PLANNED INSTRUCTION

A PLANNED COURSE FOR:

STEELS: Science, Technology and Engineering,
Environmental Literacy and Sustainability

Curriculum writing committee:

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Grade 6 Science

Date of Board Approval: _June 2025___

Marking Period Course Grade Weighting

Major Assessments	40%
Quizzes	30%
Classwork/Labs	20%
Homework/Participation	10%
Total	100%

Curriculum Map

Overview:

This course provides an introductory exploration of essential topics in Earth and Space Science, including—but not limited to—the properties and behavior of light and matter, astronomy, the solar system, the universe, weathering and erosion, weather and climate, the properties and behavior of water, plate tectonics, rock cycling, matter and energy in Earth systems, natural disasters, and the impact of human activities on Earth's resources and climate.

All units are interconnected through the principles of the Pennsylvania STEELS standards (Science, Technology, Engineering, Environmental Literacy, and Sustainability). The value of each unit lies not only in its content but in how it is taught. Instruction is designed to promote student-driven learning and the development of critical problem-solving skills. Through investigations and inquiry-based learning, students will discover scientific principles rather than solely receive information through direct instruction.

While the content remains consistent across classrooms, instructional delivery will vary to meet the diverse needs of students. Teachers are encouraged to select the most appropriate methodologies based on the capabilities and learning styles of their students. A variety of teaching strategies will be used to ensure mastery of standards and subtopics, including direct instruction, digital simulations and manipulatives, scientific modeling, engineering design tasks, laboratory investigations and demonstrations, hands-on problem-solving projects, text and media analysis, collaborative activities, guided inquiry, and written assessments.

All middle school science courses are part of the planned science curriculum of the Delaware Valley School District.

Time/Credit for the Course: One full year, meeting daily for ~46 minutes/ 1 credit

Goals:

1. **Marking Period One: Over a 45-day period of time, students will aim to understand:**

    Unit 1: Light and Matter

    - Light travels in straight lines from a source and can be reflected, refracted, transmitted, or absorbed when it interacts with materials.
    - We see objects only when light from them enters our eyes, either directly or after reflecting off surfaces.
    - The appearance of an object—its color, brightness, or visibility—depends on how the material interacts with light and the conditions of the light source.
    - Transparent, translucent, and opaque materials affect how much light passes through them and how clearly we can see objects behind them.
    - Differences in lighting and viewing angles can cause people to see the same object differently.
    - Models help explain how light behaves and how our eyes detect light to form images.
    - Light interaction with materials determines which wavelengths (colors) are reflected, transmitted, or absorbed.

    Approximately 20 days

    Unit 2: Earth and Space

    - The Sun's position in the sky changes throughout the day and year, creating patterns that affect daylight and seasons.
    - Earth's tilt and orbit around the Sun cause seasonal temperature changes, not Earth's distance from the Sun.
    - The Moon's phases and eclipses happen because of the relative positions and motions of the Earth, Moon, and Sun.
    - Gravity is a force that keeps planets in orbit and shapes patterns in the solar system and universe.
    - Light from the Sun and other sources is affected by Earth's atmosphere, which can explain things like sunsets, eclipses, and the reddish Moon.
    - The solar system formed from a rotating cloud of gas and dust, shaped by gravity over time.
    - The universe is made up of galaxies, stars, and planetary systems that are organized by gravity and separated by vast distances.

    Approximately 25 days

2. **Marking Period Two: Over a 45-day period of time, students will aim to understand:**

    Unit 3: Weather, Climate, and Water Cycling

    - Weather and climate patterns are shaped by the movement of water and energy in Earth's atmosphere and surface systems.
    - Temperature increases can intensify both floods and droughts by affecting evaporation and precipitation patterns.

- Water continuously moves through Earth’s systems in processes like evaporation, condensation, precipitation, infiltration, and runoff.

- Energy from the Sun drives the water cycle and influences weather and climate conditions.
- Rising global temperatures have impacted all components of Earth’s water system, from ocean currents to glacier melt.
- Greenhouse gases trap energy in Earth’s atmosphere, leading to an increase in global average temperatures.
- Human activities, especially the burning of fossil fuels, are increasing the concentration of greenhouse gases in the atmosphere.
- Ice cores help scientists learn about Earth's past climate by preserving samples of ancient air.
- Carbon moves through Earth’s systems in processes like combustion, respiration, and photosynthesis, and an imbalance in these processes leads to climate change.
- The increase in atmospheric carbon dioxide is causing disruptions to natural systems, including water availability and weather extremes.
- Solutions to climate change include reducing emissions, changing behaviors, and making communities more resilient to changes already underway.
- Communities can use resilience planning to prepare for and adapt to the impacts of climate change while also working to reduce future risks.
- Modeling, data analysis, and community investigation are essential tools to understand and communicate about climate systems and solutions.

