heated, warm water rises, cools, and falls back again.** ***note: all photo and video above links to suggested activities below***

MS- ESS2-1 Suggested Activities	MS- ESS2-1 Recommended Formative Assessments
Energy in Earth's Systems (*TCI Planet Earth: Unit 1 Earth's Systems, Lesson 1*) Students will identify Earth's systems and explore how the flow of energy causes changes to matter within those systems through the process of convection. (210 minutes)	• Draw a model depicting the flow of matter and energy in the atmosphere. • Explain convection in terms of energy flow in the system you created. • Improve the diagram of the Biosphere using TCI *Handout B: Improving a Model of Energy Flow*.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop and use a model to describe phenomena. **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.**	**ESS2.A: Earth's Materials and Systems** • All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.	**Stability and Change** • Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.

Performance Expectation
MS- ESS2-1 Earth's Systems

Connections to other DCIs in Middle School:
MS.PS1.A ; MS.PS1.B ; MS.PS3.B ; MS.LS2.B ; MS.LS2.C ; MS.ESS1.B ; MS.ESS3.C

Articulation of DCIs across grade-levels:
4.PS3.B ; 4.ESS2.A ; 5.ESS2.A ; HS.PS1.B ; HS.PS3.B ; HS.LS1.C ; HS.LS2.B ; HS.ESS2.A ; HS.ESS2.C ; HS.ESS2.E

Common Core State Standards Connections*:*
ELA/Literacy -

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.*(MS- ESS2-1)*

Mathematics- N/A

Lesson Level Vocabulary: *crust, mantle, core, conduction, density, convection, radiation*

DCI Domain Vocabulary:
Domains are bold:

- **Earth's Systems→Earth's Materials and Systems (ESS2)**
  atmospheric composition, atmospheric layers, atmospheric pressure,biosphere,catastrophic,coastal,continental,crust,deposition,destructive,distribution,dynamic,Earth's atmosphere, Earth's climate, Earth's layers, Earth's system, formation, geochemical reaction, geologic, geoscience, geosphere, greenhouse gas, ground water, humidity, hydrosphere, igneous rock, impact, increase, internal, landslide, mass wasting, metamorphic rock, meteor, meteor impact, microscopic, mineral, molten ,molten rock, negative, ocean trench, optimal, original, plate tectonics, positive, runoff, sedimentary rock, sedimentation, spatial, surface runoff, water cycle, wetland

Performance Expectation
MS-ETS1-4 Engineering Design

Students who demonstrate understanding can:

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

Clarification Statement: *N/A*

Assessment Boundary: *N/A*

Lesson Level Phenomenon: **When the bottom of a tank of water is heated, warm water rises, cools, and falls back again.**

***note: all photo and video above links to suggested activities below**

MS-ETS1-4 Suggested Activities	MS-ETS1-4 Recommended Formative Assessments
Energy in Earth's Systems (*TCI Planet Earth: Unit 1 Earth's Systems, Lesson 1*) Students will identify Earth's systems and explore how the flow of energy causes changes to matter within those systems through the process of convection. (210 minutes)	• Draw a model depicting the flow of matter and energy in the atmosphere. • Explain convection in terms of energy flow in the system you created. • Improve the diagram of the Biosphere using TCI *Handout B: Improving a Model of Energy Flow*.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models • Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs. **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.**	**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. • Models of all kinds are important for testing solutions. **ETS1.C: Optimizing the Design Solution** • The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	N/A

Performance Expectation ETS1-4 Engineering Design

Connections to other DCIs Middle School:
Physical Science: MS-PS1-6, MS-PS3-3, Life Science: MS-LS2-5

Articulation of DCIs across grade-levels:
Physical Science: MS-PS1-6

Common Core State Standards Connections:
ELA /Literacy -

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ETS1-4)*

Mathematics -

MP.2 Reason abstractly and quantitatively. *(MS-ETS1-4)*

7.SP Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is n discrepancy. *(MS-ETS1-4)*

Lesson Level Vocabulary:

DCI Domain Vocabulary:

