Stanford NGSS Integrated Curriculum
An Exploration of a Multidimensional World

UNIT 2

Matter Matters

How can models of matter help us understand the resources we use?

SCALE
Stanford Center for Assessment, Learning & Equity

Stanford NGSS Integrated Curriculum: An Exploration of a Multidimensional World
Unit 2: Matter Matters

Essential Question: How can models of matter help us understand the resources we use?

Total Number of Instructional Days: 29

Lift-Off Task: A Shrinking Sea	**Task 1:** Explosions in Human Population	**Task 2:** Unequal Access to Resources	**Task 3:** What is Water?	**Task 4:** Changing States

Connect to the Culminating Project using the Project Organizer

Group Culminating Project:
Create a video for an online magazine describing a solution to access freshwater

Individual Culminating Project
Write a digital article detailing the science behind your solution to freshwater access

Unit 2 Pop-Out
Natural Resources, Wealth, and Fairness
(*Implement after Task 2*)

7th Grade Science Unit 2: Matter Matters
Unit Overview

Storyline for Unit 2

As humans, we use many resources from our surrounding ecosystems to help us survive. As our population grows, we take more and more from the environment. In this unit, students will learn that these natural resources are limited, in high demand, and not always equally available to people around the world. As part of their culminating project, they will consider how they might use knowledge of states of matter to make one natural resource—water—more accessible to people around the world without putting too much strain on the environment.

In the Lift-Off Task, students are introduced to the phenomenon of the shrinking Aral Sea and asked to generate a list of questions they would ask in order to learn more. As they explore these questions throughout the unit, students will begin to form a complex picture of natural resources, like the water in the Aral Sea, including: their importance, where they come from, how their molecular structure informs their use, and why they are at risk of disappearing.

As human population grows, this pressure on natural resources, such as the freshwater in the Aral Sea, will only continue to increase. In Task 1, students step back to think about why human population increases. They analyze data that looks at human population growth over time and notice the pattern that when more resources are made available, through innovations like new agriculture practices or fuel use, human population can dramatically increase. In the end, students are left with the question: what does this mean for our future?

Students thus realize that human population is growing, which creates a higher demand for natural resources that is having devastating effects on environments, like the Aral Sea. In Task 2, they ask themselves: why aren't natural resources always accessible? And at what lengths will humans go to in order to extract all the natural resources they desire? By exploring different types of energy resources, students learn why some regions have more access to certain resources than others, why humans have to take more extreme measures for extraction, and what the consequences are.

By this point in the unit, students have approached matter from a broader perspective, looking at different examples of natural resources, where they come from, and how humans are using them. Task 3 asks students to now look at matter from a micro perspective, using the familiar example of a natural resource that they will focus on in their culminating project—water. In this task, students investigate how water behaves in different states and begin to hypothesize about what is happening at the molecular level.

In Task 4, students then confirm or adjust their hypotheses based on a computer simulation of water in different states. By the end of this task, students will see that particle motion varies depending on the state and that adding or removing thermal energy is what causes these changes in state. By understanding changes in state, students make the final move towards their culminating project—using their knowledge of changing states of matter to make water more available in a region without much liquid water.

Once students are complete with all learning tasks, they are ready to complete their culminating project. An online "Zine" is looking for ideas on how to distribute water more equally to people around the world. Each group picks a location that does not have access to a lot of freshwater and uses their knowledge of the Earth and changing states to figure out a way to make water more available. They then create a short video that provides a background on water and and explains their solution. Each student individually writes a digital article to accompany the video, explaining the solution in more detail. By focusing on water (instead of allowing a choice in natural resource), we ensure students are making a clear connection between the physical, chemical, and life science Performance Expectations in this unit.

Three-Dimensional Breakdown of the Performance Expectations

This unit was developed to align with, teach, and assess students' understanding and skills related to these Performance Expectations. Below, we have mapped out the disciplinary core ideas, crosscutting concepts, and science and engineering practices addressed in this unit. Aspects of the dimensions that are not explicitly addressed in this unit are crossed out.

Performance Expectations	Scientific and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-LS2-1. 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.]	**Analyzing and Interpreting Data** • Analyze and interpret data to provide evidence for phenomena.	**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.~~ (Addressed in Unit 1). • 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.
MS-ESS3-1. 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.	**Constructing Explanations** • 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	**ESS3.A: Natural Resources** • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

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).]	the future.	around the planet as a result of past geologic processes.	
MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a complete description of all individual atoms in a complex molecule or extended structure is not required.]	**Developing and Using Models** • Develop a model to predict and/or describe phenomena.	**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.
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification	**Developing and Using Models** • Develop a model to predict and/or describe phenomena.	**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.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]		• 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.	

Connections to Common Core Math and ELA Standards:

Over the course of this unit, students will gain knowledge and skills in science, as well as in English-language-arts and math. Below we list the Common Core ELA and Math standards for middle school and 7th grade that are relevant to the curriculum tasks in this unit. Within the curriculum, there are opportunities to incorporate components of the following ELA and Math Standards:

Middle School Common Core ELA Standards		Unit Task
Key Ideas and Details	CCSS.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.	Task 1 Task 2 Culminating Project
Integration of Knowledge and Ideas	CCSS.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).	Task 1 Task 3 Task 4 Culminating Project
Research to Build and Present Knowledge	CCSS.ELA-Literacy.WHST.6-8.9: Draw evidence from informational texts to support analysis, reflection, and research.	Task 1 Task 2 Culminating Project

Middle School and 7th Grade Common Core Math Standards		Unit Task
Mathematical Practice	CCSS.MATH.MP.2: Reason abstractly and quantitatively.	Task 1 Task 4
	CCSS.MATH.MP.4: Model with mathematics.	Task 3 Task 4 Culminating Project

Connections to English Language Development (ELD) Standards:

We acknowledge that language development is a key component of disciplinary understanding and helps to support more rigorous and equitable outcomes for diverse students. This curriculum thus takes into account both the receptive and productive language demands of the culminating projects and strives to increase accessibility by including scaffolds for language development and pedagogical strategies throughout learning tasks. We aim to support language acquisition through the development of concept maps; utilizing sentence frames; implementing the Critique, Clarify, Correct technique; employing the Stronger Clearer strategy; and fostering large and small group discussions.

The California ELD Standards are comprised of two sections: the standards and a rubric. Outlined below are the standards from Section One that are met within this curriculum. For additional information, please refer to: https://www.pausd.org/sites/default/files/pdf-faqs/attachments/SS_ELD_7.pdf.

7th Grade ELD Standards		
Part I: Interacting in Meaningful Ways	A: Collaborative	1.Exchanging information and ideas with others through oral collaborative discussions on a range of social and academic topics
		2. Interacting with others in written English in various communicative forms (print, communicative technology, and multimedia)
		3. Offering and justifying options, negotiating with and persuading others in communicative exchanges
		4. Adapting language choices to various contexts (based on task, purpose, audience, and text type)
	B: Interpretive	5. Listening actively to spoken English in a range of social and academic contexts
		6. Reading closely literary and informational texts and viewing multimedia to determine how meaning is conveyed explicitly and implicitly through language
		7. Evaluating how well writers and speakers use language to support ideas and arguments with details or evidence depending on modality, text type, purpose, audience, topic, and content area
		8. Analyze how writers and speakers use vocabulary and other language resources for specific purposes (to explain, persuade, entertain, etc.) depending on modality, text type, purpose, audience, topic, and content area
	C: Productive	9. Expressing information and ideas in formal oral presentations on academic topics
		10. Writing literary and informational texts to present, describe, and explain ideas and information, using appropriate technology
		11. Justifying own arguments and evaluating others' arguments in writing
		12. Selecting and applying varied and precise vocabulary and other language resources to effectively convey ideas
Part II: Learning About How English Works	A: Structuring Cohesive Texts	1. Understanding text structure
		2. Understanding cohesion
	B: Expanding and Enriching Ideas	3. Using verbs and verb phrases
		4. Using nouns and noun phrases
		5. Modifying to add details
	C: Connecting and Condensing Ideas	6. Connecting ideas
		7. Condensing ideas

Connections to Environmental Awareness:

Over the course of this curriculum, students will explore content related to various environmental principles and concepts that examine the interactions and interdependence of human societies and natural systems. In accordance with the *Education and the Environment Initiative (EEI),* tasks throughout this curriculum explore many of *California's Approved Environmental Principles and Concepts.* The principles relevant to this unit are outlined in the chart below:

Unit Task	EEI Principle	EEI Concept
Task 1 Task 2 Culminating Project	Principle I: The continuation and health of individual human lives and of human communities and societies depend on the health of the natural systems that provide essential goods and ecosystem services.	Concept B: The ecosystem services provided by natural systems are essential to human life and to the functioning of our economies and cultures.
		Concept C: The quality, quantity, and reliability of the goods and ecosystem services provided by natural systems are directly affected by the health of those systems.
Task 1 Task 2 Culminating Project	Principle II: The long-term functioning and health of terrestrial, freshwater, coastal and marine ecosystems are influenced by their relationships with human societies.	Concept A: Direct and indirect changes to natural systems due to the growth of human populations and their consumption rates influence the geographic extent, composition, biological diversity, and viability of natural systems.
		Concept B: Methods used to extract, harvest, transport and consume natural resources influence the geographic extent, composition, biological diversity, and viability of natural systems.
		Concept C: The expansion and operation of human communities influences the geographic extent, composition, biological diversity, and viability of natural systems.
Task 2 Task 3 Task 4 Culminating Project	Principle III: Natural systems change in ways that people benefit from and can influence.	Concept A: Natural systems proceed through cycles and processes that are required for their functioning.
		Concept B: Human practices depend upon and benefit from the cycles and processes that operate within natural systems.
Task 2	Principle IV: The exchange of matter between natural systems and human societies affects the long-term functioning of both.	Concept B: The byproducts of human activity are not readily prevented from entering natural systems and may be beneficial, neutral, or detrimental in their effect.

7th Grade Science Unit 2: Matter Matters
Teacher Materials List

Unit Essential Question: *How can models of matter help us understand the resources we use?*

Overall Unit – All Tasks

- Unit 2, Task Cards Student Version, Lift-Off and Tasks 1 through 4
- Culminating Project Student Task Card
- Project Organizer
- Projector with Audio (for video or images, whenever needed)

Lift-Off Task (2 days)

Per Student

- Task Card Student Version: Lift-Off
- Post-Its (Optional)
- Task Card Student Version: Culminating Project
- Project Organizer

Per Group

- Poster paper and markers

Whole Class

- Poster paper and markers
- *See Instructions in Lift-Off for other optional materials to use for the class concept map

Task 1 (3.5 days)

Per Student

- Task Card Student Version: Task 1
- Project Organizer

Per Pair

- Explosions in Human Population Resource Card

Task 2 (3.5 days)

Per Student

- Task Card Student Version: Task 2
- Project Organizer

Per Pair

- Station Cards in sheet protectors

Whole Class

- Projector and Speakers (for video)

Task 3 (4 days)

Per Student

- Task Card Student Version: Task 3
- Project Organizer
- Jelly Beans (1 color) – 2
- Gumdrops (1 color) – 1
- Toothpicks – 1, cut in half

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Teacher Materials List

Per Station (*Recommended: Create multiple of each station so there are less students per station)
- Station Cards in sheet protectors (cut apart and provide a few per station)
- Station 1
  - Hot water in a glass beaker
  - Cold Water in a glass beaker
  - Yellow food coloring
  - Blue food coloring
- Station 2
  - Hot water in a glass beaker
  - Cold water in a glass beaker
  - Glass flask
  - Soap solution in a small plastic beaker
- Station 3
  - 2 ice trays (identical)
    - One empty
    - One with exactly 2 tablespoons of water frozen in each well
  - Tablespoon
  - Cup of Water

Per Group
- Environment Images (cut apart and give one to each group)

Whole Class
- Optional: Projector to show environment images

Task 4 (4.5 days)
Per Student
- Task Card Student Version: Task 4
- Project Organizer

Group
- Computers
- Definition Cards, cut

Culminating Project (8 days)
Per Group: Zine Video
- Poster Paper
- Color pencils/pens or computer graphics
- Computers with internet and presentation capabilities
- Phone or camera with video capabilities

Per Student: Digital Article
- Computer with word processing

Unit 2 Pop-Out (3.5 days)
Per Student
- Student Version: Unit 2 Pop-Out

7th Grade Science Unit 2: Matter Matters
Teacher Materials List

- Unit 2, Pop-Out Case Study – Water, Farming, and Wealth

Per Pair
- Computer or tablet
- Markets, colored pencils, or art supplies

Per Group
- Computer or tablet

Whole Class
- Projector and Speakers (for video)

7th Grade Science Unit 2: Matter Matters
Building on Prior Knowledge

Unit 2 connects all three disciplines—life science, physical science, and earth science—as students consider the interdependent relationship between natural resources and human population. In the process, students explore how geoscience processes unevenly distribute natural resources and how they can use understanding of molecular structure to provide more equitable and sustainable access to resources.

The integrated model requires students to access and use a wide range of ideas from prior grades. This content knowledge spans three different Disciplinary Core Ideas: LS2.A. Interdependent Relationships in Ecosystems, ESS3.A. Natural Resources, and PS1.A. Structure and Properties of Matter.

As students explore these core ideas, they build on their skills in the following science and engineering practices: Developing and Using Models, Analyzing and Interpreting Data, and Constructing Explanations. In addition to science and engineering practices, students also continue to build on their knowledge of the following crosscutting concepts: Cause and Effect and Scale, Proportion, and Quantity.

*This summary is based on information found in the NGSS Framework.

K-8 Progression of Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts for Unit 2

Disciplinary Core Ideas	K-2	3-5	6-8
LS2.A Interdependent Relationships in Ecosystems	Plants depend on water and light to grow. Plants depend on animals for pollination or to move their seeds around.	The food of almost any animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants, while decomposers restore some materials back to the soil.	Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth.
ESS3.A Natural Resources	Plants and animals can change their environment. Living things need water, air, and resources from the land, and they live in places that have the things they need. Humans use natural resources for everything they do.	Energy and fuels humans use are derived from natural sources and their use affects the environment. Some resources are renewable over time, others are not.	Humans depend on Earth's land, ocean, atmosphere, and biosphere for different resources, many of which are limited or not renewable. These resources are distributed unevenly around the planet as a result of past geologic processes.
PS1.A. Structure and Properties of Matter	Matter exists as different substances that have observable different properties. Different properties are suited to different purposes. Objects can be built up from smaller parts.	Because matter exists as particles that are too small to see, matter is always conserved even if it seems to disappear. Measurements of a variety of observable properties can be used to identify particular materials.	The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.

7th Grade Science Unit 2: Matter Matters
Building on Prior Knowledge

Science and Engineering Practices	K-2	3-5	6-8
Developing and Using Models*	Modeling in K-2 builds on prior experiences and progresses to include using and developing models (i.e., diagram, drawing, physical replica, diorama, dramatization, or storyboard) that represent concrete events or design solutions. • Develop and/or use a model to represent amounts, relationships, relative scales (bigger/smaller), and/or patterns in the natural and designed world(s).	Modeling in 3-5 builds on prior experiences and progresses to building and revising simple models and using models to represent events and design solutions. • Develop and/or use models to describe and/or predict phenomena.	Modeling in 6-8 builds on prior experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems. • Develop a model to predict and/or describe phenomena.
Analyzing and Interpreting Data*	Analyzing data in K-2 builds on prior experiences and progresses to collecting, recording, and sharing observations. • Record information (observations, thoughts, and ideas). • Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems. .	Analyzing data in 3-5 builds on prior experiences and progresses to introducing quantitative approaches to collecting data and conducting multiple trials of qualitative observations. When possible and feasible, digital tools should be used. • Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships. • Analyze and interpret data to make sense of phenomena, using logical reasoning, mathematics, and/or computation.	Analyzing data in 6-8 builds on prior experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to provide evidence of a phenomenon.
Constructing Explanations*	Constructing Explanations in K-2 builds on prior experiences and progresses to the use of evidence and ideas in constructing evidence-based accounts of natural phenomena. • Use information from observations (firsthand	Constructing Explanations in 3-5 builds on prior experiences and progresses to the use of evidence and ideas in constructing explanations that specify variables that describe and predict phenomena. • Use evidence (e.g., measurements,	Constructing Explanations in 6-8 builds on prior experiences and progresses to include constructing explanations supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. • Construct a scientific explanation based on valid and reliable evidence obtained from sources

	and from media) to construct an evidence-based account for natural phenomena.	observations, patterns) to construct or support an explanation or design a solution to a problem.	(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.