Approximately 45 Days

3. **Marking Period Three: Over a 45-day period of time, students will aim to understand:**

Unit 4: Plate Tectonics and Rock Cycling

- Earth's surface is constantly changing due to plate movements and the cycling of rocks through different Earth systems.
- Plate tectonics explains the locations of mountain ranges, earthquakes, volcanoes, and ocean trenches.
- Convection currents in Earth’s mantle drive the movement of tectonic plates.
- Rocks change over time through processes such as melting, cooling, weathering, erosion, compaction, and heat and pressure.
- The rock cycle connects Earth’s interior and surface processes and shows how matter is conserved through Earth’s systems.
- Evidence from rock layers and fossils helps us understand Earth’s history and the timing of major geologic events.
- Models and data from seismic activity, rock formations, and plate boundaries help us predict and explain Earth’s dynamic changes.

Approximately 25 Days

Unit 5: Natural Hazards

- Natural hazards are events caused by natural processes that can lead to significant loss or damage.
- Hazards like earthquakes, volcanoes, and tsunamis are caused by the movement of Earth's tectonic plates.
- Weather-related hazards such as hurricanes, floods, and droughts are driven by atmospheric and oceanic systems.
- Earth's systems (geosphere, hydrosphere, atmosphere, and biosphere) interact to cause and influence the severity of natural hazards.
- Scientific data, such as historical records and real-time measurements, are used to predict and prepare for natural hazards.
- Engineers design systems and structures to reduce the impact of hazards and protect communities.
- Communities can increase resilience by developing and following preparedness plans to mitigate the impacts of hazards.

Approximately 20 Days

4. **Marking Period Four: Over a 45-day period of time, students will aim to understand:**

Unit 6: Earth's Resources and Human Impact

- Earth's natural resources, such as water, minerals, and fossil fuels, are essential to human life and industry.
- Human activities, such as resource extraction, agriculture, and energy consumption, impact the environment and Earth's systems.
- The use of renewable and non-renewable resources affects ecosystems, biodiversity, and the global climate.
- Energy production and consumption, particularly through burning fossil fuels, contribute to climate change by increasing greenhouse gas emissions.
- Sustainable practices, such as reducing waste and conserving resources, can minimize environmental impact.
- Scientific data and models help predict the long-term effects of human activities on Earth's systems.
- Solutions to mitigate human impact include using renewable energy sources, recycling, and improving resource management.

Approximately 45 days

Unit 1 Overview

Overview: How does a one-way mirror work? Though most everyone knows that one-way mirrors exist, having students model how they work turns out to be a very effective way to develop their thinking about how visible light travels and how we see images. Initial student models in this 6th grade light and matter science unit reveal a wide variety of ideas and explanations that motivate the unit investigations that help students figure out what is going on and lead them to a deeper understanding of the world around them.

A video of an experience with a one-way mirror, gets students to organize and write down their initial ideas and then they dig in to test those ideas and figure out what is really happening. Students build a scaled box model of what they saw in the video to test out their ideas. Using two boxes combined together with a one-way mirror in between the two, students vary the presence of light in the two boxes to figure out how a one-way mirror works and improve their initial models so they accurately explain how light is reflected and transmitted through materials and the basics of how these behaviors of light result in the images we see.

As the first 6th grade science unit in the OpenSciEd program, during the course of this unit, students also develop the foundation for classroom norms for collaboration that will be important across the whole program while answering several questions.

Big Ideas:

- Energy can be modeled as either motions of particles or as being stored in force fields.
- Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave pattern of changing electric and magnetic fields that interact with matter.

Textbook and Supplemental Resources: OpenSciEd Unit 6.1: Light and Matter, Science Fusion Textbook

Unit 1: Light and Matter Curriculum Map

Essential Questions:	• Why do we sometimes see different things when looking at the same object? • What is energy? • What is light? • How can one explain the varied effects that involve light? • What other forms of electromagnetic radiation are there?
Standards (by number)	
Science:	3.2.6-8.Q Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave. 3.2.6-8.R Develop and use a model to describe how waves are reflected, absorbed, or transmitted through various materials.
Technology and Engineering:	3.5.6-8.M (ETS) Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Environmental Literacy and Sustainability:	

Students will know…. (DCI)	Students will be able to… (SEP)	Students will apply…(CCC)
A sound wave needs a medium through which it is transmitted. When light shines on an object, it is reflected, absorbed, or transmitted through the object, depending on the object's material and the frequency (color) of the light. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air and glass) where the light path bends. A wave model of light is useful for explaining brightness, color, and the frequency dependent bending of light at a surface between media. However, because light can travel through space, it cannot be a matter wave, like sound or water waves. Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.	Developing and Using Models: Develop and use a model to describe phenomena. Analyzing and Interpreting Data: Construct and interpret graphical displays of data to identify linear and nonlinear relationships.	Structure and Function: Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. Scale, Proportion, and Quantity: Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Core Activities / Corresponding Instructional Methods
Driving Question - Why do we sometimes see different things when looking at the same object?