Domains are bold:

- **Engineering Design→Developing a Solution; Optimizing the Design Solution (ETS1)**
  abstract, agreed-upon, break down, collaboratively, computational, concrete, consideration, control of variables, controlled experiment, convincing, criteria, cultural, data analysis, data interpretation, data presentation, design system, element, impact, iterative process, jointly, linear, mathematical model, nonlinear, optimal, physical replica, priority, prototype, quantitative, real-world, redesign process, representation, societal, statistical, systematic, systematic, test results, theoretical model, trial

Performance Expectation
MS-ESS2-2 Earth's Systems

Students who demonstrate understanding can:

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Clarification Statement*: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.*

Assessment Boundary: *N/A*

Lesson Level Phenomenon: **Ice breaks off a glacier and falls into the ocean.**

note: all photo and video above links to suggested activities below

MS- ESS2-2 Suggested Activities	MS- ESS2-2 Recommended Formative Assessments
Scales of Change on Earth's Surface (*TCI Planet Earth: Unit 1 Earth's Systems, Lesson 2*) Students will place a series of Earth's processes on a time and spatial scale and observe the crystallization process. (315 minutes)	• List three slow and three fast changes to Earth's surface. • Draw a picture of crystals at three different time periods. • Write an explanation justifying your placement of Earth's processes on the time/space scale.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future. **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.**	**ESS2.A: Earth's Materials and Systems** • The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. **ESS2.C: The Roles of Water in Earth's Surface Processes** • Water's movements—both on the land and underground—cause weathering and erosion, which change the land's surface features and create underground formations.	**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.

Performance Expectation
MS-ESS2-2 Earth's Systems

Connections to other DCIs Middle School:
MS.PS1.B ; **MS.LS2.B**

Articulation of DCIs across grade-level bands:
4.ESS1.C ; 4.ESS2.A ; 4.ESS2.E ; 5.ESS2.A ; HS.PS3.D ; HS.LS2.B ; HS.ESS1.C ; HS.ESS2.A ; HS.ESS2.B ; HS.ESS2.C ; HS.ESS2.D ; HS.ESS2.E ; HS.ESS3.D

Common Core State Standards Connections:
ELA/Literacy-

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS2-2)

WHST.6-8.2 Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS2-2)

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. *(MS-ESS2-2)*

Mathematics -

MP.2 Reason abstractly and quantitatively. (MS-ESS2-2)

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-ESS2-2)*

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-ESS2-2)*

Lesson Level Vocabulary: *weathering, erosion, deposition, uplift, uniformitarianism*

DCI Domain Vocabulary:
Domains are bold:

- **Earth's Systems→Earth's Materials and Systems; The Roles of Water in Earth's Surface Processes (ESS2)**
  alternative, atmosphere, atmospheric composition, atmospheric layers, atmospheric pressure, biosphere, catastrophic, coastal, condensation, content, continental, crust, crystal, cycle, deposition, destructive, dissolve, distribution, dynamic, Earth's atmosphere, Earth's climate, Earth's layers, Earth's surface, Earth's system, evaporation, force, formation, forms of water, geochemical reaction, geologic, geoscience, geosphere, greenhouse gas, groundwater, humidity, hydrologic cycle, hydrosphere, igneous rock, impact, increase, internal, landslide, mass wasting, mechanical, melting point, metamorphic rock, meteor impact, meteor, microscopic, mineral, molecular, molten rock, molten, negative, ocean trench, optimal, original, percentage, percolation, plate tectonics, polar ice caps, positive, properties, reservoir, rock breakage, rock composition, rock cycle, runoff, sedimentary rock, sedimentation, soil color, soil composition, soil texture, spatial, store, surface runoff, transfer, transmit, transpiration, universal solvent, water cycle, weathering, wetland

Performance Expectation
MS-ESS2-3 Earth's Systems

Students who demonstrate understanding can:

Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

Clarification Statement: *Examples of data include similarities of rock and fossil types on different continents, the shapes of the continents (including continental shelves), and the locations of ocean structures (such as ridges, fracture zones, and trenches).*