*These SEPs are summatively assessed using the Culminating Project.

Crosscutting Concepts	K-2	3-5	6-8
Cause and Effect*	Students learn that events have causes that generate observable patterns. They design simple tests to gather evidence to support or refute their own ideas about causes. • Events have causes that generate observable patterns.	Students routinely identify and test causal relationships and use these relationships to explain change. They understand events that occur together with regularity might or might not signify a cause and effect relationship. • Cause and effect relationships are routinely identified, tested, and used to explain change.	Students classify relationships as causal or correlational, and recognize that correlation does not necessarily imply causation. They use cause and effect relationships to predict phenomena in natural or designed systems. They also understand that phenomena may have more than one cause, and some cause and effect relationships in systems can only be described using probability. • Cause and effect relationships may be used to predict phenomena in natural or designed systems.
Scale, Proportion, and Quantity*	Students use relative scales (e.g., bigger and smaller; hotter and colder; faster and slower) to describe objects. They use standard units to measure length. • Relative scales allow objects and events to be compared and described (e.g., bigger and smaller; hotter and colder; faster and slower).	Students recognize natural objects and observable phenomena exist from the very small to the immensely large. They use standard units to measure and describe physical quantities such as weight, time, temperature, and volume. • Natural objects and/or observable phenomena exist from the very small to the immensely large or from very short to very long time periods.	Students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale, and the function of natural and designed systems may change with scale. They use proportional relationships (e.g., speed as the ratio of distance traveled to time taken) to gather information about the magnitude of properties and processes. They represent scientific relationships through the use of algebraic expressions and equations. • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.

*These CCCs are summatively assessed using the Culminating Project.

7^{th} Grade Science Unit 2: Matter Matters
Building on Prior Knowledge

Progression of Knowledge from Kindergarten – 8^{th} grade

LS2.A. Interdependent Relationships in Ecosystems: In Kindergarten – second grade, students explore some specific examples that demonstrate how various parts of an environment interact with each other. For example, plants need nonliving things, like water and light, in order to grow, and they also rely on living things, like animals, for reproduction purposes. By the third – fifth grade level, students are no longer considering isolated examples of interactions, but rather considering the ecosystem as a whole. In fifth grade, students model how all organisms are connected through feeding relationships and decomposition. They continued to explore these interactions between organisms in the first seventh grade unit. This prepares them for this unit, as students are asked to delve deeper into the interactions between organisms and their environment. While Developing and Using Models and Systems and System Models seem the most relevant to the content of this DCI, students also engage in a number of other science and engineering practices and crosscutting concepts across grade levels, including: Planning and Carrying Out Investigations, Analyzing and Interpreting Data, Constructing Explanations, Patterns, Cause and Effect, and Structure and Function.

The following is the progression of the Performance Expectations for this DCI:

2-LS2-1 Plan and conduct an investigation to determine if plants need sunlight and energy to grow.

2-LS2-2 Develop a simple model that mimics the function of an animal in dispersing seeds or pollination.

5-LS2-1 Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment.

MS-LS2-1 Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS2-2 Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

ESS3.A. Natural Resources: In Kindergarten – second grade, students are first introduced to the idea that humans use natural resources for everything they do. At this level, students are engaging with the science and engineering practice of Developing and Using Models and the crosscutting concept of Systems and System Models to describe this relationship. By third – fifth grade level, students move towards Obtaining, Evaluating, and Communicating Information about the specific example of how energy and fuels are derived from natural resources. At this point, they move past just knowing that humans use natural resources, but also that their use can negatively impact the environment. Thus, they begin to look at this content through the lens of Cause and Effect, which they will continue to do in this seventh grade curriculum. In this unit, students continue to explore this idea of limited and nonrenewable resources, but apply it to other types of resources, such as minerals and groundwater. They begin to form a more comprehensive picture of why resources are distributed the way they are due to past geoscience processes and current human activity—a concept that they were initially introduced to in Unit 1.

The following is the progression of the Performance Expectations for this DCI:

K-ESS3-1 Use a model to represent the relationship between the needs of different plants or animals (including humans) and the places they live.

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

MS-ESS3-1 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.

PS1.A. Structure and Properties of Matter: In Kindergarten - second grade, students begin their initial exploration of matter by beginning to observe and analyze tangible materials and their properties. They also explore how an object made of small pieces can be disassembled and made into a new object, a concept that will be crucial as they begin to think about atoms, molecules, chemical reactions, and conservation of matter in later grade bands. In third-fifth grade, they build on explorations from second grade to identify specific materials based on their properties. They also use experiments to gather evidence of the law of conservation of matter, a schema they started to develop in second grade. At this point, students are moving past observations of matter they can see and towards developing an understanding that matter is made of particles too small to be seen. Thus, by this seventh grade unit, they are able to develop models of unseen particles, such as the atomic composition of various molecules and the movement of particles in different states of matter. In later seventh grade units, students will also delve deeper into chemical reactions, learning how to determine when a chemical reaction has occurred and applying this knowledge to the processes that transforms natural resources to synthetic materials. Because of the vast number of Performance Expectations related to this DCI, students engage with a large range of science and engineering practices and crosscutting concepts.

The following is the progression of the Performance Expectations for this DCI:

2-PS1-1 Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

2-PS1-3 Make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-2 Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.

5-PS1-3 Make observations and measurements to identify materials based on their properties.

MS-PS1-1 Develop models to describe the atomic composition of simple molecules and extended structures.

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

7th Grade Science Unit 2: Matter Matters
Building on Prior Knowledge

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

MS-PS1-4 Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

7th Grade Science Unit 2: Matter Matters
Culminating Project

Unit Essential Question: *How can models of matter help us understand the resources we use?*

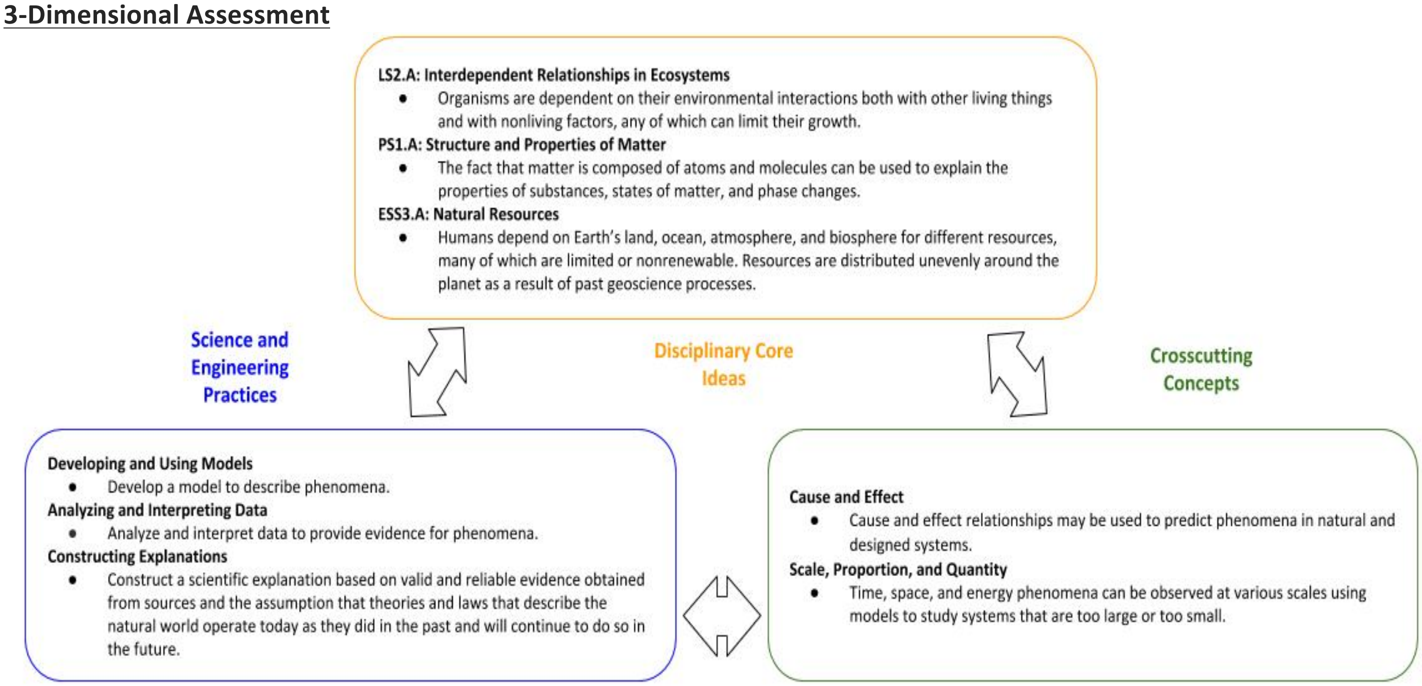
Introduction

Nature provides us with many resources that we use in our daily lives. This is why we call them natural resources. As our population grows, this means we take more and more from the environment. Unfortunately, while natural resources are in high and increasing demand, they are also limited and often nonrenewable. Furthermore, they are also not always equally available to people around the world.

Water is one example of a limited resource found in Earth's environments that is very important to all living things. With the Aral Sea, students saw an example of a water reservoir that has dramatically changed over time. Phenomena, like these, are happening all over the world. For this unit's culminating project, students learn that an online "Zine" is looking for ideas on how to distribute water more equally to people around the world. Each group's job is to pick a location that does not have access to a lot of freshwater and use their knowledge of the Earth and changing states to figure out a way to make water more available in that community. Each group then creates a short video that provides a background on water and explains their solution. Each student individually writes a digital article to accompany his or her group's video, explaining the solution in more detail.

In this project, we want to ensure students are making a clear connection between the physical, chemical, and life science Performance Expectations addressed in this unit. We thus decided to focus on water rather than allow students to select from a variety of natural resources. Unlike other natural resources, water provides a unique context for students to use what they learn about changing states of water from Tasks 3 and 4 to figure out a way to make more of it available to people around the world. These could include solutions like diverting snowmelt or collecting water vapor on sheets in humid areas.

3-Dimensional Assessment



7th Grade Science Unit 2: Matter Matters
Culminating Project

Time Needed (Based on 45-Minute Periods)

8 days at end of unit

- Group Project: 4 periods
- Individual Project: 4 periods
    - First draft: 2 periods
    - Feedback: 1 period
    - Revision: 1 period

Materials

Zine Video

- Poster Paper
- Color pencils/pens or computer graphics
- Computers with internet and presentation capabilities
- Phone or camera with video capabilities

Digital Article

- Computer with word processing

Instructions for the Culminating Project

1. Introduce the Culminating Project at the end of the Lift-Off task, including both group and individual components outlined in the Challenge.

2. Read over the Culminating Project Task Card with the students. We recommend only reading the Challenge and Group Project Criteria for Success at this time in order to not overwhelm students with information.
    - Take questions for clarification.
    - Optional: Show the following video from Unit 1 to remind students about what they learned about natural resources: https://www.youtube.com/watch?v=8LfD_EKze2M.

3. Remind students that as they go through the Project Organizer, they will be planning pieces of their solution and recording scientific concepts they will likely need for their individual project. However, there is nothing wrong with going back and changing their ideas over the course of the unit. The students won't fully design their solution until the end of the unit, so change during the imaginative and creative time is acceptable and often experienced.

4. Make sure students fill out the Project Organizer after each task, which will help them think about different parts of their solution along the way. This process allows students to both apply and document relevant scientific concepts as they move throughout the unit. This will inform both their group and individual projects.
    - We recommend that students complete the Project Organizer individually. They might discuss ideas first as a group, but should then respond individually. This allows students time to process concepts on their own and generate their own ideas, which can be used later when it comes to developing their group project.

5. The table below summarizes how the Project Organizer guides the students through developing different components of their zine video and digital article.

7th Grade Science Unit 2: Matter Matters
Culminating Project

Task	Project Organizer	Group and Individual Culminating Project
Lift Off A Shrinking Sea	• Use your own prior knowledge to identify some ways humans use the natural resource of water.	• N/A
Task 1 Explosions in Human Population	• Research and explain why water is important to humans. • Explain how the availability of water might affect human growth and population, using data from the task as justification.	• An explanation that uses data to justify how they think availability of water affects human population size
Task 2 Unequal Access to Resources	• Explain why water is not available equally throughout the world, focusing on the process that makes it. • How are some humans using more than their share of water? • What is the effect on environmental systems?	• An explanation that uses evidence to explain why water is unevenly distributed throughout the world
Task 3 What is Water?	• Develop a model of the molecular structure of water, labeling and explaining its parts. • Research and explain how the molecular structure of water gives it properties that make it useful to humans.	• Model of atomic composition of water • Explanation of valuable properties of water
Task 4 Changing States	• How might using water sometimes require changing its original state? • Brainstorm possible ways to provide water to a community that needs it without putting too much strain on the environment. Create a few possible design sketches with captions explaining how they work. Explain some of the pros and cons of your solutions.	• Solution that uses a change in state to make water more available • Model of solution showing molecule motion, kinetic energy of particles, and how thermal energy affects state of water

6. After all the learning tasks are completed, and all the Project Organizers are completed, the students can start to design their solution. Students will then create a video presentation that gives a background on water, explains all the components of their solution, and meets all the criteria in the student handout. The Project Organizers and Group Project Criteria for Success should be used as reference for the students to remind them of all the components of their group project.
   - As always, we recommend the use of group roles for Culminating Project work time (See "How to Use This Curriculum" for details). We recommend changing the roles every workday.

7. Once the videos are designed and presented, students are ready to move on to their individual project. Students will write a digital article to go along with the video that explains their solution in more detail and meets all the criteria in the student handout.

8. Conduct a peer review of the digital articles after students have completed a first draft.
   - Copy the Digital Article Peer Review Feedback form found in the Student Instructions. Another option is to use the Student 3-Dimensional Individual Project Rubric.

- Assign each student a partner, preferably a partner from a different group.
- Students switch drafts and assess them using the peer review feedback form.
    - Remind each student to give one positive comment and one constructive comment for each section on the checklist.
    - Allow students time to present their feedback to their partner, so their partner may ask clarifying questions if needed.

9. After receiving feedback, allow students time to complete a final draft based on the feedback they received.

Assessment

The Project Organizer can be formatively assessed using:

- *Criteria of your choice*. We recommend using the 3-Dimensional Assessment matrix from the Unit Overview to inform your criteria.

The Group Culminating Project will be summatively assessed using:

- The *Group Project Criteria for Success* Checklist

The Individual Culminating Project will be summatively assessed using:

- The *3-Dimensional Individual Project Rubric*.
- Keep in mind that the Proficient level indicates that the student has successfully demonstrated understanding of the criteria. Because we are in the early stages of NGSS adoption, it may take multiple opportunities throughout the course of the year for students to reach Proficient.
- If you wish to give students a numeric score, you could take the average score of all of their rubrics or add up rubric scores to give students a summation out of the total. Because of the note above, this scoring may not correlate to traditional grading systems.
- While we recommend scoring all of the project criteria with the rubrics for each student, we understand the burden of that level of scoring.
    - One option is to select the rubrics that you wish to focus on for this project and use those to assess each student's individual project.
    - Another option is to review the Proficient level of each of the project's rubrics and use the descriptions to generally analyze all student work for trends.

7th Grade Science Unit 2: Matter Matters
3-Dimensional Individual Project Rubric

Overview: The following rubrics can be used to assess the individual project: the digital article. Each rubric is aligned to one section of the *Individual Project Criteria for Success*, located on the Culminating Project Student Instructions. *If student provides no assessable evidence (e.g., "I don't know" or leaves answer blank), then that student response cannot be evaluated using the rubric and should be scored as a zero.

Below we provide an alignment table that details the dimensions assessed for each criterion.