Lesson 1 - How can something act like a mirror and a window at the same time?

Core Activity: Students watch a video of an interesting object that acts as a mirror from one side and a window from the other side. They set up a box model to make observations and test ideas about the phenomenon.

1. Develop a shared set of classroom norms (DOK 1)
2. Establish Routines for set up and break down (DOK 1)
3. Build a science notebook that includes numbered pages and a table of contents. (DOK 1)
4. Students watch a video of an interesting object that acts as a mirror from one side and a window from the other side. (DOK 1)
    a. Diagram important parts of the observed model and diagram the interactions between the important parts. (DOK 2)
5. Set up a box model to make observations and test ideas about the phenomenon. (DOK 2)
    a. Investigate the system using the box model. (DOK 2)
    b. Develop initial class consensus, brainstorm related phenomena, create driving question board and ideas for investigation chart. (DOK 3)

Lesson 2 - What happens if we change the light?
Lesson 3 - What happens when the light shines on the one-way mirror?
Lesson 4 - How do similar amounts of light transmit through and reflect off the one-way mirror?

Core Activity: Students investigate how changing the light affects the phenomenon, how much light is transmitted through and reflected off the one-way mirror, and how the one way mirror is structured.

1. Observe the one way mirror in and out of the box model. (DOK 1)
2. Observe the differences of moving the flashlight to room B, making both rooms light, and making both rooms dark. (DOK 2)
3. Compare what happens when light shines on the one way mirror, a pane of glass, and a regular mirror. (DOK 2)
4. Record initial observations and then use a light meter to measure the amount of light transmitted through and reflected off of each material. (DOK 2)
5. Summative Assessment Practice: CER Introduction and Practice (Class Modeling Activity)
    a. Write a statement about how light interacts with a material (reflection, transmission, or absorption). Provide data and observations collected during the experiment. Explain why the material behaved this way based on its properties and the scientific principles learned about light. (DOK 3)
6. Develop an experimental question and then plan an investigation. (DOK 4)
7. Document our observations and analyze data to figure out what happens when light shines on the one-way mirror. (DOK 3)
8. Read to discover the differences and similarities between one-way and two-way mirrors. (DOK 2)
9. Modify a model to explain what happens when light shines on the different structures in each material. (DOK 3)

Lesson 5 - How do light and the one-way mirror interact to cause the one-way mirror phenomenon?
Lesson 6 - Why does the music student not see the teacher?

Core Activity: Students develop a model to explain how light interacts with the one-way mirror and then develop a more complete model to explain how the eye-brain system processes light inputs to the eye.

1. Revisit anchoring phenomenon. (DOK 1)
2. Model interactions between the light, the people, and the mirror to explain why the music student and the teacher all see the music student. (DOK 3)
3. Students realize a little light reflects off the teacher and enters the student's eyes, students wonder why then the student does not see the teacher. (DOK 2)
4. Obtain information about what happens when light enters the eye. (DOK 2)
5. Model how light is used by the brain to create an image that we see. (DOK 3)
6. Connect experiences from our everyday lives to help to explain why we only see some inputs of light better than others. (DOK 3)

Lesson 7 - Why do the music student and the teacher see the music student but the music student can't see the teacher?
Lesson 8 - Why do we sometimes see different things when looking at the same object?

Core Activity: Students construct an explanation for the one-way mirror phenomenon and apply ideas about the one-way mirror phenomenon to explain related phenomena they experience every day.

1. Review class models from lessons 5 and 6, the class science ideas list, and our individual progress trackers. (DOK 2)
2. Develop a written explanation to answer the question: Why does the teacher see the music student? (DOK 3)
3. Individually students draft an explanation to answer the question: Why does the music student see himself, but not the teacher? (DOK 3)
4. Teachers and students work in constructive feedback loops to self-assess, give and receive peer feedback on the answer to question. (DOK 3)
    1. The music student sees himself because light reflects off the music student to the one-way mirror and reflects back to his eyes. This light input is the strongest signal that is processed by the brain.
    2. The teacher sees the music student because light reflects off the music student to the one-way mirror and transmits through the one-way mirror to her eyes. This light input is the strongest signal that is processed by her brain.
    3. The music student can't see the teacher and the teacher can't see her reflection because the light inputs from those objects are weaker and the brain doesn't respond to them.
5. Investigate the best light conditions for the one-way mirror phenomenon to occur and decide the effect is greatest when there is a large difference in light on both sides of the material. (DOK 3)
    1. Use this idea to investigate related phenomena, such as why tinted windows appear different in varying light positions and saturations. (DOK 4)
    2. Conclude that other materials, like glass, can act like one-way mirrors in situations in which there is a similar light differential on either side of the material. (DOK 3)
6. "Explaining One-Way Mirror Phenomenon" Summative Assessment (DOK 3)
7. Revisit the Driving Question Board to document the questions we have answered in the unit and to reflect on our learning. (DOK 2)
8. Draw Conclusions
    1. Differences in light on either side of an object or material can cause us to see different things when looking at the same object or material.
    2. The brighter or more prominent an object appears, the more light that reaches our eyes from the object.