Assessment Boundary: *Paleomagnetic anomalies in oceanic and continental crust are not assessed.*

Lesson Level Phenomenon: **Fossils that had broad, flat leaves are found in Antarctica.**

note: all photo and video above links to suggested activities below

MS-ESS2-3 Suggested Activities	MS-ESS2-3 Recommended Formative Assessments
Earth's Tectonic Plates (TCI Planet Earth: Unit 2 Processes that Shape the Earth, Lesson 2) Students will collect and analyze evidence to support the continental drift hypothesis and explore how plate tectonic theory works. (315 minutes)	• Explain the patterns of fossil remains based on group and individual gathered evidence. • Draw and label models for convergent, divergent, and transform plate boundaries.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to provide evidence for phenomena. • **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.** --- ***Connections to Nature of Science*** **Scientific Knowledge is Open to Revision in Light of New Evidence** • Science findings are frequently revised and/or reinterpreted based on new evidence.	**ESS1.C: The History of Planet Earth** • Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. *(HS.ESS1.C GBE),(secondary)* **ESS2.B: Plate Tectonics and Large-Scale System Interactions** • Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.	**Patterns** • Patterns in rates of change and other numerical relationships can provide information about natural systems.

Performance Expectation
MS-ESS2-3 Earth's Systems

Connections to other DCIs Middle School:
MS.LS4.B

Articulation of DCIs across grade-levels:
3.LS4.A ; 3.ESS3.B ; 4.ESS1.C ; 4.ESS2.B ; 4.ESS3.B ; HS.LS4.A ; HS.LS4.C ; HS.ESS1.C ; HS.ESS2.A ;HS.ESS2.B

Common Core State Standards Connections:
ELA/Literacy –

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. *(MS-ESS2-3)*

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-ESS2-3)

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-ESS2-3)

Mathematics -

MP.2 Reason abstractly and quantitatively. (MS-ESS2-3)

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-ESS2-3)*

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-ESS2-3)*

Lesson Level Vocabulary: *hypothesis, continental drift, fault, seafloor spreading, criteria, constraints, scientific theory, plate tectonics, subduction*

DCI Domain Vocabulary:
Domains are bold:

- **Earth's Systems→The History of Planet Earth; Plate Tectonics and Large-Scale System Interactions (ESS2)**
  ancient, atomic, chemical change, chemical process, Continental, continental boundary, continental crust, continental shelf, convection, crust, crustal deformation, crustal plate movement, crystalize, crystalline solid, crystallization, cycle, decay, deform, density, distribution, Earth's crust, fracture zone, geologic, geologic force, geologist, gravitational, interdependence, interior, laboratory, lithosphere, ocean trench, outward, physical change, physical replica, plate tectonics, pressure, radioactive, reconstruction, recrystallization, rock layer movement, sedimentation, spontaneous, tectonic process, thermal, topographic map, wave

Performance Expectation
MS-ESS3-1 Earth and Human Activity

Students who demonstrate understanding can:

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Clarification Statement: *Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).*

Assessment Boundary: *N/A*

Lesson Level Phenomenon: Every device contains parts that are made from natural resources.

note: all photo and video above links to suggested activities below

MS-ESS3-1 Suggested Activities	MS-ESS3-1 Recommended Formative Assessments
Earth's Natural Resources (*TCI Planet Earth: Unit 2 Processes that Shape the Earth, Lesson 6*) Students will explore the availability of renewable and nonrenewable resources. (330 minutes)	• Create a chart of non-renewable and renewable resources used during the class game "Resources Rounded Up". • Write an explanation about relationship between natural resources located in different locations and the flow of energy. • Graph the populations of three organisms over time. Make a claim as to how increases in human population and increases of natural resources affects Earth's systems.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. **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.**	**ESS3.A: Natural Resources** • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems. --- ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** • All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