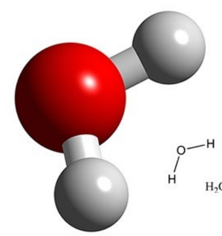
	Student Criteria for Success	Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
1	❒ A background on the natural resource of water ○ Draw and explain a model that shows the atomic composition of water. ▪ Explain how the molecular structure gives water properties that make it useful to humans.	**Developing and Using Models** ● Develop a model to predict and/or describe phenomena.	**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.	**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.
2	○ Explain how you think the availability of water affects human population size in a region. ○ Describe data from Task 1 that allows you to conclude this cause-and-effect relationship between water availability and population.	**Analyzing and Interpreting Data** ● Analyze and interpret data to provide evidence for phenomena.	**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. ● 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.
3	❒ An explanation of the global problem of freshwater access ○ Explain why water is unevenly distributed throughout the world. ○ Describe how humans are making the problem worse. ○ Reference your group's location as an example and cite evidence from Task 2 to	**Constructing Explanations** • Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories	**ESS3.A: Natural Resources** • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

	support your explanation.	and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.	These resources are distributed unevenly around the planet as a result of past geologic processes.	
4	○ Draw a model of your solution to describe how it changes water into the state that is most useful to humans. In your model, include pictures, labels, and descriptions of: ○ The motion of water molecules and kinetic energy of particles in each state shown ○ Water as a solid, liquid, and/or gas ○ Explain how thermal energy and temperature affects the states of water in your solution.	**Developing and Using Models** ● Develop a model to predict and/or describe phenomena.	**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.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

7th Grade Science Unit 2: Matter Matters
3-Dimensional Individual Project Rubric

Rubric 1: Student develops a scale model to describe the atomic composition of water that is too small to be seen.

- Dimensions Assessed: SEP – Developing and Using Models, DCI – PS1.A: Structure and Properties of Matter, CCC – Scale, Proportion, and Quantity

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student develops an **inaccurate** scale model to describe the atomic composition of water that is too small to be seen.	Student develops a **partially accurate** scale model to describe the atomic composition of water that is too small to be seen.	Student develops a **mostly accurate** scale model to describe the atomic composition of water that is too small to be seen.	Student develops a **completely accurate** scale model to describe the atomic composition of water that is too small to be seen.
Look Fors: ● Student develops an inaccurate model to describe the micro scale of atomic composition. ● For example, student shows inaccurate components (ie. 2 oxygen atoms and 1 hydrogen atom OR 1 giant hydrogen atom and 1 oxygen atom).	**Look Fors:** ● Student develops a partially accurate model to describe the micro scale of atomic composition, including the main components (2 hydrogen atoms and 1 oxygen atom) but missing both of the following details: o Atoms joined in an accurate formation (shown in *Advanced* Look-Fors) o Accurate labels ● For example, all the components are present but the labels may be missing AND the atoms are not drawn in the correct formation.	**Look Fors:** ● Student develops a mostly accurate model to describe the micro scale of atomic composition, including the main components (2 hydrogen atoms and 1 oxygen atom) but missing one of the following details: o Atoms joined in an accurate formation (shown in *Advanced* Look-Fors) o Accurate labels ● For example, all the components are present but the labels may be missing OR the atoms are not drawn in the correct formation.	**Look Fors:** ● Student develops a completely accurate model to describe the micro scale of atomic composition, including: o 2 hydrogen atoms and 1 oxygen atom o Atoms joined in an accurate formation (shown below) o Accurate labels 

7th Grade Science Unit 2: Matter Matters

3-Dimensional Individual Project Rubric

Rubric 2: Student explains how the availability of water likely affects human population size in a region, using data and a cause-and-effect relationship from Task 2 as evidence to justify this prediction.

- Dimensions Assessed: SEP – Analyzing and Interpreting Data, DCI – LS2.A: Interdependent Relationships in Ecosystems, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student **inaccurately** explains how the availability of water likely affects human population size in a region. OR Student **accurately** explains how the availability of water likely affects human population size in a region, using **no** data and **no** cause-and-effect relationship from Task 2 as evidence to justify this prediction.	Student **accurately** explains how the availability of water likely affects human population size in a region, using **no** data, just a cause-and-effect relationship from Task 2 as evidence to justify this prediction.	Student **accurately** explains how the availability of water likely affects human population size in a region, using **a** source of data and a cause-and-effect relationship from Task 2 as evidence to justify this prediction.	Student **accurately** explains how the availability of water likely affects human population size in a region, using **multiple** sources of data and a cause-and-effect relationship from Task 2 as evidence to justify this prediction.
Look Fors: ● Student inaccurately explains that the more water there is available in a region, the smaller the population size. OR ● Student accurately explains that the more water there is available in a region, the larger the population size in a region. However, student does not give any explanation for why they think this is the case.	**Look Fors:** • Student accurately explains that the more water there is available in a region, the larger the population size in a region. • Student does not cite any data as evidence, but does use the cause-and-effect relationship identified in Task 2. For example, "In Task 2, we learned that when there are more resources available, human population grows, so this implies that when there is more of the natural resource of water available, the population will grow."	**Look Fors:** • Student accurately explains that the more water there is available in a region, the larger the population size in a region. • Student cites one source of data and uses the cause-and-effect relationship identified in Task 2 as evidence. For example, "In Task 2, we learned that when there are more resources available, human population grows. This was the case during the industrial revolution in the mid-1800s: when natural resources like coal became available, the population exploded on the graph. This suggests that if there is more of the natural resource of water available, the population will also grow."	**Look Fors:** • Student accurately explains that the more water there is available in a region, the larger the population size in a region. • Student cites multiple sources of data and uses the cause-and-effect relationship identified in Task 2 as evidence. For example, "In Task 2, we learned that when there are more resources available, human population grows. This was the case during the industrial revolution in the mid-1800s: when natural resources like coal became available, the population exploded on the graph. This was also the case during the Green revolution in the 1950s, when resources like fertilizer and access to water led to population explosions in the graph. This suggests that if there is more water available, the population will grow."

7th Grade Science Unit 2: Matter Matters
3-Dimensional Individual Project Rubric

Rubric 3: Student constructs an explanation for the causes of uneven distribution of water throughout the world, using evidence to support their explanation.

- Dimensions Assessed: SEP – Constructing Explanations, DCI – ESS3.A: Natural Resources, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student constructs an **inaccurate** explanation for the causes of uneven distribution of water throughout the world.	Student constructs a **partial but accurate** explanation for the causes of uneven distribution of water throughout the world, using **no** evidence to support their explanation.	Student constructs a **partial but accurate** explanation for the causes of uneven distribution of water throughout the world, using **relevant** evidence to support their explanation.	Student constructs a **complete and accurate** explanation for the causes of uneven distribution of water throughout the world, using **relevant** evidence to support their explanation.
Look Fors: • Student inaccurately explains why water is unevenly distributed. • For example, "The amount of water in the region depends on how many other resources the region has. If there are a lot of other natural resources, there will be a lot of water too."	**Look Fors:** • Student accurately explains that water is unevenly distributed due to past geoscience processes, but does not discuss the effect of current human removal practices. • The explanation does not cite any evidence from Task 2 or other research. • For example, "Water is unevenly distributed throughout the world because depending on their location, different regions have different precipitation and different types of rock."	**Look Fors:** • Student accurately explains that water is unevenly distributed due to past geoscience processes, but does not discuss the effect of current human removal practices. • The explanation cites evidence from Task 2 or other research. • For example, "According to the Task 3 article, water is unevenly distributed throughout the world because depending on their location, different regions have different precipitation and different types of rock. For example, in the region our group researched, there is not very much rain or snow. There are also no sedimentary rocks, which tend to hold more water."	**Look Fors:** • Student accurately explains that water is unevenly distributed due to past geoscience processes AND current human removal practices. • The explanation cites evidence from Task 2 or other research. • For example, "According to the Task 3 article, water is unevenly distributed throughout the world because depending on their location, different regions have different precipitation and different types of rock. You can see this in the different colors on the graph that shows variations in precipitation around the world. For example, in the region our group researched, there is not very much rain or snow. There are also no sedimentary rocks, which tend to hold more water. This uneven distribution is being made worse because humans are using up too much of the water for it to be naturally replenished."

Rubric 4: Student develops a model to describe how their solution changes water into a state that is most useful to humans and accurately explains relevant science content.

- Dimensions Assessed: SEP – Developing and Using Models, DCI – PS1.A: Structure and Properties of Matter, CCC – Cause and Effect

Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Student develops an **irrelevant** model to describe how their solution changes water into a state that is most useful to humans and **does not** accurately explain relevant science content.	Student develops a **relevant** model to describe how their solution changes water into a state that is most useful to humans and accurately explains **limited** relevant science content.	Student develops a **relevant** model to describe how their solution changes water into a state that is most useful to humans and accurately explains **almost all** relevant science content.	Student develops a **relevant** model to describe how their solution changes water into a state that is most useful to humans and accurately explains **all** relevant science content.
Look Fors: • Student draws a model of a solution that is not relevant to the prompt and does not use the science content required. • For example, student draws a model of a well pulling up groundwater.	**Look Fors:** • Student draws a model of a relevant solution. See example in *Advanced Look-Fors*. • Student model uses pictures, labels, and descriptions to accurately explain some of the relevant science concepts. For example, student model may have a similar explanation as in the *Advanced Look-Fors*, but is missing any mention of the effect of thermal energy and does not discuss kinetic energy of the particles.	**Look Fors:** • Student draws a model of a relevant solution. See example in *Advanced Look-Fors*. • Student model uses pictures, labels, and descriptions to accurately explain most, but not all relevant science concepts. For example, student model may have a similar explanation as in the *Advanced Look-Fors*, but is missing any mention of the effect of thermal energy.	**Look Fors:** • Student draws a model of a relevant solution. For example, collecting water from the air using sheets in humid areas. • Student model uses pictures, labels, and descriptions to accurately explain all relevant science concepts. For example, "My solution shows water in a gas state changing into water in a liquid state to be used by the community. When water is in a gas state as water vapor, the water molecules are far apart and moving quickly, so the kinetic energy of the particles is high. As water vapor loses thermal energy, it collects on the sheets as liquid water. In liquid water, the molecules are still moving but are closer together and the kinetic energy of the particles is slower than a gas."

7th Grade Science Unit 2: Matter Matters
Project Organizer

Unit Essential Question: *How can models of matter help us understand the resources we use?*

You will be developing a solution to make a specific natural resource—water—more available to people around the world, while also considering strain on the environment. After each task, you will return to the table below to organize what you learn as you go through the unit. By the end of the four tasks, you will have all this information to use for your culminating project. For each activity, be sure to include answers to **ALL** the questions provided.

Lift-Off Task: A Shrinking Sea	Now that you have seen an example of a water reservoir changing drastically over time, think about why this might matter. Use your own prior knowledge to identify some ways humans use the natural resource of water.
Task 1: Explosions in Human Population	Now that you have seen how the availability of different resources has affected human population growth, apply this to the resource of water. ❒ Research and explain why water is important to humans. ❒ Explain how the availability of water might affect human population growth. ○ Use data from the task to justify why you think this is the case.

7th Grade Science Unit 2: Matter Matters
Project Organizer

Task 2: Unequal Access to Resources	Every natural resource comes from some geologic process, which only happens in certain areas of the world. ❑ Explain why water is not available equally throughout the world, focusing on the process that makes it. ❑ How are some humans using more than their share? ❑ What is the effect on environmental systems?
Task 3: What is Water?	You've explored molecular structure with a simple molecule—water. ❑ Draw a model of the molecular structure of water. 　○ Label and explain its parts. ❑ Research and explain how the molecular structure of water gives it properties that make it useful to humans.

7th Grade Science Unit 2: Matter Matters
Project Organizer

<table>
<tr><td rowspan="2">Task 4:
Changing States</td><td>Sometimes humans use natural resources as they exist in nature; other times humans use them by changing their state.
❑ Do some research: how might using water sometimes require changing its original state?
❑ Many communities don’t have enough water (to drink, grow crops, etc.) Use what you have learned about changing states of water to brainstorm possible ways to provide them water. Keep in mind that you do not want to put too much strain on the environment!
○ Create a few possible design sketches with captions explaining how they work.
○ Explain some of the pros and cons of your solutions.</td></tr>
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8th Grade Science Unit 2: Matter Matters
Lift-Off Task: A Shrinking Sea

Unit Essential Question: *How can models of matter help us understand the resources we use?*

Introduction

The Aral Sea is situated in Central Asia, between Kazakhstan and North Uzbekistan, and was once the fourth largest lake in the world. Thanks to decades of water diversions for irrigation and a recent drought, much of this freshwater reservoir is now completely dry. In this Lift-Off Task, students are introduced to the phenomenon of this shrinking Aral Sea and asked to generate a list of questions they would ask in order to learn more. As they explore these questions throughout the unit, students will begin to form a complex picture of natural resources, like the water in the Aral Sea, including: their importance, where they come from, how their molecular structure informs their use, and why they are at risk of disappearing. In gaining this knowledge, students can start to envision what kinds of solutions they could use to make water more accessible to certain regions in sustainable ways—their culminating project for this unit.

Alignment Table

Because the Lift-Off tasks focus on student-generated questions, we do not identify specific Disciplinary Core Ideas or Science and Engineering Practices in this table.

Crosscutting Concepts (*depending upon student-generated questions)
• Cause and Effect
  ○ Cause and effect relationships may be used to predict phenomena in natural or designed systems.
• 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.

Equity and Groupwork • Share and listen to broad and diverse student contributions. • Make connections between each other's ideas. • Work together to co-construct a concept map.
Language • Use connector words to link ideas. • Generate and write questions about the phenomenon. • Organize key questions in a concept map.

Learning Goals

This learning task introduces students to the phenomenon of the changing Aral Sea and begins generating questions that will guide them through the unit. More specifically, the purpose is to:

- Individually analyze satellite images and generate a list of questions about the changing Aral Sea.
- Make connections between related questions.
- Generate possible answers to questions, using prior knowledge.
- Apply prior knowledge of water as a natural resource to make a list of ways humans use water.

Content Background for Teachers

At this point in the unit, we are building off of students' prior knowledge of human use of natural resources, asking students to generate questions they would need to ask to make sense of this phenomenon of the changing Aral Sea. These might be questions related to what they observe in the images, why this might be happening, whether this phenomenon is happening elsewhere, why this matters, and much more.

This Lift-Off task uses the phenomenon of the shrinking Aral Sea because it provides a startling visual example of humans depleting the natural resource of water in real life. This ties specifically to students' culminating project and to the sequence of tasks in this unit. While concepts of matter are not introduced explicitly in this Lift-Off task, students will be exploring concepts of matter within the context of water later in this unit.

In this task, students create a concept map, which is a graphical tool that helps to organize and represent knowledge and questions, and is a successful academic language instruction tool. As students learn more about matter and resources, they will add more questions and ideas to this concept map. If your students have not had previous experience making concept maps, please see the instructions in Part B below for strategies on teaching this skill.

Academic Vocabulary

- Freshwater
- Reservoir
- Natural Resource
- Matter

*Additional academic vocabulary will vary by class

Time Needed (Based on 45-Minute Periods)

2 Days

- Introduction, Part A and Part B: 1 period
- Class Concept Map, Project Overview, and Project Organizer: 1 period

Materials

- Unit 2, Lift-Off Task Student Version

Part B

- Poster paper and markers
- Post-Its (Optional)

Part C

- Class Poster Paper and markers
- *See Instructions below for other optional materials to use for the class concept map

Connecting to the Culminating Project

- Culminating Project Handout
- Project Organizer Handout

8th Grade Science Unit 2: Matter Matters
Lift-Off Task: A Shrinking Sea

Instructions

1. Introduce students to the unit by reading or projecting the Unit Essential Question aloud.

2. Read the introduction on page 1 of the student guide aloud, which introduces the phenomenon for the unit: the changing Aral Sea. Then have students analyze the satellite images taken of the Aral Sea over a 35-year-period and make observations of what they notice.

Part A

1. In this Lift-Off task, students will be generating questions to help them make sense of the phenomenon.

2. Have students complete this section individually in their student guide.
   - For students who need more support, encourage them to look at the satellite images they observed, think of what natural resource it shows, and consider any questions they have.
   - Here is a list of some potential questions students might generate: "What is happening to the Aral Sea? Why is it shrinking? How does this affect plants, animals, and humans in the area? Is this phenomenon happening elsewhere in the world? Is this happening with other natural resources? Who is at fault? What can we do to stop it from shrinking? Why does this matter?"