9. “Portraits Through Glass” Individual Summative Assessment (DOK 4)
Summative EOU CER Response - Prompt: Why does a one-way mirror appear reflective from one side and transparent from the other? Provide data and observations or explain the conditions under which the behavior occurs. Explain the science behind the mirror’s behavior, using knowledge of light interaction and properties of materials. (DOK 4)

Words that “Might be Encountered” throughout the Unit:

dependent variable	opaque	scattering
experimental question	optic nerve	silvering
independent variable	reflect	system
model	refract	transmit
norm	retina	transparent
specular reflection	one-way mirror	scale model

Correctives:

1. 1. Reinforce Foundational Knowledge -
    a. Review basic concepts of light (reflection, refraction, transmission, absorption) for students struggling with vocabulary or foundational understanding.
    b. Use visual aids like diagrams, videos, or hands-on demonstrations to clarify key principles.
2. 2. Word Wall and Word Wall Routines
3. Provide Targeted Practice
4. Differentiate Instruction.
5. Use Formative Assessments.
6. Hands-On Remediation Activities
7. CER Scaffolding
8. Relate to Real-World Applications.
9. Extend Time and Revisit Content
10. Offer Visual and Kinesthetic Learning Opportunities.

Extensions:

Lesson 6: the refraction Extension Opportunity will allow students to develop a more robust understanding of how light bends(or changes direction when it encounters different transparent mediums (air, water, glass)

Lesson 8: The scattering Extension Opportunity allows students to explain more fully why certain smooth surfaces result in a mirror reflection compared to bumpier surfaces.

Assessments:

Diagnostic	Formative	Summative
• Driving Question Board • Pre-assessment Initial Models	• Practice CER Response • Progress Trackers	• Explaining the One-Way Mirror Phenomenon(Lesson 7)

• Continuous Student Self-Assessment • Peer Feedback	• Student Self-Assessment (Anytime after a discussion):	• Portraits through Glass: Individual Assessment (Lesson 8) • Summative EOU - CER Response

Unit 2 Curriculum Map

Overview: Humans have always been driven by noticing, recording, and understanding patterns and by trying to figure out how we fit within much larger systems. Students begin observing the repeating biannual pattern of the Sun setting perfectly aligned between buildings in New York City along particular streets and then connecting, exploring, and trying to explain additional patterns in the sky that they and others have observed. Students draw on their own experiences and the stories of family or community members to brainstorm a list of patterns in the sky. They listen to a series of podcasts highlighting indigenous astronomies from around the world that emphasize how patterns in the sky set the rhythms for their lives, their communities, and all life on Earth. These are added to their growing list of related phenomena (other patterns in the sky people have observed). In the first two lesson sets, students develop models for the Earth-Sun and Earth-Sun-Moon systems that explain some of the patterns in the sky that they have identified, including seasons, eclipses, and lunar phases. The end of the second lesson set and start of the third lesson set problematizes a predicted observation from the model they developed that they cannot fully explain. This unexpected observation leaves them wondering about why the Moon does not go completely dark during a lunar eclipse and instead turns a dim red color. In the third lesson set, students investigate a series of related phenomena motivated by their questions and ideas for investigations. These include rainbows, sunsets, and other sky and space phenomena related to changes in color and light. In the final lesson set, students explore the remaining questions on their Driving Question Board, related to planets and other objects farther out in space (beyond the stars they can see with the unaided eye). In this lesson set they explore scale and develop a model of the solar system and figure out that gravity is the driving force behind the patterns of motion of these objects and the organization of the solar system as well as the driving force behind the organization of more distant systems (galaxies) that we cannot see with unaided eyes from Earth.

Big Ideas:

- Develop and use both physical and conceptual models of objects in space to explain seasonal temperature variation across the globe, lunar phases, lunar eclipses, solar eclipses, and transits of Venus and Mercury.
- Attend explicitly to the perspective taken by the observer in their systems models and eventually include multiple perspectives at various scales, beginning here on Earth and expanding out to include the solar system and galactic scales.
- Use simulations to look for patterns of objects over time, including carrying out experiments on how the part of the Moon that is visible at a particular part of a lunar month is related to the position of the Moon related to the Earth and a person on Earth and the factors that influence the orbits of one object around another.
- Analyze, interpret, and collect data about objects in the solar system in order to gather evidence to explain the patterns we see in the sky and space with both our unaided eyes and from telescopes and spacecraft, as well as results from a computer simulation of the formation of the solar system
- Investigate phenomena and develop a model of light that can account for changes in color and brightness when it interacts with matter, and then revise a lunar eclipse model to represent the Earth-Sun-Moon system and that the matter in Earth's atmosphere selectively absorbs and bends light from the Sun to color the Moon red.
- Obtain information about objects in the sky and space that connect to observations made by other cultures and people throughout history.