Performance Expectation
MS-ESS3-1 Earth and Human Activity

Connections to other DCIs in Middle School:
MS.PS1.A ; MS.PS1.B ; MS.ESS2.D

Articulation of DCIs across grade-levels:
4.PS3.D ; 4.ESS3.A ; HS.PS3.B ; HS.LS1.C ; HS.ESS2.A ; HS.ESS2.B ; HS.ESS2.C ; HS.ESS3.A

Common Core State Standards Connections:
ELA /Literacy –

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts. (MS-ESS3-1)
WHST.6-8.2	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. (MS-ESS3-1)
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research. (MS-ESS3-1)

Mathematics —

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-ESS3-1)*
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-ESS3-1)*

Lesson Level Vocabulary: *natural resource, renewable resource, nonrenewable resource, sustainable, petroleum, geothermal energy, soil, ore*

DCI Domain Vocabulary:
Domains are bold:

- **Earth and Human Activity→Natural Resources (ESS3)**
  agricultural, biosphere, civilization, conservation, consumption, deposition, development, distribution, economic, energy source, geologic process, geologic trap, geoscience, groundwater, human decision, hydrothermal, impact, interdependence, issue, long-term, management, marine sediment, material world, metal ore, mineral, modern, negative, nonrenewable energy, organic, per-capita, physical replica, positive, renewable energy, short-term, subduction zone

Performance Expectation
MS-ESS3-2 Earth and Human Activity

Students who demonstrate understanding can:
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.
Clarification Statement: Emphasis is on how some natural hazards, such as volcanic eruptions and severe weather, are preceded by phenomena that allow for reliable predictions, but others, such as earthquakes, occur suddenly and with no notice, and thus are not yet predictable. Examples of natural hazards can be taken from interior processes (such as earthquakes and volcanic eruptions), surface processes (such as mass wasting and tsunamis), or severe weather events (such as hurricanes, tornadoes, and floods). Examples of data can include the locations, magnitudes, and frequencies of the natural hazards. Examples of technologies can be global (such as satellite systems to monitor hurricanes or forest fires) or local (such as building basements in tornado-prone regions or reservoirs to mitigate droughts).
Assessment Boundary: *N/A*

Lesson Level Phenomenon: **Volcanoes erupt and earthquakes shift the ground at similar places around the globe, but there are other places that see very little earthquake and volcanic activity.**

note: all photo and video above links to suggested activities below

MS-ETS1-3 Suggested Activities	MS-ETS1-3 Recommended Formative Assessments
Volcanic Eruptions and Earthquakes (*TCI Planet Earth: Unit 4 Earth's Natural Hazards, Lesson 9*) Students will analyze data to determine the locations of volcanoes and earthquakes, create a poster identifying high risk areas, and explore how bridge design can mitigate the risks caused by earthquakes. (155 minutes)	• Create and share a poster with the class concerning how bridge design can mitigate risks caused by earthquakes and other natural disasters.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Analyze and interpret data to determine similarities and differences in findings. **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.**	**ESS3.B: Natural Hazards** • Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events.	**Patterns** • Graphs, charts, and images can be used to identify patterns in data. --- ***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. Thus technology use varies from region to region and over time.

Performance Expectation
MS-ESS3-2 Earth and Human Activity

Connections to other DCIs Middle School:
MS.PS3.C

Articulation of DCIs across grade-levels:
3.ESS3.B ; 4.ESS3.B ; HS.ESS2.B ; HS.ESS2.D ; HS.ESS3.B ; HS.ESS3.D

Common Core State Standards Connections:

ELA/Literacy —

RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts. *(MS-ESS3-2)*

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-ESS3-2)

Mathematics —

MP.2 Reason abstractly and quantitatively. (MS-ESS3-2)

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-ESS3-2)*

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-ESS3-2)*

Lesson Level Vocabulary: *natural hazard, precursor events, frequency, magnitude, mitigate*

DCI Domain Vocabulary:

Domains are bold:

- **Earth and Human Activity→Natural Hazards (ESS3)**
  catastrophic, debris, development, economic, frequency, geologic, impact, interdependence, magnitude, mass wasting, natural process, reservoir, satellite