Part B:

1. In this part of the task, students create a concept map as a group.
   - Remind students to refer to the directions on their student guide to help them make their concept map. First, students should compare each member's list of questions and record/connect key questions on a piece of poster paper. They will then draft possible answers to the questions, using prior knowledge.
   - Remind students that there are no right or wrong questions or predictions, so students feel encouraged to contribute any and all questions and ideas they think of.
   - Because this is a collaborative task, it is recommended that you remind students of group work norms and assign group roles, such as Resource Manager, Facilitator, Recorder, and Harmonizer (See "How to Use this Curriculum" for more details).

2. Students will post their posters on a wall and then walk around and look at each group's ideas. One suggestion for gallery walks is for students to interact with the posters in some way. For example, students are required to initial or leave post-its on three questions that they are also excited about on other posters.

8th Grade Science Unit 2: Matter Matters
Lift-Off Task: A Shrinking Sea

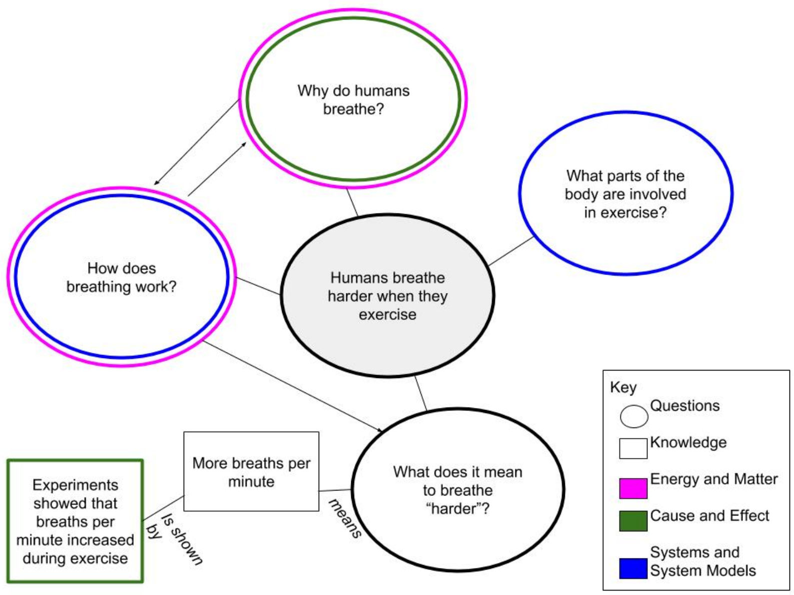
How to Concept Map

For students who have not had a lot of experience making concept maps, we have detailed a strategy below for introducing concept mapping using more familiar content. An example is also provided, but this will vary depending on what your students come up with as you make your own model.

1. Write the phenomenon in the middle of the poster, in this case "Humans breathe harder when they exercise."

2. Ask students to share questions they might ask to make sense of this phenomenon and make a list of these questions on the board.

3. Model the process of reviewing the list and finding similarities amongst the questions.
    - Place these key questions on the concept map poster, modeling how to put similar questions near each other on the poster. Circle these to signify that these are questions, not content knowledge.



4. Ask students to look at the key questions and see if any of the questions are connected: Would answering one question lead to one of the other questions? Model making these connections by drawing arrows between the circles.

5. In this Lift-Off task, students will only be drafting possible answers to the questions, not actually gathering and recording learned concepts. However, throughout the unit, they will be adding content they have learned. Model this by recording a student's prior knowledge to one of the questions, using boxes to signify that these are pieces of content knowledge rather than questions.
    - Use connector words to identify the relationships between the content boxes (See image above for an example).

6. Optional: To emphasize crosscutting concepts using a concept map, make a key of different colors for the crosscutting concepts emphasized in this unit. Identify questions that clearly show evidence of the different crosscutting concepts and circle them with the corresponding colors. Explain to students how you made that choice by pointing out the language that hints at that crosscutting concept. *Note: not all boxes and circles will necessarily have a crosscutting concept.

Part C

1. Construct a whole-class concept map that begins to help students make sense of the phenomenon of the changing Aral Sea.
    - Start with the phenomenon in the middle.
    - Then ask students to share out the questions that were most common across all the posters in the classroom. As you record questions on the poster, organize them based on connections you see. Draw circles around each question (as you add to the concept map throughout the unit, you'll also be adding concepts learned, which can be written in boxes to distinguish them from the questions).
    - Ask students to identify any connections they see between the questions and record these as lines between the questions.
        - Recommended: Give pairs of students think time to come up with 1-2 connections to add to the class concept map and call on pairs using equity sticks. This encourages more equitable participation in this class-wide activity.
    - The purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.
    - This whole class concept map will be revisited at the end of each subunit, asking students questions like: Are there any new questions you have about the phenomenon? Are there any connections you want to add or change? What is your reason for that addition/revision? Are there more connections we can make between the questions/ideas already on the map? Do you want to add any new ideas/concepts to the map?

2. Because this concept map will be added to and revised throughout the unit, here are some practical options for implementation.
    - If you have access to white board paper, we encourage you to use these for class posters since it will allow you and your students to make revisions throughout the unit.
    - Another option is to use smaller pieces of paper for each class and project using a document camera; this will save space as opposed to doing large class posters.
    - We highly recommend students keep their own version of this concept map in their notebooks, adding questions and concepts as they go through the unit.

3. Once the draft concept map is complete, introduce students to the crosscutting concepts for this unit. We recommend posting posters of each crosscutting concept in your classroom (See beginning of teacher guide for templates).
    - The crosscutting concepts for this unit are: Cause and Effect; Scale, Proportion, and Quantity. Assign a color for each crosscutting concept that can be used throughout the unit.
    - Have students analyze the class concept map for as many examples of the crosscutting concepts as they can find. Depending on the questions they have, they may be able to find an example of each of the crosscutting concepts or perhaps just some.

  - We recommend modeling this process by picking a question, identifying the crosscutting concept, and tracing the circle in the corresponding color. Explain the key words that helped you identify the crosscutting concept in this question. Some identifying words that students might look for are:
    - **Cause and Effect:** These could be phrases such as, "that results in," "that causes," "that explains why," "is due to," etc.
    - **Scale, Proportion, and Quantity**: These could be phrases such as, "is proportional to," "compared to," "has a ratio of," "is bigger/smaller than," "is longer/shorter than," etc.

Connecting to the Culminating Project

1. Hand out the Culminating Project Task Card and read the Challenge and Group Project Criteria for Success aloud as a class.
   - Take questions for clarification.

2. Optional: Display an example of an online magazine to show what a video and digital article look like.

3. Pass out their Project Organizer and explain that they will complete a section of this after each task in class. Students should independently complete the Lift-Off Task section of the Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.
   - Students have been tasked with developing a solution to make water more available to people in a certain area, while also considering strain on the environment. Now that you have seen an example of a water reservoir changing drastically over time, think about why this might matter. Use your own prior knowledge to identify some ways humans use the natural resource of water.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
   - At the beginning of this task, you made a list of all the questions you have about the changing Aral Sea. Look back at your list: think about the questions your peers asked that you did not initially write down. How are their questions different from the ones you originally asked?
   - In this unit, we will be focusing on two crosscutting concepts: **Cause and Effect**: cause and effect relationships may be used to predict events; and **Scale, Proportion, and Quantity**: scaled models can be used to study systems that are too large or too small. Looking at your class concept map, give one example of how a crosscutting concept came up in today's task.
   - Now that you understand what project you'll be working on over the course of this unit, what else do you need to know? What additional questions do you have?

2. There are no right answers, but encourage students to look back at their initial list of questions and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their questions and ideas based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and the gathering of knowledge and skills for their final project.

7th Grade Science Unit 2: Matter Matters
Task 1: Explosions in Human Population

Unit Essential Question: *How can models of matter help us understand the resources we use?*

Introduction

In the Lift-Off task, students saw an example of humans having a major impact on a precious natural resource. As human population grows, the pressure on natural resources, such as the freshwater in the Aral Sea, will only continue to increase. Human population is currently increasing at a dramatic rate, but it has not always been this way. Throughout history, we have seen spikes in human population growth due to periods of drastic technological innovation, such as the agricultural revolution or the industrial revolution. In this task, students will analyze data that looks at human population growth over time and try to identify the catalyst. By the end of the task, students will notice a pattern that when more resources are made available, through innovations like new agricultural practices or fuel use, human population can dramatically increase. In the end, students are left with the question: what does this mean for our future? This sets the stage for them to begin thinking about our human need for environmental resources and the resulting impacts, which are foundational concepts for their culminating project.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-LS2-1. 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.]	**Analyzing and Interpreting Data** • Analyze and interpret data to provide evidence for phenomena.	**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. • 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.
Supplementary Science and Engineering Practices • Constructing Explanations ○ Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.			
Supplementary Crosscutting Concepts • Patterns ○ Graphs, charts, and images can be used to identify patterns in data.			

7th Grade Science Unit 2: Matter Matters

Task 1: Explosions in Human Population

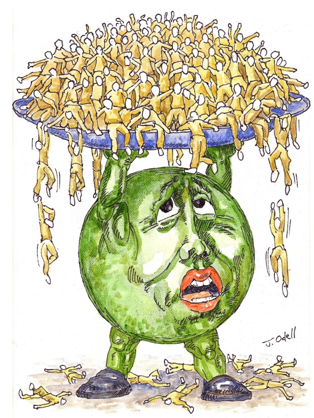
Equity and Groupwork • Discuss graphs and text analysis as a group.
Language • Connect observations from graphs to information gathered from text. • Identify relevant evidence to support an explanation.

Learning Goals

This learning task introduces students to the concept of resource availability and population growth within the context of human overpopulation. More specifically, the purpose is to:

- Make predictions about future population size and the impacts.
- Analyze and interpret data on the historical changes in human population.
- Explain why technological innovation has resulted in extra resources that spur human population growth.
- Extrapolate how this cause-and-effect relationship can predict future population growth and associated effects.
- Apply knowledge of resources and population to explain how availability of water might affect human population growth.

Content Background for Teachers



In Unit 1, students engaged with this same Performance Expectation by simulating how available resources affect different organisms in an ecosystem. In this task, they apply the same concepts to the case of natural resources and human population. According to the United Nations, world population is currently over 7 billion people. However, there has not been a steady growth in human population to get us to this point. For thousands of years, human population increased very slowly. Humans were hunter-gatherers, meaning they hunted animals and gathered naturally growing plants as their source of food. This resulted in a nomadic lifestyle.

Around 10,000 BC, farming was developed in a period called the Agricultural Revolution. Farming meant a steady supply of food, which meant that people could settle in one place, rather than moving around in search of food. This also often resulted in a surplus of food, meaning humans could now afford to feed more children and do other jobs that helped support a higher quality of life. This led to the first population explosion that students see on their graphs in this task.

This population explosion, however, was very subtle in comparison to the next population explosion, which happened in the late 1700s to mid-1850s. This period is known as the Industrial Revolution, in which areas mostly in Europe and North America began to use fossil fuels in industry. Previous to this, most labor was done manually. Changing the power source from humans to fossil fuels created much more efficiency. More work was being done, more products being made, and more food was being produced. This time also brought technological innovations like medicine and improved sanitation, which meant the death rate was also decreasing. For these reasons, this period saw rapid population growth.

The most recent increase in population is known as the Green Revolution, which began in the mid-1900s. This Green Revolution is so-named because it refers to improvements in agricultural practices. Genetically modified crops improved productivity, artificial fertilizers increased crop-yield, and chemical pesticides reduced the amount of crops lost to pests. New agricultural machinery was built and powered by fossil fuels, rather than humans, thus increasing efficiency. New irrigation practices also led to increased access to water. All of this, while at great costs to the environment, greatly improved the productivity of farms, allowing more food to be grown and feeding an additional 1 billion people who otherwise would not have been able to live.

While these historical events paint a foreboding picture of rampant, unchecked population growth and the associated rapid depletion of Earth's resources, some researchers maintain hope that this may be controlled. Some studies on a subject known as demographic transition have shown that as lean countries continue to develop, they will naturally transition to a lower birth rate. For more information on any of these concepts, please see the graphs and resource card associated with this task.

Academic Vocabulary

- Human Population
- Population Growth
- Population Explosion
- Agricultural Revolution
- Industrial Revolution
- Green Revolution
- Fertilizers
- Pesticides
- Genetically Modified Crops
- Resources

Time Needed (Based on 45-Minute Periods)

3.5 Days

- Engage: 0.5 period
- Explore: 1 period
- Explain: 0.5 period
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 2, Task 1 Student Version

Explain

- Explosions in Human Population Resource Card

Evaluate

- Project Organizer Handout

7th Grade Science Unit 2: Matter Matters
Task 1: Explosions in Human Population

Instructions

Engage

1. Introduce Task 1: In the Lift-Off Task, you looked at satellite images and asked questions to begin to make sense of the phenomenon of the shrinking Aral Sea. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
   - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 1: Many of you asked why this is happening and began to make predictions that humans might be somehow at fault. In this task, you will explore how and why humans are having more of a presence on planet Earth and predict how this might be affecting environments like the Aral Sea.
   - Now pass out their Task 1 student guide.

3. As a class, show the first 30 seconds of the following video to set the context: https://www.youtube.com/watch?v=QsBT5EQt348. This video introduces students to the idea of human population growth and poses a few questions that will pique students' own thinking and questioning.

4. In pairs, have students make predictions to the questions from the video and respond in their student guide.
   - This activity introduces students to the crosscutting concept that they will focus on throughout the task—**Cause and Effect**. Throughout the task, students will be using data to identify cause-and-effect relationships, which they will then use to predict future phenomena. Here students lay the foundation by using a cause-and-effect relationship from their prior knowledge to predict what population growth might mean for the future.
   - If students are stuck on Question 2, encourage students to look at the image for inspiration: What problems might this cause for Earth's environment? How are the people interacting in this photo as they run out of space?

5. Share out predictions in a class-wide discussion, emphasizing to students that there are no "correct" answers, just predictions.
   - For Question 1, most students will use the data to predict that we can expect human population to continue to increase in the future.
   - For Question 2, there are a large variety of answers students may brainstorm, such as: overcrowding, conflict, food shortages, environmental degradation, habitat loss for plants and animals, etc.
   - The use of equity sticks is encouraged for more equitable participation in class-wide discussions like these (See "How To Use This Curriculum" for more details).

Explore

1. Now that students have made initial predictions about the future of population growth, they need to gather data in order to make more informed predictions. In this activity, students look at three different graphs that sequentially introduce them to the history of human population growth.

  - This section of the task asks students to engage with the SEP of **Analyzing and Interpreting Data** and the CCC of **Patterns**, as students analyze graphs that begin to provide evidence of human population exploding at particular time periods. Here, students are also beginning to utilize the CCC of **Cause and Effect** by starting to identify cause and effect relationships in the past that can help inform predictions of future population growth. They will continue development of this CCC throughout the Explain and Elaborate.

2. Have students work in small groups to analyze each of the three graphs. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Materials Manager, Facilitator, Harmonizer, and Recorder.
    - Ask the Materials Manager to handle any resources needed to complete the task, including gathering any additional materials needed to understand the graphs.
    - Ask the Facilitator to read the directions, make sure everyone understands the task, and facilitate discussion.
    - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
    - Ask the Recorder to make sure the group is recording their graph analysis in their student guides.

3. Students should work together to answer the discussion questions that follow each graph. The purpose of these discussion questions is to help students with their graph analysis and push them to think about what might lead to human population growth.
    - Predictions about causes of human population explosion will vary by student interpretation, but overall students should find that there are three different periods of population explosion. The agricultural revolution around 10,000 BC provided a surplus of food, thus supporting more human life. The industrial revolution from the late 1700s-1850 led to increased efficiency that increased human population. The Green Revolution improved farming techniques, making it possible to feed more people and leading to more population growth.
    - At this point, the focus is on students analyzing data for events of population explosion and beginning to make predictions about causes. In the next activity, students will make connections between these events and the resources that became available at these times.