Textbook and Supplemental Resources: OpenSciEd 8.4: Earth in Space, Science Fusion Textbook

Unit 2: Earth in Space

Essential Questions:	● What is the universe, and what is Earth's place in it? ● What is the universe, and what goes on in ● stars? ● What are the predictable patterns caused by Earth's movement in the solar system?
Standards (by number)	
Science:	3.3.6-8.A Develop and use a model of the Earth sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons 3.3.6-8.B Develop and use a model to describe the role of gravity in the motion within galaxies and the solar system. 3.3.6-8.C Analyze and interpret data to determine scale properties of objects in the solar system.
Technology and Engineering:	3.5.6-8.KK Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations. 3.5.6-8.Y Compare, contrast, and identify overlap between the contributions of science, technology, engineering, and mathematics in the development of technological systems. 3.5.6-8.Z Analyze how different technological systems often interact with economic, environmental, and social systems. 3.5.6-8.AA Adapt and apply an existing product, system, or process to solve a problem in a different setting.
Environmental Literacy and Sustainability:	

Students will know…. (DCI)	Students will be able to… (SEP)	Students will apply…(CCC)
Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models. This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are	Developing and Using Models: Develop and use a model to describe phenomena. Developing and Using Models: Modeling in 6–8 builds on K–5 experiences and progresses to developing, using, and revising models to describe, test, and predict more abstract phenomena and design systems.	Patterns: Patterns can be used to identify cause-and-effect relationships. Connections to Nature of Science Scientific Knowledge: Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.

caused by the differential intensity of sunlight on different areas of Earth across the year. Earth and its solar system are part of the Milky Way galaxy, which is one of many galaxies in the universe. The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. The solar system appears to have formed from a disk of dust and gas, drawn together by gravity. The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	Analyzing and Interpreting Data: Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. Analyze and interpret data to determine similarities and differences in findings.	Systems and System Models: Models can be used to represent systems and their interactions. 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.

Core Activities / Corresponding Instructional Methods
Driving Question - How are we connected to the patterns we see in the sky and in space?
Lesson Set 1 (Lessons 1-5) - How can we explain the patterns of the sun we see and connect to in the sky and space?
Lesson 1 - How are we connected to the patterns we see in the sky? Core Activity: Students analyze how the sunset has aligned with human made structures and consider other interesting patterns in the sky from their own experiences, community members' ideas, and additional cultures' stories about how these patterns are connected to the rhythms of human life. 1. Analyze and consider how light from the Sun aligned with structures made by humans on a particular day and develop an initial model to explain this phenomenon. (DOK 3) 2. Gather, connect with, and jigsaw stories about patterns in the sky they have seen or heard about and how these might be connected to the rhythms of human life. (DOK 2) 3. Develop a model of the parts of the system that are needed to explain many of the patterns we have identified. (DOK 4)

Lesson 2 - What patterns are happening in the sky that I have experienced and can observe (through models and tools)? Lesson 3 - How can we explain the sun's path change over time? Lesson 4 - How do these changes in sunlight impact us here on Earth? Core Activity: Students investigate patterns they and others have observed in the sky related to the sun and stars, then analyze seasonal temperature data and to explain seasonal temperature variation and determine why the seasons are opposite in Australia from the United States. 1. Gather information from videos of Native American stories about a star that does not move in the night sky. (DOK 1) 2. Share our experiences about noticing this star, sometimes called the North Star. (DOK 2) 3. Watch a video and share the repeated patterns and changes that we observe in the sky. (DOK 2) 4. Develop initial models to explain why the North Star does not appear to move in the night sky. (DOK 3) 5. Watch a video to observe the simulated motion of the Sun through the sky over a day for different times of the year. Notice that in summer the apparent path of the Sun in the sky is higher and the daytime is longer. (DOK 2) 6. Create physical models to see if our understanding about why this is happening is correct. Our physical models cannot account for differences in the length of daylight over a year. (DOK 3) 7. Revise our model of the system in small groups to try to account for changes in the amount of daylight. (DOK 4) 8. Analyze seasonal temperature data from two cities in the US and argue that changes in Earth's distance from the Sun do not explain seasonal temperature differences. (DOK 3) 9. Develop a physical model and use it to collect changes of sunlight energy on Earth's surface as a result of changes in solar elevation. (DOK 4) 10. Use this relationship to explain seasonal temperature differences in other parts of the world. (DOK 4)
Lesson 5 - How can we explain phenomena like Manhattanhenge? Core Activity: Students use what they have figured out about the Earth and Sun system to model and explain the sunset alignment phenomena from Lesson 1. 1. Use a video simulation to investigate patterns we think might be responsible for Manhattanhenge. (DOK 2) 2. Revise a model of the Manhattan solar phenomenon. (DOK 3) 3. Revisit the Driving Question Board to connect what questions we have answered and what questions remain. (DOK 3)
Lesson Set 2 (Lessons 6-7) - How can we explain the patterns of the Moon we see and connect to in the sky and space?
Lesson 6 - Why do we see the shape of the moon change? Lesson 7 - Why do we see eclipses and when do we see them? Core Activity: Students investigate patterns they and others have noticed in the shape of the moon over time for lunar phases and eclipses and develop a physical model of the Earth, Sun, Moon system to explain and predict these patters. 1. Use a physical model and an online interactive to help make sense of the positions of the objects in the Earth-Sun-Moon system that cause us to see the current shape of the Moon. (DOK 2) 2. Use our physical models to predict the next phase of the Moon. (DOK 3) 3. Watch a video of a solar eclipse. (DOK 1) 4. Develop a model to explain what we saw in the video using a physical model of the system. (DOK 3)

5. Compile the ideas we want to include in a drawn model using multiple perspectives to communicate what is seen when a solar eclipse happens and why. (DOK 3)
6. Return to our physical models to figure out why we do not see a solar eclipse every month and how often we might expect to see a solar eclipse. (DOK 3)

Lesson Set 3 (Lessons 8-12) - Why do we see colors change in the sky and space?

Lesson 8 - What does a lunar eclipse look like and how can we explain it?

Core Activity: Students analyze images of lunar eclipses, list possible causes for the unexpected changes in color and dimness in its appearance. They brainstorm other color related phenomena for object and add additional color-related questions and ideas for investigations.

1. Analyze images of lunar eclipses and compare them to the lunar eclipse predictive model we made as a class in Lesson 7. The reddish color of the Moon that we observe during a lunar eclipse is unexpected. (DOK 3)
2. List possible causes of that reddish color and gather examples of related phenomena of objects reddening in the sky. (DOK 2)
3. Generate ideas for investigating our color-related questions. (DOK 3)

Lesson 9 - Why do the Moon and Sun appear to change color near the horizon?
Lesson 10 - How does light interact with matter in the atmosphere?
Lesson 11 - How does the shape of a water droplet or an ice crystal cause sunlight to form into a rainbow?
Lesson 12 - Why does the Moon always change color during a lunar eclipse?

Core Activity: Students investigate what happens to the color, brightness, and bending of light as it moves from its source to their eyes (or other detectors) and then apply what they have figured out to lunar eclipses and to a new phenomenon: light changes underwater.

1. Examine images of the Sun and Moon and propose that something about the Earth's atmosphere could be contributing to the color changes. (DOK 2)
2. Examine diagrams of the atmosphere and images of the Sun from space. (DOK 1)
3. Add the Earth's atmosphere to our model of the Earth–Sun system and zoom in on the Sun at different times. (DOK 3)
4. Predict different angles of light and/or the amount of the atmosphere affects the color at sunrise compared to midday. (DOK 3)
5. Investigate the color and brightness changes we see as light travels through the Earth's atmosphere by using a flashlight to simulate the Sun and a rectangular bin of milky water to simulate the atmosphere. (DOK 3)
6. Use our investigation results to co-construct a model of light transmitting and scattering through the simulated atmosphere. (DOK 4)
7. Investigate times, places and perspectives needed to see white light split into its component colors—making a rainbow. (DOK 2)
8. Investigate the effect that different materials and their shapes have on (white) light—causing it to change direction (refract) and sometimes make colors and rainbows. (DOK 3)
9. Conduct another investigation to recombine colors of light. (DOK 3)
10. Discover that combining light in different ways can change the overall color and brightness of the light that you see. (DOK 2)
11. Celebrate the knowledge we have figured out in previous lessons that can help us explain color change during lunar eclipses. (DOK 1)
12. Evaluate models created in those lessons before co-constructing a new model of what is happening during a lunar eclipse. (DOK 4)
13. Prepare for and complete a transfer task. (DOK 4)

Lesson Set 4 (Lessons 13-17) - How can gravitational forces explain the patterns in the organization of the Solar System, galaxies, and the universe?

Lesson 13 - What new patterns do we see when we look more closely at other objects in the sky?

Core Activity: Students investigate patterns of objects beyond the Earth, Sun, and Moon because many of their unanswered questions pertain to patterns in objects and the motion of those objects in the sky and space.

1. Revisit unanswered DQB questions and decide to focus on other objects in our solar system. (DOK 2)
2. Gather information to identify connections and observations about one other planet, Venus. (DOK 2)
3. Notice additional patterns and record new questions about these. (DOK 3)
4. Use a model showing the relative position of motion of Venus and Earth in the system to explain these patterns. (DOK 3)
5. Analyze the scale properties of other planets to look for other patterns. (DOK 3)

Lesson 14 - Why do some solar system objects orbit planets and others orbit the sun?
Lesson 15 - How did the solar system get to be the way it is today?
Lesson 16 - What patterns and phenomena are beyond our solar system that we cannot just see with just our eyes?