Explain

1. While students have made predictions about why these three population explosions have occurred, they have not yet received the information to draw concrete conclusions. In this section of the task, students are provided a resource card that gives more detail about the three technological revolutions. Using this resource card and data from the graphs, students are then able to write a paragraph that draws conclusions.
    - Here, students are asked to practice the SEP of **Constructing Explanations**, as they apply scientific reasoning to show why the evidence is adequate for the conclusion that resource availability affects human population growth. This process also continues students' engagement with the CCC of **Cause and Effect** as students gather the information they need to identify this cause-and-effect relationship, which they can then use to make predictions in the Elaborate.
    - This activity refers explicitly back to their learning from Unit 1 about resource availability and populations of organisms in ecosystems.

2. Distribute a resource card to each pair of students and have them read and discuss it in partners before writing the paragraph on their own.
    - You may want to have students annotate the reading with an annotation strategy of your choice (An option is provided in the "How to Use This Curriculum" document).
    - Students should use explicit evidence from the graphs and resource card in their paragraph.

3. Optional scaffold: Conduct a Critique, Correct, and Clarify language exercise in pairs before students write their own paragraphs. We recommend using equity sticks to share out a few pair's critiques as a class before they move on to independently writing an improved paragraph in their student guides. An example protocol and graphic organizer is provided below:

> **Critique, Correct, and Clarify: The Effects of Resource Availability on Human Population**
>
> Prompt: Individually write a paragraph explaining if the evidence (graphs and resource card) supports the idea that the availability of natural resources affects human population growth.
>
> In pairs:
> 1. Critique: Analyze the response below. Identify the error(s) or things that aren't clear. Share your ideas with a partner.
>
>   *The data supports that the availability of natural resources affects human population growth. For example, in Graphs 1 and 2, I observed that there was an increase in population around 10,000 BC and again more dramatically around 1700-1850. In graph 3, I saw that this happened again in the last 50 years because of the Green Revolution. Thus, the evidence clearly shows through these three cases that availability of natural resources affects human population.*
>
> 2. Correct: Individually write an improved paragraph in your student guide.
>
> 3. Clarify: Describe how and why you corrected the response.

4. Optional Sentence Stems to Provide:
    - The graphs and resource card together support the idea that…
    - For example, in Graphs 1 and 2, I observed…
    - One piece of evidence is ______, which shows…
    - Lastly, in graph 3, we saw that…
    - The resource card explained that…
    - In each population explosion…

- For example, in the ___ Revolution…
- Similarly, in the ____ Revolution…
- This is because…
- Thus, the evidence clearly shows through these three cases that…

5. Sample Paragraph: *The graphs and resource card together support the idea that the availability of natural resources affects human population growth. For example, in Graphs 1 and 2, I observed that there was an increase in population around 10,000 BC and again more dramatically around 1700-1850. The resource card explained that during both of these time periods there was a technological revolution that made more resources available to humans. For example, in the Agricultural Revolution, more food became available through farming, which increased the population. Similarly, in the Industrial Revolution, they began to use fossil fuels, like coal and oil, for industry, which increased efficiency and thus human population could grow. Lastly, in graph 3, we saw that this happened again in the last 50 years because of the Green Revolution. GMOs, fertilizers, chemical pesticides, and better access to water increased crop yield so many more people could be fed. This access to resources also increased population. Thus, the evidence clearly shows through these three cases that availability of natural resources affects human population.*

6. Optional peer review: Have table partners switch paragraphs and make suggestions for revisions.
    - This revised paragraph can also be a good option for formative assessment. Collect student work to identify trends in students' ability to apply scientific reasoning to show why the evidence is adequate for the conclusion. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

Elaborate

1. The first question of this Elaborate asks students to take what they have learned to make a prediction about human population in the future.
    - In doing so, students approach these concepts through the lens of the CCC of **Cause and Effect**, as they use cause-and-effect relationships they identified from past population data in order to inform predictions about the future of the human population.
    - We recommend students do this individually as it can also serve as a good formative assessment for this task. Collect student work to identify trends in students' ability to use a cause-and-effect relationship to make a relevant prediction and support their prediction with data from the task. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

2. The second question asks students to think back to the phenomenon of the Aral Sea from the Lift-Off task as a way to spark their thinking on what resources we might run out of if human population continues to grow in this way.
    - The purpose of this question is to get students to begin to consider how and why some natural resources are at risk of depletion. This will orient students towards their culminating project.

3. To wrap up the task, we recommend sharing out responses to these questions in a class-wide discussion. The use of a Think-Pair-Share with equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).

4. Return to the whole-class concept map from the Lift-Off Task.
   - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
     - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
     - Draw circles around each question and boxes around each concept.
     - Write connector words to describe connections between the concept boxes.
     - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: other examples of resources and human population growth.
   - Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
     - **Cause and Effect**. These could be phrases such as, "which results in," "which causes," "that explains why," "is due to," etc.
   - Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 1 section of the Unit 2 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with developing a solution to make a specific natural resource—water—more available to people around the world, while also considering strain on the environment. Their prompt is as follows: Now that you have seen how availability of different resources has affected human population growth, apply this to the resource of water.
   - Research and explain why water is important to humans.
   - Explain how the availability of water might affect population growth.
     - Use data from the task to justify why this is the case.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
   - At the beginning of this task, you were asked to predict what population growth might mean for our future. Look back at your prediction: after collecting all the evidence today, how would you change or add to your prediction? Use evidence from the task to justify your changes or additions and record below.
   - In this task, we focused on the crosscutting concept of **Cause and Effect**: cause and effect relationships may be used to predict events. Where did you see examples of **Cause and Effect** in this task?
   - Now that you have learned more about how availability of resources affects human population, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
   - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
   - Students may make changes to their Project Organizer according to your comments OR
   - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Explosions in Human Population

Explain

The Agricultural Revolution: 10,000 BC

Before the Agricultural Revolution, humans were hunter-gatherers, meaning they moved around to hunt animals and gather naturally growing plants for food. During the Agricultural Revolution, farming practices were developed, which meant that humans could settle in one place and grow a surplus (extra amount) of food. This meant that humans could now afford to feed more children and do other jobs that helped support a higher quality of life. This led to the first population explosion that you saw on your graphs.

Discuss:

- Why did the Agricultural Revolution lead to a huge increase in human population?
- What natural resources did humans have more of because of the Agricultural Revolution?

The Industrial Revolution: Late 1700s to mid-1850s

The Industrial Revolution led to a population explosion that was much larger than the Agricultural Revolution. During this time period, many areas, mostly in Europe and North America, began to use fossil fuels (oil, coal) in industry. Previous to this, most labor was done by hand. Changing the power source from humans to fossil fuels created much more efficiency. More work was being done, more products being made, and more food was being produced. This time also brought technological innovations in medicine and improved sanitation, which meant the death rate was also decreasing. For these reasons, this period saw rapid population growth.

Discuss:

- Why did the Industrial Revolution lead to a huge increase in human population?
- What natural resources did humans have more of because of the Industrial Revolution?

The Green Revolution: mid-1900s

The most recent increase in population is known as the Green Revolution. This Green Revolution is so-named because it refers to improvements in agricultural practices. Genetically modified crops and artificial fertilizers increased crop-yield, and chemical pesticides reduced the amount of crops lost to pests. New agricultural machinery was built and powered by fossil fuels, rather than humans, which increased efficiency. New irrigation practices also led to increased access to water. All of this, while at great costs to the environment, greatly improved the productivity of farms, allowing more food to be grown. This fed an additional 1 billion people who otherwise would not have been able to live.

Discuss:

- Why did the Green Revolution lead to a huge increase in human population?
- What natural resources did humans have more of because of the Green Revolution?

7th Grade Science Unit 2: Matter Matters
Task 2: Unequal Access to Resources

Unit Essential Question: *How can models of matter help us understand the resources we use?*

Introduction

There is no doubt that humans require natural resources to live. In the last task, students used data to confirm what they most likely already logically understood—that humans thrive when more resources become available. However, as our population continues to grow and our demand for natural resources grows along with it, we are beginning to run lower on these natural resources. Because many of these resources are limited and nonrenewable, this has created a contentious struggle between access to these resources and sustaining Earth's natural ecosystems. But why aren't these natural resources always accessible? And at what lengths will humans go to in order to extract all the natural resources they desire? In this task, students explore different types of energy resources to try and figure out why some regions have more access to certain resources than others, why humans have to take more extreme measures for extraction, and what the consequences are. This will lay the foundation for their culminating project as they think about why water is not available to everyone and how they might make it more accessible in a sustainable way.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-ESS3-1. 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	**Constructing Explanations** • 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.	**ESS3.A: Natural Resources** • Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, freshwater, 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.

of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]			
Equity and Groupwork • Participate in a jigsaw activity that requires each group member to be responsible for contributing information on one of three resources.			
Language • Watch a video and summarize as written information. • Read, listen, and discuss information on resources. • Construct an explanation using evidence.			

Learning Goals:

This learning task asks students to explain how Earth's resources are unevenly distributed on Earth because of past and current geoscience processes. More specifically, students will:

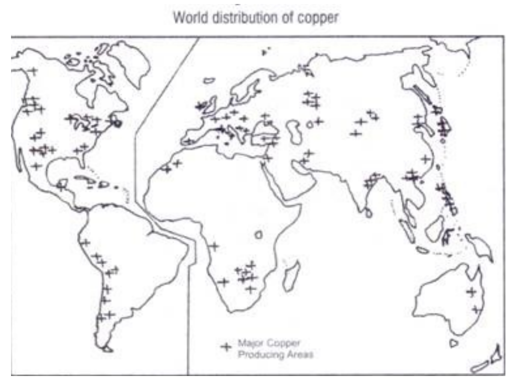
- Engage with fracking as a case study of extreme measures taken to extract natural resources in certain regions.
- Explore how different types of resources are formed throughout the world and how humans have affected them.
- Explain if every type of resource is available equally and why.
- Discuss possible conservation efforts for natural resources.
- Apply knowledge of uneven distribution of resources to water.

Content Background for Teachers

Uneven distribution of resources is one of the foremost politically charged environmental issues of today. Not only are resources unevenly distributed, causing conflict and tension, but many of the resources humans are using are non-renewable, meaning they are not able to renew themselves in meaningful human time frames. As our human population increases, our demand for natural resources grows, and this reliance on non-renewable energy sources creates a conundrum.

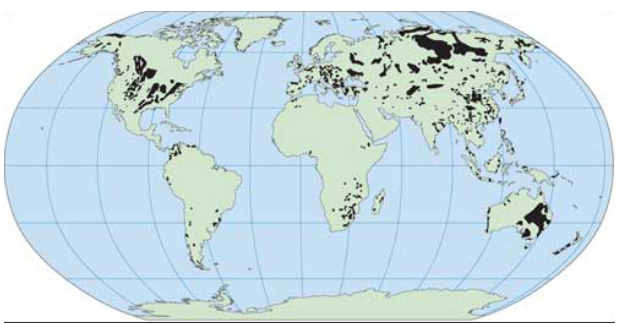
In Unit 1, students learned about plate motions leading to the geological world they experience. They have also previously engaged with this Performance Expectation to understand why some resources are located in specific locations on Earth, focusing on the role of plate movements. In this task, students are reminded that tectonic plates move and thus at their boundaries, they can bang into, dive under, split further apart, or slide along each other. The thermal energy generated at these plate boundaries can be used to generate electricity and as a source of energy for heating buildings and commercial purposes. Volcanic and uplift processes can also bring important minerals on or near the surface where they can be profitably mined.

This performance expectation focuses on Earth's mineral, energy, and groundwater resources. Students have already explored many of these concepts in Unit 1, so some of this will be a review. One new concept comes in the form of mineral resources, such as gold, copper, and other metal ores, which are brought to the surface by



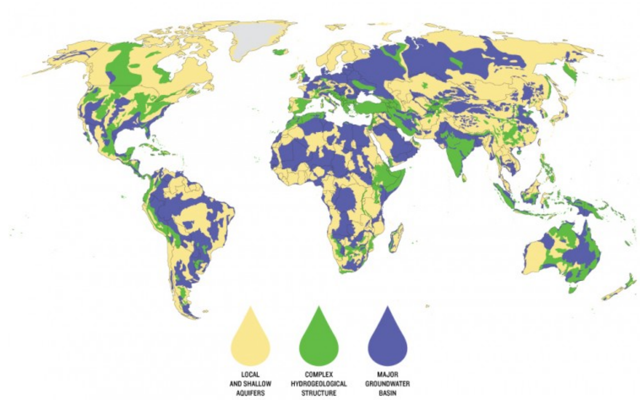
volcanic and uplift processes as stated above. Thus, these mineral resources are concentrated to areas of volcanic and uplift processes. These mineral resources are limited and as humans continue to remove them from the Earth, it is becoming more and more difficult and environmentally damaging to extract them (ex: pollution).

Two of our most used energy resources, fossil fuels and coal, come about from two different geoscience processes. Fossil fuels, such as petroleum and natural gas, are generally associated with sedimentary rocks. These fuels formed from soft-bodied sea organisms whose remains sank to the ocean floor, decomposed in the relative absence of air, and were further transformed by heat and pressure deep underground. The Middle East has about 2/3 of the world's proven reserves of crude oil. This resource is extremely limited and more extreme measures of extraction as well as the burning of fossil fuels are causing increased environmental pollution, not to mention the consequences for climate change.



Coal, another important energy resource, was created 300 to 400 million years ago during the Carboniferous period that had a generally warm and humid climate. Tropical swamp forests of Europe and North America provided much of the organic material that was buried and compressed in sediments to form coal. Locations, such as today's Appalachian Mountain region, that supported these Carboniferous swamp forests have more of the unevenly distributed coal. While coal is the most abundant fossil fuel, it is still in danger of depletion because of the long time period needed to make coal. Extraction and burning of coal also causes many negative environmental impacts, such as air pollution, water pollution, and habitat loss.

Lastly, groundwater, a natural resource essential for human life, refers to the water located in storage below the surface of the Earth. Its distribution is directly tied to the amount of precipitation in that area and the permeability of the soil and rocks in that region. At present, humans are using much more water than can naturally be replenished by nature, resulting in major droughts and in some areas, complete desertification.



Regardless of the example, students will find that none of these resources are found equally throughout the world because of the processes that form them. This results in uneven access that can cause major global conflict. Not only that, but all of these natural resources described are limited and as humans continue to remove them from the Earth, it is becoming more and more difficult and environmentally damaging to extract them. Some environmental effects of the extraction processes include air pollution, water pollution, carbon emission (which then contributes to climate change), and habitat loss. The fracking video in the *Engage* section of this task is a prime example of the human demand on natural resources and the environmental consequences of extraction. Students will consider these ideas in their culminating project. For more information on any of these topics, please reference the resource cards for this task.

Academic Vocabulary

- Fracking
- Resource
- Energy
- Coal
- Distribution
- Pollution
- Metal Ore
- Extraction
- Groundwater
- Uneven distribution

Time Needed (Based on 45-Minute Periods)

3.5 Days

- Engage: 0.5 period
- Explore: 1 period
- Explain: 0.5 period
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 2, Task 2 Student Version

Engage

- Projector and Speakers (for video)

Explore

- Station Cards in sheet protectors for each station (1 per pair)

Explain

- Projector and Speakers (for video)

Evaluate

- Project Organizer Handout

Instructions

Engage

1. Introduce Task 2: In the last task, you discovered that humans, like all organisms, need different natural resources to sustain populations. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?

- Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share out a few of these as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 2: As our population grows, so does our need for more and more of these natural resources. In this task, we will ask the questions: Where do these resources come from? And what lengths will we go to in order to extract these natural resources from the Earth?
    - Now pass out their Task 2 student guide.

3. Project the following video about fracking to watch as a class: https://www.youtube.com/watch?v=7wXZE1uuJ8o. This video is intended to engage students with an interesting real-life phenomenon that brings to light some of the core concepts of this task. By the end of this activity, students should understand that natural gas is an example of a natural resource that is not evenly distributed throughout the world. They should also understand that as we use up more of it, more extreme measures are being taken to extract it from the Earth, leading to negative consequences.
    - Students may then complete the discussion questions in pairs, but we recommend sharing responses aloud in a class-wide discussion. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).

Explore

1. The questions for students now become: Why isn't there an unlimited amount of resources for us to use? Why are some resources, like natural gas, available in some places but not others?
    - In order to answer these questions, students must explore the geoscience processes that created these resources.

2. Before students research resources, they will need a little review on tectonic plates.
    - Students may read this background from their student guide silently, in pairs, or as a class. This review connects to their prior knowledge from Unit 1, in which they learned that the continents have moved over time and create different geologic features.
    - This introduction emphasizes the crosscutting concept of **Cause and Effect** as students use prior knowledge of the cause-and-effect relationship between geoscience processes and geological features to make predictions about natural resource formation.

3. Now that students have an understanding of how plates interact, they can move on to learning about distribution of resources. This part of the task is a jigsaw activity in which there is a home group of three members and three different expert groups that students move to (you may want to split up expert groups so the table sizes are smaller). The jigsaw strategy is known to be especially helpful for English Language Learners.
    - Students will leave their home group to become an expert in coal, metal ore, or groundwater. At these groups, you will provide station cards for students to read and discuss before recording their data in their student guide. As you can see, the guiding questions emphasize the crosscutting concept of **Cause and Effect**, so students gather information to make causal connections between geologic processes/human activities and resource distribution for use in

their explanation of all resources later in this task. We recommend that students prepare a statement in their expert groups, so they are ready to present back to their home groups.

- Students then return to their home groups to present about the resource they became an expert in. We recommend that students turn over their student guides as they present to their home group, so that other group members don't just copy what they have. Other members of the group thus have a chance to listen and take notes, as well as ask questions of the expert as needed. By the end of this section, students should have notes on all of the resources.
- Jigsaw activities naturally lend themselves to equitable participation, as every member of the home group is an expert with necessary information to provide. Thus, group roles are not necessary for this part of the task.

Sample Resource Data Collection Chart

Resource	What caused it to form?	Where can you find it?	How have humans affected it?
Coal (Energy)	Coal was created 300 to 400 million years ago during the Carboniferous period that had a generally warm and humid climate. Plants in the tropical swamp forests of Europe and North America died and became buried and compressed in sediments to form coal.	Locations, such as today's Appalachian Mountain region, that supported these Carboniferous swamp forests have more of the unevenly distributed coal. Areas without coal either did not have these tropical swamp forests 300-400 million years ago or the rocks have been eroded away.	Coal is in danger of depletion because humans are extracting it too fast and it takes a long time period to make coal. Extracting coal and burning coal leads to many negative environmental impacts, such as habitat loss from mountaintop removal, air pollution, and water pollution.
Metal Ores (Mineral)	Volcanic and uplift processes can bring important minerals on or near the surface where they can be mined. Erosion also helps to bring these minerals closer to the surface.	You will only find certain resources in certain areas around the world. For example, copper mines are located near plate boundaries, such as on the western coast of South America. You may also remember the prospector saying, "There's gold in them thar hills," which directly connects gold distribution with the plate tectonics that created those hills.	Humans are continuing to deplete these mineral resources at an increased rate. At present, we are not running out of any mineral, but it is becoming more and more difficult, expensive, and environmentally damaging to extract because the ores are becoming depleted.
Groundwater	After rain or snow, the excess water enters the pores or cracks of the soil	Sedimentary rocks such as sandstone tend to hold more water. The uneven	Right now, humans are using way more water than can be equally replenished by

	and rocks and is stored there.	distribution of groundwater strongly correlates with the regional latitude and geographic conditions (ex: climate) that determine the amount of precipitation.	nature. When major droughts hit regions like California, this can lead to major water shortages. In some cases, complete desertification can occur, which means that once fertile land is transformed into a desert.

Explain

1. Now that students understand where all these different resources come from and why they are not available everywhere on Earth, they can use what they know to think about what this means for the world. First, have students watch the following video that summarizes many of the things they have learned about natural resources: https://www.youtube.com/watch?v=LxHdUd_Q12Y (Stop at 2:45). They may use this information in the explanation they construct.

2. The prompt for the explanation asks students to consider how resources are distributed, if everyone has access, and how this affects different individuals.
   - This will set the stage for them to begin thinking about their culminating project, in which they consider what this means for people who don't have direct access to resources like water.
   - This exercise focuses on the crosscutting concept of **Cause and Effect**, as students use the relationship between plate tectonics and various resources to predict how this affects peoples' access to all kinds of resources around the globe.
   - They should also use evidence from the *Engage, Explore*, and video to justify their response, thus explicitly practicing the skill of **Constructing Explanations.**

Optional Sentence Stems to Provide

Claim	Every natural resource is/is not (pick one) available to everyone around the world because…
Evidence	• One example of how resources are unevenly distributed is… • _____ is mostly located… • Another example of this is… • …which can only be found in… • Lastly, the sources of ______ serves as another piece of evidence for how only some resources are available in certain regions.
Reasoning	• ______'s distribution can be explained by… • ______ can explain the uneven distribution of ______. • Lastly, uneven distribution of ______ results because… • Each of these resources is susceptible to… • In conclusion… • Thus… • This means that… • This is why…

Sample Student Response

Claim	Every natural resource is not available to everyone around the world because the geoscience processes that have created these resources happen in different parts of the world and humans extract them at different rates.
Evidence	One example of how resources are unevenly distributed is coal. Coal is mostly located in North America and Europe, where tropical swamp forests were located 300-400 million years ago. Another example of this is metal ores, which can only be found in areas near plate boundaries, like mountains along the coast of South America. Lastly, the sources of groundwater serves as another piece of evidence for how only some resources are available in certain regions. Groundwater is strongly correlated with regional latitude and geographic conditions, so more is found in some regions than others.
Reasoning	Coal's distribution can be explained by the fact that it is extracted from areas where there were once warm and humid swamps. These swamps had plants that died and were then buried and compressed to form coal. The volcanic and uplift processes that happen along plate boundaries, bringing minerals to the surface, can explain the uneven distribution of metal ores. Lastly, uneven distribution of groundwater results because of different climates that determine the amount of precipitation in the region. Each of these resources is then susceptible to how much humans remove in each region. Thus, different geoscience processes as well as human removal cause resources to be unevenly distributed throughout the world. This means that different individuals will have access, which often decides who is wealthy and who is less advantaged. This is why natural resource distribution often causes conflict.

3. This paragraph can be a good option for formative assessment. Collect student work to identify trends in students' ability to use evidence to support an explanation. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

Elaborate

1. This section focuses on the human impact aspect of this PE and helps students to better connect to their culminating project. Students are asked to think about all the resources they have explored and brainstorm ways that they can help conserve these resources.
    - Student responses will likely include suggestions, such as: take public transportation or walk instead of driving a car, take shorter showers, eat less meat (reduces water), barbeque less, etc.

2. Return to the whole-class concept map from the Lift-Off Task.
    - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
        - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the

questions/ideas already on the map? What new questions do you have about the phenomenon?
        - Draw circles around each question and boxes around each concept.
        - Write connector words to describe connections between the concept boxes.
        - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how geologic processes and human activity lead to the uneven distribution of natural resources.
    - Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
        - **Cause and Effect**. These could be phrases such as, "which results in," "which causes," "that explains why," "is due to," etc.
    - Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 2 section of the Unit 2 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with creating a proposal to make water more available to people around the world, while also considering strain on the environment. The student prompt is as follows: Every natural resource comes from some geologic process, which only happens in certain areas of the world.
    - Explain why water is not available equally throughout the world, focusing on the process that makes it
    - How are some humans using more than their share?
    - What is the effect on environmental systems?

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
    - At the beginning of this task, you watched a video on fracking and thought about the availability of natural gas throughout the world. Look back at your response: does this example seem to match what you have learned about distribution of other resources? Why or why not?
    - In this task, we focused on the crosscutting concept of **Cause and Effect**: cause and effect relationships may be used to predict phenomena. Where did you see examples of **Cause and Effect** in this task?
    - Now that you have learned more about how natural resources are distributed, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
   - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
   - Students may make changes to their Project Organizer according to your comments OR
   - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Station 1 – Coal (Energy Resource)

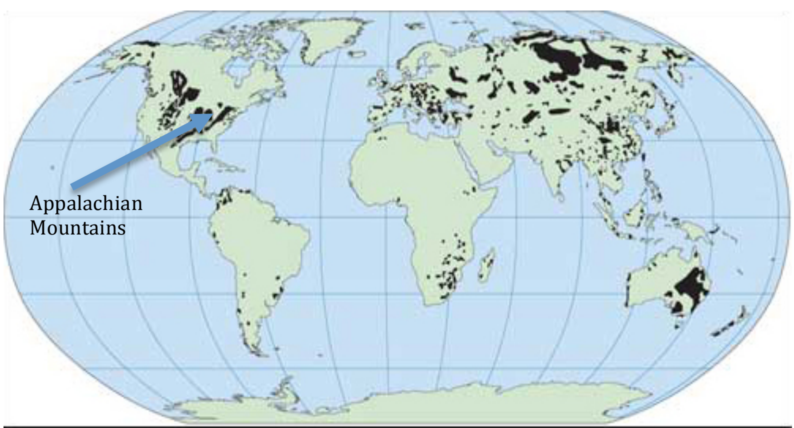
Coal is the most abundant fossil fuel we have today. It can be burned for energy or heat.

Coal was created 300 to 400 million years ago during the Carboniferous period, which had a generally warm and humid climate. Plants in these tropical swamp forests died and became buried and compressed in the earth to form coal.

Swamps with giant plants hundreds of millions of years ago covered the earth.

Water and dirt covered the plant remains 100 million years ago.

Rocks, dirt and sediment created pressure and heat to form coal deep in the ground.



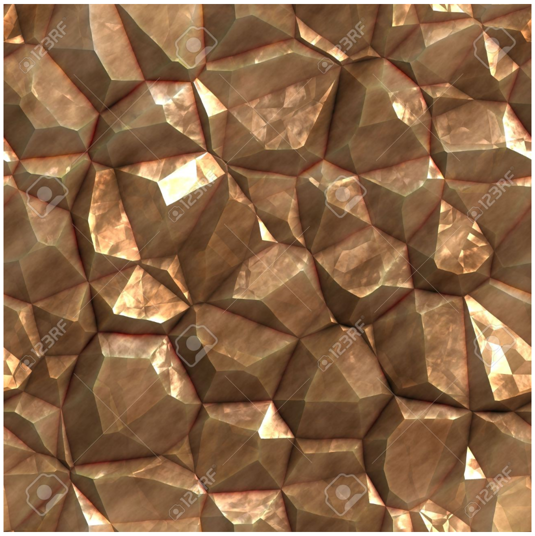
These swamp forests were located unevenly across the Earth—most were in what is now North America, Europe, and Russia. As a result, those same areas have more coal. For example, areas such as today's Appalachian Mountains supported these Carboniferous swamp forests and thus have more of the distributions of coal. Areas without coal either did not have these tropical swamp forests 300-400 million years ago or the rocks have been eroded away.

While coal is one of the more abundant fossil fuels, we are still in danger of running out because it takes a *very* long time for coal to form. More importantly, extracting coal (taking it out from the Earth) and burning coal leads to many negative environmental impacts, such as habitat loss from mountaintop removal, air pollution, and water pollution.

Sources:

- http://www.open.edu/openlearn/ocw/pluginfile.php/66232/mod_oucontent/oucontent/460/ab23d665/6f74db2a/s278_3_f034hi.jpg
- https://c03.apogee.net/contentplayer/?coursetype=kids&utilityid=pseg&id=16200
- https://www.scientificamerican.com/article/what-to-do-about-coal-2006/
- Draft CA Science Framework – Chapter 5B: Preferred Integrated Grades 6-8, NGSS

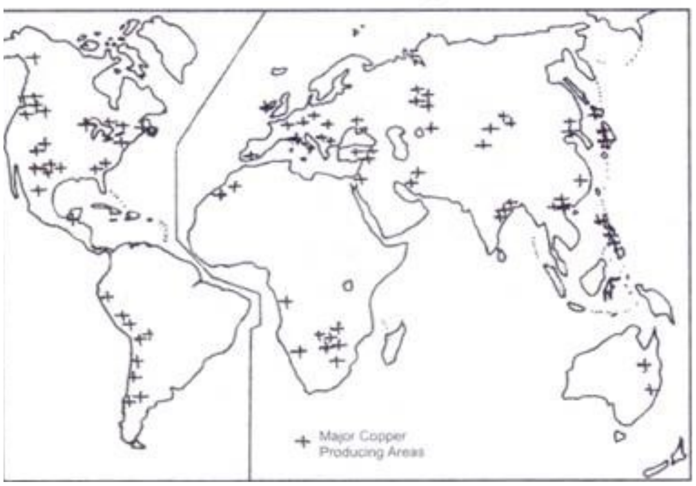
Station 2 – Metals



Metals, such as copper, gold, and iron are essential to industry and trade. Copper is often used for electrical wire and construction materials. Gold is used for jewelry and coins. Iron is used to make the strongest building material possible.

These metals can be found in rocks that are called "metal ores". The Earth contains only a limited amount of metal ore and it takes millions of years to make. Volcanic eruptions and plate movement can bring important metals on or near the surface where they can be mined. Erosion also helps to bring these metals closer to the surface.

World distribution of copper



For this reason, you will only find certain resources in certain areas around the world. For example, copper mines are located near plate boundaries. You may remember the prospector saying, "There's gold in them thar hills." This directly connects gold distribution with the plate tectonics that created those hills.

Since there is only a limited amount of metal ore in the Earth, we should be careful, but humans are continuing to use these resources at an increased rate. Right now, we are not running out of any metal, but it is becoming more and more difficult, expensive, and environmentally damaging to extract them because the amount of ore is running low.

Sources:

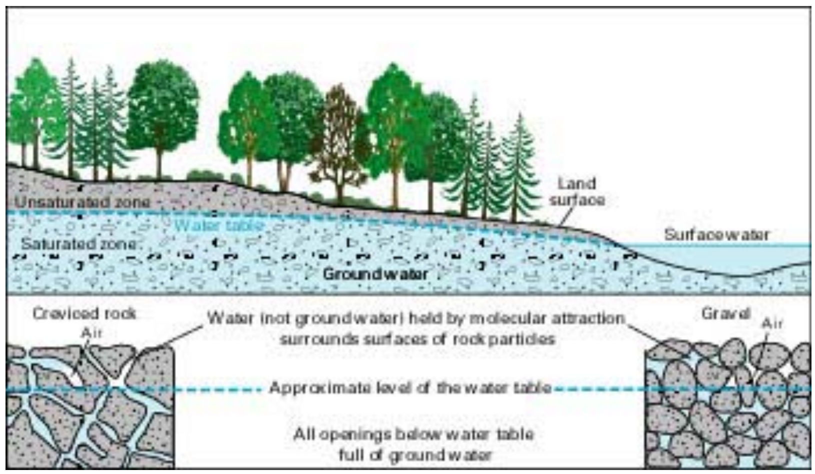
- Draft CA Science Framework – Chapter 5B: Preferred Integrated Grades 6-8, NGSS
- http://www.nationalgeographic.org/encyclopedia/ore/
- http://www.yourarticlelibrary.com/essay/production-and-distribution-of-copper-around-the-world-with-maps/25468/
- https://www.theguardian.com/environment/earth-insight/2014/jun/04/mineral-resource-fossil-fuel-depletion-terraform-earth-collapse-civilisation

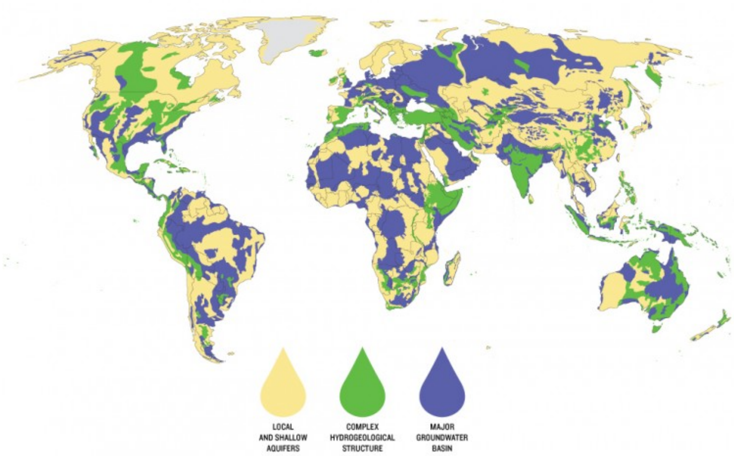
Station 3 – Water (Groundwater)

Groundwater is the water located in storage below the surface of the Earth. Because all living things need water to survive, groundwater is one of the most important natural resources we have.