Core Activity: Students want to know why objects in space move the way they do, so they investigate the gravitational forces influencing the movement of those objects and the formation of the Solar System.

1. Share initial ideas about patterns of motion in the solar system, which leads us to conduct a cause-and-effect thought experiment around those patterns. (DOK 2)
2. Use a simulation to investigate how changing distance and size affects an object's orbit around another object in the solar system. (DOK 3)
3. Build understanding as a class about the relationship between size, distance, and the strength of the force of gravity before demonstrating our understanding on a formative assessment. (DOK 2)
4. Analyze images of craters on the surface of Mercury and two moons. (DOK 3)
5. Watch a video showing the results of a computer simulation that models the formation of the solar system. (DOK 2)
6. Develop storyboards to support the claim that the solar system was formed from a disk of gas and dust, drawn together by gravity. (DOK 3)
7. Build a class consensus storyboard model of the formation of the solar system. (DOK 4)
8. Look at a photo taken by the Hubble telescope of blobs in the space between stars. (DOK 2)
9. Learn that these are galaxies, islands of stars much like the ones we see in the sky. (DOK 1)
10. Watch the *Tour of the Universe* to visualize how scientists model the universe at various scales. Notice that the universe appears to be organized into systems held together by gravity, separated by vast emptiness. (DOK 2)

Lessons 17 - How are we connected to all of the systems in space beyond the planet we live on?

Core Activity: Students zoom out to a galactic scale and then back down to the Earth-Moon-Sun System to make connections between the systems of the universe at different scales with regards to gravity.

1. Make a classroom consensus model at various scales to show how gravity organizes the universe. (DOK 4)
2. Return to the DQB to take stock of how far we have come in this unit and then reflect on the unit and Earth's place in the universe. (DOK 3)

Words that "Might be Encountered" throughout the Unit:

(lunar) phases	orbit	solar system
accretion	pattern	transit
change in perspective	Polaris, daily (or diurnally)	transmit
eclipse	reflect	universe
elevation	refract	yearly (or annually)
galaxy	scatter	
gravitational forces	solar	

Correctives:

1. Supplemental Teaching
    a. Supplemental teaching of the definitions of *forces* would be required to help students understand a model of what causes gravitational forces, why they vary, and why they can produce relatively y and stable orbits in some conditions.
    b. Force pairs are the result of the interaction of two objects or systems. There are no single forces. Each force in a force pair is equal in strength, opposite in direction, and acting on a different part of the system or object in the system.
    c. Some forces act a distance rather than through contact between matter. Magnetic fields can be used to map and visualize the direction and strength of magnetic forces at various distances from one or more objects in a system. Distance affects the strength of these forces.
2. Word Wall and Word Wall Routines
3. Provide Targeted Practice
4. Differentiate Instruction.
5. Use Formative Assessments.
6. Hands-On Remediation Activities
7. CER Scaffolding
8. Relate to Real-World Applications.
9. Extend Time and Revisit Content
10. Offer Visual and Kinesthetic Learning Opportunities.

Extensions:

Many lessons: Within many lessons are extension readings, videos, simulations, or activities offered as alternates or home learning. If you find that students are highly engaged or looking for a challenge, offer these readings as either in-class or home learning extensions.
All lessons: Remove scaffolds provided with Science and Engineering Practices as a way to give students more independent work with the elements of these practices.

Assessments:

Diagnostic	Formative	Summative
● Initial Model ● Driving Question Board ● Continuous Self-Assessment ● Peer Feedback	● What causes the seasons in Australia and Why are they opposite of our seasons? (Lesson 4)	● Explaining Fishing Related Phenomena (Lesson 12) ● Structure of the Universe Model, Groups Work (Lesson 17)

	• Physical Models, Predictive Model, Lesson 7: Self-Assessment for Collaborative Group Work, Predictions • Lesson Performance Expectations • Progress Tracker/Summary Table	

Unit 3 Curriculum Map

Overview: This 6th-grade science unit on weather, climate, and water cycling is broken into four separate lesson sets. In the first two lesson sets, students explain small-scale storms. In the third and fourth lesson sets, students explain mesoscale weather systems and climate-level patterns of precipitation. Each of these two parts of the unit is grounded in a different anchoring phenomenon.

The unit starts with anchoring students in the exploration of a series of videos of hailstorms from different locations across the country at different times of the year. The videos show that pieces of ice of different sizes (some very large) are falling out of the sky, sometimes accompanied by rain and wind gusts, all on days when the temperature of the air outside remained above freezing for the entire day. These cases spark questions and ideas for investigations, such as investigating how ice can be falling from the sky on a warm day, how clouds form, why some clouds produce storms with large amounts of precipitation and others don't, and how all that water gets into the air in the first place.