Groundwater is simply the water that fully soaks into pores or cracks in soils and rocks. After rain or snow, the extra water enters the pores or cracks of the soil and rocks and is stored there.

The distribution of groundwater is most directly related to the amount of rain/snow in that area and to the amount of water the soil and rocks can hold. Sedimentary rocks such as sandstone tend to hold more water. The uneven distribution of groundwater strongly relates to where it is on earth and the geographic conditions (ex: climate) that determine the amount of rain and snow.





Groundwater needs to be refilled by rain and snowmelt since it can be used up by plants, evaporation and human uses. However, right now, humans are using way more water than can be equally refilled by nature. When major droughts hit regions like California, this can lead to major water shortages. In some cases, complete "desertification" can occur, which means that once useable land is transformed into a desert.

Sources

- https://pubs.usgs.gov/gip/gw/how_a.html
- Draft CA Science Framework – Chapter 5B: Preferred Integrated Grades 6-8, NGSS
- https://ensia.com/features/groundwater-wake-up/

7th Grade Science Unit 2: Matter Matters
Task 3: What is Water?

Unit Essential Question: *How can models of matter help us understand the resources we use?*

Introduction
So far in this unit, students have approached matter from a broader perspective, looking at different examples of natural resources, where they come from, and how humans are using them. This task asks students to now look at matter from a micro perspective, using the familiar example of a natural resource that they will focus on in their culminating project—water. In accordance with the idea of Scale, Proportion, and Quantity, students start big, looking at different examples of water they see in different environments, such as rain, snow, rivers, water vapor, etc. Then students make physical models of water molecules before investigating how water behaves in different states. By the end of this task, students should be able to make hypotheses about the behavior of water molecules in different states and what causes water to change into a different state. They will explore these ideas in more depth in the next task.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-PS1-1. Develop models to describe the atomic composition of simple molecules and extended structures. [Clarification Statement: Emphasis is on developing models of molecules that vary in complexity. Examples of simple molecules could include ammonia and methanol. Examples of extended structures could include sodium chloride or diamonds. Examples of molecular-level models could include drawings, 3D ball and stick structures, or computer representations showing different molecules with different types of atoms.] [Assessment Boundary: Assessment does not include valence electrons and bonding energy, discussing the ionic nature of subunits of complex structures, or a	**Developing and Using Models** • Develop a model to predict and/or describe phenomena.	**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.	**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.

complete description of all individual atoms in a complex molecule or extended structure is not required.]			
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]	**Developing and Using Models** • Develop a model to predict and/or describe phenomena.	**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.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Supplementary Science and Engineering Practices

- Planning and Carrying Out Investigations
    - Conduct an investigation to produce data to serve as the basis for evidence that meet the goals of the investigation.

Equity and Groupwork

- Participate in group roles to conduct experiments and analyze data.
- Work together to discuss observations and draw conclusions.

Language

- Orally present observations of an image.
- Record lab observations.
- Read and annotate an article.

7th Grade Science Unit 2: Matter Matters
Task 3: What is Water?

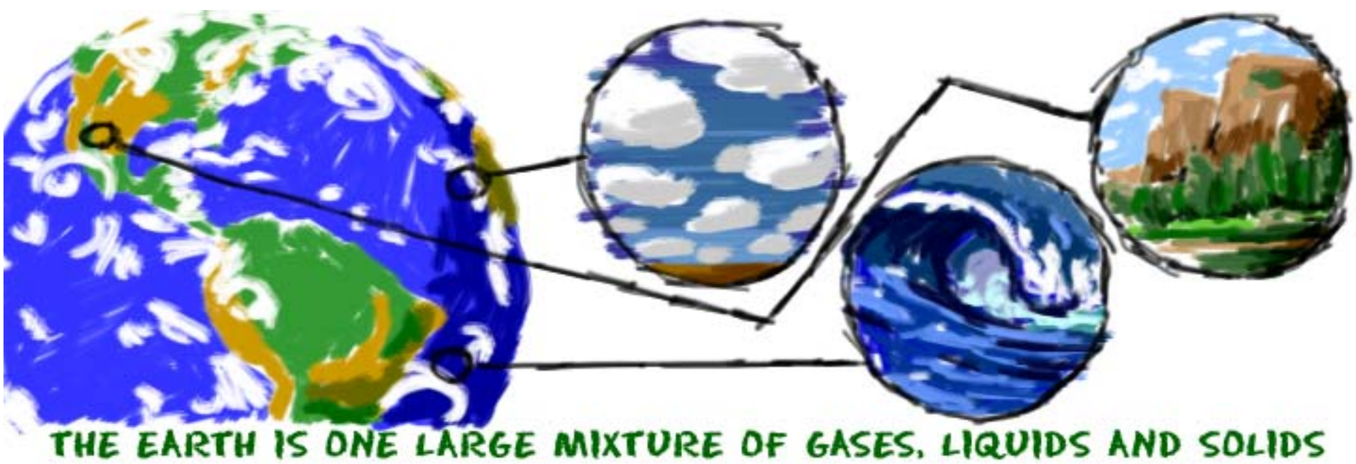
Learning Goals

This learning task asks students to model the atomic composition of simple molecules and the changes in state that occur when thermal energy is added or removed. More specifically, the purpose is to:

- Identify different examples of water in an environment.
- Construct a model displaying the atomic composition of a water molecule.
- Investigate and model how water molecules behave in different conditions.
- Read and annotate an article about atoms, molecules, and states of matter.
- Explain lab conclusions related to states of water.
- Apply knowledge of states of matter to a real-life problem.
- Use understanding of molecular structure to inform research on properties of water.

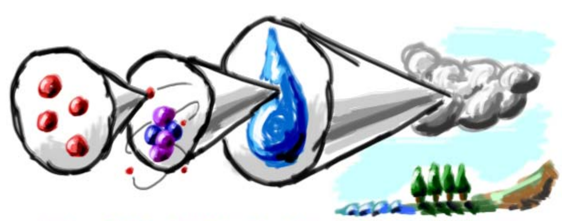
Content Background for Teachers

Matter is everything that exists around us—anything that has mass and takes up space. In this task, students begin by thinking of matter in this basic, experiential way—by using their eyes to think about what they see. In every environment, students can observe that matter is present in many different examples—different plants, such as trees and flowers; different animals, such as antelope and wildebeest; non-living objects, like soil, rocks, and water. Students may also use their prior knowledge to think about matter that exists, but that they can't see—the matter in the air, such as oxygen, nitrogen, and carbon dioxide.



http://www.chem4kids.com/files/matter_intro.html

Throughout this task, students engage more deeply with the science behind matter by focusing on water as an example. They learn that **atoms** are the building blocks for all types of matter. They are like the letters that make up every language. Each type of atom is known as an **element** and each element has its own different characteristics and properties.



When one type of atom combines with another type of atom, it creates a **molecule**. This molecule has different properties than either of the original atoms. The example students explore in this task is a very simple molecule—water. Water is formed when hydrogen and oxygen combine and form covalent bonds. Each water molecule consists of two hydrogens and one oxygen, hence the name H^20. After students make models of a water molecule, it will often need to be made explicit to students that the water that they are able to see consists of millions of these molecules put together. This also emphasizes one of the crosscutting concepts for this task—Scale, Proportion, and Quantity.

When students investigate water in different states, they are actually looking at the behavior of many water molecules together. In these lab stations, students will see that water can come in several different states—solid, liquid, and gas. In all these states, the water molecules themselves do not change, but rather the motion of the molecules changes. Water molecules move faster when at higher temperatures. Water behaves a little differently when frozen because it expands when in solid form. This is because of the shape of the water molecule; the way in which the molecules link together in solid form creates large spaces between the molecules, thus causing water to expand when frozen. Students will explore these concepts more in the next task.

Academic Vocabulary

- Water
- Matter
- Atoms
- Molecules
- Hydrogen
- Oxygen
- States
- Properties

Time Needed (Based on 45-Minute Periods)

4 Days

- Engage: 0.5 period
- Explore: 1.5 periods
- Explain: 0.5 period
- Elaborate: 0.5 period
- Evaluate and Reflection: 1 period

Materials

- Unit 2, Task 3 Student Version

Engage

- Environment Images (cut apart and give one to each group)
- Optional: Projector to show images

Explore (*Recommended: Create multiple of each station so there are less students per station)

- Jelly Beans (1 color) – 2 per student
- Gumdrops (1 color) – 1 per student
- Toothpicks – 1 per student, cut in half
- Station Cards in sheet protectors (cut apart and provide a few per station)
- Station 1

- Hot water in a glass beaker
    - Cold water in a glass beaker
    - Yellow food coloring
    - Blue food coloring
- Station 2
    - Hot water in a glass beaker
    - Cold water in a glass beaker
    - Glass flask
    - Soap solution in a small plastic beaker
- Station 3
    - 2 ice trays (identical)
        - One empty
        - One with exactly 2 tablespoons of water frozen in each well
    - Tablespoon
    - Cup of Water

Evaluate
- Project Organizer Handout

<u>Instructions</u>

Engage

1. Introduce Task 3: In the last task, you learned about the processes that distribute natural resources around the world. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
    - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 3: One of those resources was water—a very important resource for humans and all other organisms. In this activity, you will look at pictures of environments and discuss where you see examples of water.
    - Now pass out their Task 3 student guide.

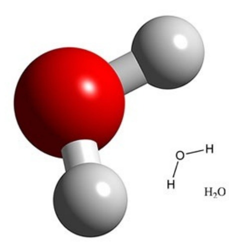
3. Distribute one environment picture to each group of students. In groups, students will discuss and record examples of matter they see as well as examples of water they see.
    - For matter, students will most likely come up with examples like: water, rocks, air, plants, animals, humans, etc. For water, students will most likely come up with examples like: rain, snow, rivers, lakes, ocean, clouds, fog, water vapor, groundwater, etc.
    - The purpose of this activity is to help students to understand water at a larger, more experiential scale before they dive into looking at the microscopic scale. This begins students exploration of the crosscutting concept of **Scale, Proportion, and Quantity**, which they will use models to explore throughout this task.

4. Once all students have discussed their observations, project the images to debrief as a class. Call on each group to share their observations before opening up the discussion to other students who notice examples the group may have missed.
    - Encourage students to think about matter that may be in the environment, but they can't necessarily see with the naked eye (Ex: carbon dioxide, oxygen, water within plants, water vapor, etc).
    - You may want to keep lists of examples of matter and examples of water on the board, so you can add tally marks for examples that are common across environments.

Explore

1. Now that students have considered examples of water in real environments, they can begin to investigate water on a more microscopic scale.
    - By making a model of a water molecule (micro scale) and then using investigations to model how water molecules behave when together (macro scale), they are engaging with the crosscutting concept of **Scale, Proportion, and Quantity**. Models are necessary to study these systems because water molecules are too small to be seen.
    - Students are also using the science and engineering practice of **Developing and Using Models**, as they construct both physical and visual models to make sense of water at the molecular level in different conditions.

2. Before students are ready to investigate how water behaves under different conditions, they must first understand the atomic composition of water—something they may already be familiar with from earlier grade levels. Give each student 2 jelly beans of the same color, one gumdrop, and a toothpick split in half.
    - Display an example of a water molecule to guide their modeling and explain what each piece represents. Optional: draw a key on the board.
    - Students make a physical model of a water molecule, like the one to the right.
    - Optional check for understanding: have students practice identifying the parts with their shoulder partner.



3. Students are now ready to begin investigating how water molecules behave in different forms. At this point, make it explicit to students that their model only represents one water molecule. When they see water in real-life, they are seeing millions of water molecules together.

4. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
    - Ask the Facilitator to read the directions and to make sure everyone understands the task.
    - Ask the Materials Manager to handle all the materials related to the task.
    - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
    - Ask the Recorder to make sure the group is recording their observations and drawing models in their student guides.

5. Rotate students through the three lab stations.
    - It is recommended that you provide at least two of each station so there are not too many students at each station.
    - They should follow the procedures provided on the station cards. Encourage students to discuss the discussion questions with their group members, as these questions are meant to help facilitate student thinking.

6. At each station, students should diagram the experiment itself, record their observations, and draw a model predicting how they think water molecules are behaving.
    - This continues their engagement with the practice of **Developing and Using Models** and the crosscutting concept of **Scale, Proportion, and Quantity** as described above.
    - Students are also now beginning to apply the lens of **Cause and Effect** as they use relationships they identify within the experiments to predict how the molecules might be behaving. The hope is that students begin to notice that different temperatures cause water to behave differently and so the molecules themselves might be moving differently.

Expected Lab Observations

Station 1: Liquid Water—Hot and Cold	Students should observe that the food coloring mixes much more quickly in the warm water beaker than in the cold water beaker.
Station 2: Gaseous Water (Water Vapor)	Students should observe that when the flask is placed in warm water, the soap bubble inflates. When it is placed in cold water, the soap bubble deflates.
Station 3: Solid Water (Ice)	Students should observe that the already frozen water takes up more space than the liquid water.

Explain

1. Now that students have experimented with water, it is time for them to learn more about the science within the matter.

2. Students independently read an article in their student guides that tell them more about the science of what they have experienced. This article delves into concepts such as matter, atoms, molecules, and states of matter and applies these concepts to the case of water.
    - Provide students with the annotation protocol you typically use in your classroom to hep them make sense of the ideas in the reading. For an annotation protocol option, see “How to Use This Curriculum.”

3. Using what they have learning through the investigations and the article, groups of students draw conclusions about their lab and use **cause and effect** relationships they have identified throughout this task to make hypotheses. It is important to remember that at this point, they are just hypotheses. Students will be able to confirm these ideas with more information in the next task.
    - The first question asks them to refer back to their model to remind them of water at a microscopic scale. This re-emphasizes the crosscutting concept of **Scale, Proportion, and Quantity**.

- The second question asks students to draw models of how they think water molecules are behaving in the different experiments based on their observations.
  - Give each group a blank piece of paper. Have students put their water molecule models on the piece of paper and kinesthetically model how they think water is behaving at each of the stations. This allows students to work together and think aloud as they try to figure out water molecule motion at different temperatures.
  - As students begin to draw their models, you may want to recommend a particular shape/symbol to represent a water molecule (Ex: a circle). This gives students a starting point when drawing their models.
  - Their first drawing may show that the water molecules in the warm water are farther apart and moving faster (This is what caused the food coloring to mix more quickly). Their second drawing may show that the water molecules in the cold water are closer together and moving more slowly (This is what caused the food coloring to mix more slowly). The last drawing is more complicated for students so drawings will vary widely, but the correct drawing would show water molecules stationary in an orderly formation with spaces between them that causes the expansion.
- The third question asks students to use the investigations to identify what they think causes water to change states. Students should be able to deduce that heating or cooling water causes changes in state from their own experience and the investigations. They are also asked whether they think the water molecules themselves change. Based on the investigations and their model, most students will respond that the water molecules are the same, but the speed of the molecules is changing.

Elaborate

1. In this section, students are given a real-life scenario of a student who tries to freeze water in her water bottle, but finds that it exploded. Students use what they learned throughout the task to explain what happened.
   - This scenario not only allows students to apply learned knowledge, but also shows students the real-life value of understanding this science.
   - We recommend students do this task individually as it can be a good option for formative assessment. Collect student work to identify trends in students' ability to apply their learning about states of matter to a new situation. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

2. Return to the whole-class concept map from the Lift-Off Task.
   - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
     - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason

for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
  - Draw circles around each question and boxes around each concept.
  - Write connector words to describe connections between the concept boxes.
  - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: different examples of matter in environments, the molecular structure of water, and how water behaves in different states.
- Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concepts as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
  - **Cause and Effect**. These could be phrases such as, "which results in," "which causes," "that explains why," "is due to," etc.
  - **Scale, Proportion, and Quantity:** These could be phrases such as, "is proportional to," "compared to," "has a ratio of," "is bigger/smaller than," "is longer/shorter than," etc.
- Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 3 section of the Unit 2 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with creating a proposal to make water more available to people around the world, while also considering strain on the environment. Their prompt is as follows: You've explored molecular structure with a simple molecule—water.
   - Draw a model of the molecular structure of water.
     - Label and explain its parts.
   - Research and explain how the molecular structure of water gives it properties that make it useful to humans.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
   - At the beginning of this task, you identified different examples of water in an environment. Look back at your initial response: after learning everything you have about properties of water, how would you categorize each of the examples you identified: as solid, liquid, or gas?
   - In this task, we focused on the crosscutting concepts of **Cause and Effect**: cause and effect relationships may be used to predict phenomena, and **Scale, Proportion, and Quantity**: scaled models can be used to study systems that are too large or too small. Where did you see examples of **Cause and Effect** and **Scale, Proportion, and Quantity** in this task?

- Now that you have learned more about the molecular structure of water and how it behaves in certain conditions, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
   - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
   - Students may make changes to their Project Organizer according to your comments OR
   - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Environment Images

Engage


TICKETS
© 2013 Thomas Riecken

Source: Flickr Creative Commons

Station Cards
Explore

Station 1: Liquid Water—Hot and Cold

Procedure:
1. Carefully place one drop of yellow food coloring and one drop of blue food coloring at the same time into each beaker (one with hot water and one with cold water).
2. Observe for a few minutes as colors mix on their own. Record your observations.

Discussion Questions:
- Why do you think one mixed more quickly than the other?
- What does this tell you about the speed of the water molecules in hot vs. cold water?

Station 2: Gaseous Water (Water Vapor)

Procedure:
1. Carefully turn over your glass flask and dip the opening of it into the soap to get a film of soap covering the rim.
2. While holding the flask, slowly push the bottom of the flask down into the hot water. Write down your observations.
3. If there is still a soap bubble, slowly push the bottom of your flask down into the cold water. If there is no bubble, make another by dipping the opening into a soap solution and then slowly push the bottom of the flask into cold water. Record your observations.

Discussion Questions:
- Why do you think the bubble behaved in these ways in hot vs. cold water?
- What does this tell you about the speed of the water molecules?

Station 3: Solid Water (Ice)

Procedure
1. Carefully measure and pour 2 tablespoons of water into the ice tray provided.
2. Your teacher has also carefully measured and poured 2 tablespoons into the same type of ice tray and put it in the freezer overnight.
3. Look at the liquid and frozen water in the ice cube trays side by side and note any differences. Record your observations.

Discussion Questions:
- Why do you think there was a difference between frozen water and liquid water?
- What does this tell you about the water molecules in frozen water vs. liquid water?

7th Grade Science Unit 2: Matter Matters
Task 4: Changing States

Unit Essential Question: *How can models of matter help us understand the resources we use?*

Introduction

In the last task, student began to explore the science behind matter, modeling what a water molecule looks like at the atomic level and observing how water behaves in different states. Students ended the last task by drawing hypotheses of how water molecules behave based on what they observed in real experiments. In this task, students confirm or adjust these hypotheses based on a computer simulation of water in different states. By the end of this task, students will see that particle motion varies depending on the state and that adding or removing thermal energy is what causes these changes in state. By understanding changes in state, students make the final move towards their culminating project—using their knowledge of changing states of matter to make water more available in a region without much liquid water.

Alignment Table

Performance Expectations	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. [Clarification Statement: Emphasis is on qualitative molecular-level models of solids, liquids, and gases to show that adding or removing thermal energy increases or decreases kinetic energy of the particles until a change of state occurs. Examples of models could include drawings and diagrams. Examples of particles could include molecules or inert atoms. Examples of pure substances could include water, carbon dioxide, and helium.]	**Developing and Using Models** • Develop a model to predict and/or describe phenomena.	**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.	**Cause and Effect** • Cause and effect relationships may be used to predict phenomena in natural or designed systems.

7th Grade Science Unit 2: Matter Matters

Task 4: Changing States

Equity and Groupwork
• Students work together to analyze a computer simulation. • Students take on different roles in a kinesthetic model of changing states. • Use the Stronger Clearer protocol to share and learn from others. • Students use feedback from the Stronger Clearer protocol to revise their model as a team.
Language
• Annotate a model. • Represent observations in visual and written formats. • Use definition cards to incorporate vocabulary into a model. • Use the Stronger Clearer language protocol to practice and refine language. • Orally present scientific concepts through a skit.

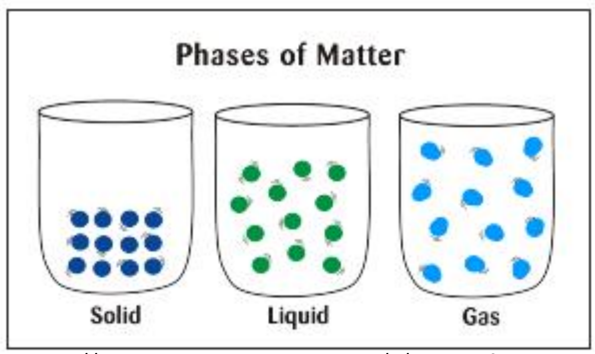
Learning Goals

This learning task asks students to model the changes in particle motion, temperature, and state that occur when thermal energy is added or removed. More specifically, the purpose is to:

- Use prior knowledge to form an idea of what is happening when water changes state.
- Explore states of water through a computer simulation.
- Construct a kinesthetic model showing the science behind changing states of water.
- Share and revise science concepts and language using the Stronger Clearer protocol.
- Apply knowledge of changing states to brainstorm solutions that will make water more available in a region.

Content Background for Teachers

Because students have already begun to explore states of matter in the previous task, most background information can be found in the Task 3 Teacher Guide.



https://www.homesciencetools.com/a/states-of-matter

Water can occur in three states: solid, liquid, or gas. These are also commonly referred to as ice, water, and vapor or steam. Solid water, or ice, is just water that has been frozen. When water freezes at 0 degrees Celsius, its molecules move farther apart, causing it to expand in size. This also makes ice less dense than water and is why ice floats within water. Liquid water is the form students are most familiar with. Water vapor is always present in the air around us, but cannot be seen. When water is boiled to 100 degrees Celsius, liquid water changes into water vapor, which students can see as steam.

Thus, we can see that matter can change from one state to another when thermal energy is added or removed. Even with all of these state changes, it is important to remember that the substance stays the same—these are still water molecules. All that is changing is the motion and position of the molecules and the kinetic energy of the particles. In a solid state, water molecules are arranged in a pattern and can only vibrate but not move around much. In a liquid state, water molecules are spaced farther apart, can slide around each other, and are not arranged in a specific pattern. In a gaseous state, water molecules are even farther apart and move quickly and freely with no pattern at all.

7th Grade Science Unit 2: Matter Matters

Task 4: Changing States

Academic Vocabulary

- Solid
- Liquid
- Gas
- Molecule
- Particles
- Thermal Energy
- Temperature
- Kinetic Energy
- States

Time Needed (Based on 45-Minute Periods)

4.5 Days

- Engage: 0.5 period
- Explore: 1 period
- Explain: 1 period
- Elaborate: 1 period
- Evaluate and Reflection: 1 period

Materials

- Unit 2, Task 4 Student Version

Explore

- Computers (1 per group)

Explain

- Definition Cards, cut (1 per group)

Evaluate

- Project Organizer Handout

Instructions

Engage

1. Introduce Task 4: In the last task, we observed water in different states—solid, liquid, and gas. Think about what you were still wondering about at the end of the last task (look back if you need to). What questions do you still have?
    - Before you pass out their student guide, give students time to reflect individually or with a partner about the questions they recorded at the end of the last task. Share a few of these out as a class, using facilitating questions to guide students toward questions that relate to this task.

2. Transition to Task 4: But how do we change water from a solid to a liquid to a gas? And what is happening to water at the molecular level to change its state? In this task, we will try to make sense of these questions.
    - Now pass out their Task 4 student guide.

3. In the last task, students observed water through investigations and developed their own hypotheses for how water behaves at the molecular level. This activity asks students to draw off prior knowledge from the last task as well as their own daily experiences to draw and explain what they think is happening when water changes states.
   - Students individually draw what they think molecules look like in different states and write down an idea of what causes water to change from one state to another.
   - Then have students share their drawings and ideas with a partner before sharing a few out as a class.
   - While molecule drawings may vary based on prior knowledge, most students should be able to identify that adding heat causes water to change states.

Explore

1. While students have already done lab investigations on states of water, they could not definitively visualize the movement of molecules in these different states. This activity uses a model in the form of a computer simulation, so students may confirm or adjust their drawings from the Engage.
   - This activity begins with students' exploration of the science and engineering practice of **Developing and Using Models** as they explore a computer simulation model before creating their own that will tie all these concepts together.

2. Assign roles to each group. You may use whatever roles you prefer. We recommend the use of the Facilitator, Materials Manager, Harmonizer, and Recorder.
   - Ask the Facilitator to read the directions and to make sure everyone understands the task.
   - Ask the Materials Manager to handle all the materials related to the task.
   - Ask the Harmonizer to make sure that everyone contributes their ideas and that everyone's voice is heard.
   - Ask the Recorder to make sure the group is recording their observations and drawing models in their student guides.

3. Students should follow the directions on the student guide to use the PhET simulation about States of Matter: https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html.
   a. For each state selected (solid, liquid, or gas), we recommend students observe for about one minute so they get a good idea of molecular motion in that state.
   b. The graphic organizer provided in their student guides is meant to highlight the relationships between temperature, particle motion, and kinetic energy of particles. In doing so, students are considering these concepts through the crosscutting concept of **Cause and Effect** by beginning to identify some cause and effect relationships that they will utilize in their model later in this task.
   c. Students will draw a diagram as well as record their observations of motion and temperature in their student guide.
   d. Optional: Instead of just clicking on the states, students can use the thermometer button on the bottom to adjust the temperature and see how that changes molecule motion. This helps emphasize how adding or removing thermal energy affects particle motion and the state of water.

7th Grade Science Unit 2: Matter Matters

Task 4: Changing States

Explain

1. This part of the task asks students to draw conclusions about the relationships they observed in the computer simulation and use it to develop a model of water changing states.
   - This asks students to use the science and engineering practice of **Developing and Using Models** as students develop a skit to describe what happens when thermal energy is added or removed. This also emphasizes the crosscutting concept of **Cause and Effect** as students use their model to provide a causal account of the relationship between the addition or removal of thermal energy and the change in particle motion, temperature, and state of a substance.

2. We recommend you read the instructions on the student guide aloud and take questions for clarification. Again, assign roles to each group. You may use the same roles used in the *Explore*, but change up which students are assigned each role.
   - Pass out the Definition Cards to each group, so students may use them for reference as they plan their skits.
   - Emphasize to students that as they narrate their skit, they must use the science words on their student guide.
   - Each student should individually record any final planning in their student guides as they will each be responsible for sharing their skit with peers in the next activity.

3. Walk around and observe groups planning and practicing their models, so that you can select a few groups that have relatively different models. While groups will not have the opportunity to present until after the *Elaborate*, it is helpful to identify some specific groups that you may call on later.
   - Some students may create metaphorical stories to represent changes in state. Other groups will simply model the molecular motion using their bodies, calling out the different states and acting out the adding or removing of thermal energy.

Elaborate

1. Students will now participate in a language routine known as *Stronger Clearer*. This activity gives students the opportunity to share their ideas, gather feedback, and revise their skits. This protocol is especially useful for this task since the skits require them to integrate many science concepts and use a lot of new content-specific language.

2. Students will share with three different partners from different groups, allowing them to discuss feedback and record any notes each time. Once complete, have students return to their original groups to revise and practice their skits based on their discussions. A protocol is provided in their student guide.

3. Once groups have revised their skits, you may wish to have all groups present or just a few groups that you observed to have relatively unique models.
   - If all groups present, these revised skits can be a good option for formative assessment. As you watch the skits, identify trends in students' ability to integrate all the scientific concepts in a model, using appropriate scientific language. See "How to Use This Curriculum" for strategies on utilizing formative assessment data to provide feedback to students and inform classroom instruction.

4. Return to the whole-class concept map from the Lift-Off Task.
    - In small groups, have students brainstorm new concepts and new connections that they have learned in this task, as well as any new questions that have come up for them. Then have groups share these aloud in a class-wide discussion and add to the class concept map. The use of equity sticks is encouraged for more equitable participation in class-wide discussions (See "How To Use This Curriculum" for more details).
        - Some facilitating questions to ask students are: What new ideas/concepts do you want to add to the map? What connections do you want to add or change? What is your reason for that addition/revision? What connections can we make between the questions/ideas already on the map? What new questions do you have about the phenomenon?
        - Draw circles around each question and boxes around each concept.
        - Write connector words to describe connections between the concept boxes.
        - For this task, students may begin to connect some of their previous question circles to concept boxes about the following: how the particle motion, temperature, and state of water changes when thermal energy is added or removed.
    - Have students analyze the additions to the class concept map for as many examples of this task's crosscutting concept as they can find. Once a student has identified the crosscutting concept, you can trace the circle in the corresponding color (decided on in the Lift-Off task). We recommend asking students to share key words that helped them identify the crosscutting concept for that concept or question. Some identifying words students might look for are:
        - **Cause and Effect**. These could be phrases such as, "which results in," "which causes," "that explains why," "is due to," etc.
    - Once again, the purpose of this concept map is to facilitate generation of student questions, promote language development, and support understanding of the science content throughout the unit. Allowing students to ask their own questions and use their own words to make meaning of the concepts will not only help them make deep connections about science content, but will also help their oral and written language development.

Evaluate: Connecting to the Culminating Project

1. Students independently complete the Task 4 section of the Unit 2 Project Organizer in class. Revisions can be done for homework, depending upon student's needs and/or class scheduling.

2. Students have been tasked with creating a proposal to make water more available to people around the world, while also considering strain on the environment. Their prompt is as follows: Sometimes humans use natural resources as they exist in nature; other times humans use them by changing their state.
    - Do some research: how might using water sometimes require changing its original state?
    - Many communities don't have enough water (to drink, grow crops, etc.) Use what you have learned about changing states of water to brainstorm possible ways to provide them water. Keep in mind that you do not want to put too much strain on the environment!
        - Create a few possible design sketches with captions explaining how they work.
        - Explain some of the pros and cons of your solutions.

Reflection

1. At the end of the task, ask students to reflect on what they have learned over the course of this task by answering the following three questions in their student guide:
   - At the beginning of this task, you drew an initial model of water molecules in different states and came up with an idea of what causes water to change from one state to another. Look back at your initial drawings and ideas. Now think about what you have learned about particle motion using the computer simulation. How would you change or add to your initial drawings and ideas?
   - In this task, we focused on the crosscutting concept of **Cause and Effect**: cause and effect relationships may be used to predict phenomena. Where did you see examples of **Cause and Effect** in this task?
   - Now that you have learned more about what happens to water when thermal energy is added or removed, what questions do you still have?

2. There are no right answers, but encourage students to look back at their student guides and their class concept map. They should not change their initial responses, but rather use this reflection space to add to their ideas and questions based on what they have learned through this task. By generating more of their own questions, students continue to engage in sense-making of the phenomenon and gathering knowledge and skills for their final projects.

Assessment

1. You may collect students' Project Organizer and assess using:
   - *Criteria of your choice.* We recommend using the 3-Dimensional Assessment matrix at the beginning of this document to inform your criteria.
   - This can be a formative tool to periodically look for trends in student understanding after the completion of a task. You can then use this formative data to inform any re-teaching as necessary.

2. You may also give students time to make revisions with one of the two options:
   - Students may make changes to their Project Organizer according to your comments OR
   - Ask students to exchange Project Organizers with a partner and give partners 5 minutes to give written feedback. Then allow students time to make changes to their work according to the feedback.

Definition Cards
Explain

Thermal Energy The energy an object has because of the movement of its particles. Also known as *heat energy*.	**Temperature** The average kinetic energy of the moving particles in a substance.
Kinetic Energy The energy an object or particles have due to motion.	**State of Matter** A form in which matter can exist, which depends on the arrangement and motion of molecules. Ex: solid, liquid, and gas.