The second half of the 6th-grade science weather and climate unit is anchored in the exploration of a weather report of a winter storm that affected large portions of the midwestern United States. The maps, transcripts, and video that students analyzed show them that the storm was forecasted to produce large amounts of snow and ice accumulation in large portions of the northeastern part of the country within the next day. This case sparks questions and ideas for investigations around trying to figure out what could be causing such a large-scale storm and why it would end up affecting a different part of the country a day later.

Big Ideas:

- Water's presence and properties impact Earth's ecosystems and surface features.
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.
- All forms of matter exist as a result of the combination or rearrangement of atoms.

Textbook and Supplemental Resources: OpenSciEd 6.3 Weather, Climate & Water Cycling, Science Fusion Textbook

Unit 3: Weather, Climate & Water Cycling

Essential Questions:	• How do the properties and movements of water shape Earth's surface and affect its systems? • What regulates weather and climate? • How do particles combine to form the variety of matter one observes? • Why does a lot of hail, rain, or snow fall at some times and not others?
Standards (by number)	
Science:	3.3.6-8.H Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity 3.3.6-8.I Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates

	3.3.6-8.J Collect data to provide evidence for how the motion and complex interactions of air masses result in changes in weather conditions 3.3.6-8.O Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century
Technology and Engineering:	3.5.6-8.W (ETS) Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions
Environmental Literacy and Sustainability:	

Students will know…. (DCI)	Students will be able to… (SEP)	Students will apply…(CCC)
Water continually cycles among land, ocean, and atmosphere via transpiration, evaporation, condensation and crystallization, and precipitation, as well as downhill flows on land. Global movements of water and its changes in form are propelled by sunlight and gravity. The complex patterns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. Because these patterns are so complex, weather can only be predicted probabilistically. Variations in density due to variations in temperature and salinity drive a global pattern of interconnected ocean currents. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These	Developing and Using Model: Develop a model to describe unobservable mechanisms. Planning and Carrying Out Investigations: Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions. Developing and Using Models: Develop and use a model to describe phenomena.	Energy and Matter: Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter. Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems. Systems and System Models: Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy, matter, and information flows within systems.

interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. Gasses 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. The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning; it refers to the energy transferred due to the temperature difference between two objects. (secondary) The temperature of a system is proportional to the average internal kinetic energy and potential energy per atom or molecule. (whichever is the appropriate building block for the system's material). The details of that relationship depend on the type of atom or molecule and the interactions among the atoms in the material. Temperature is not a direct measure		

of a system's total thermal energy. The total thermal energy (sometimes called the total internal energy) of a system depends jointly on the temperature, the total number of atoms in the system, and the state of the material. (secondary)		

Core Activities and Corresponding Instructional Methods

Be specific. List activities related to materials/resources, include links, article titles etc.

Core Activities / Corresponding Instructional Methods
Driving Question - Why does a lot of hail, rain, or snow fall at some times and not others?
Lesson Set 1 (Lessons 1-6) - What is the air outside like when this happens?
Lesson 1 - What causes this kind of precipitation to occur? Core Activity: Students observe three video clips of hail falling in different places on different days. 1. Students observe three video clips of hail falling in different areas of the United States on different days. (DOK 1) 2. Develop a model to try and explain what causes this to occur. (DOK 3) 3. Develop questions for our driving question board about the mechanisms that cause different kinds of precipitation events. (DOK 2) 4. Brainstorm investigations we could do and sources of data that could help us figure out answers to our questions. (DOK 3)
Lesson 2 - What are the conditions like on days when it hails? Lesson 3 - How does the air higher up compare to the air near the ground? Core Activity: Students analyze weather data from locations where hail occurred and from air temperature profiles of the atmosphere. 1. Examine photos of hailstones and analyze and interpret data from all cases of hail events at different locations and times of year to notice patterns and identify relevant factors that might explain the formation of hail. (DOK 3) 2. Analyze and interpret temperature profiles of the atmosphere collected from weather balloons at various altitudes at different locations during different times of the year. (DOK 3) 3. Develop a consensus model for representing the motion of the molecules that make up air at different temperatures. (DOK 3)

Lesson 4 - Why is the air near the ground warmer than the air higher up? Lesson 5 - What happens to the air near the ground when it is warmed up? Core Activity: Students collect data on light levels, surface temperatures, and air temperature from places outside, and observe changes in the air volume that result from heating and cooling in the air. 1. Plan and carry out an investigation to figure out what causes the air above different ground surfaces to be warmer than the air higher in the atmosphere. (DOK 4) 2. Measure the temperature of the air at different ground surfaces, the air temperature above those surfaces, and the amount of sunlight reaching and reflecting off those surfaces. (DOK 2) 3. Conduct an investigation to figure out how transferring thermal energy into and out of a parcel of air in a closed system (a bottle of air with a soap bubble film over the top) affects that air's volume and behavior. (DOK 3) 4. Conduct a second investigation to observe how density changes in a parcel of air (in a balloon) cause it to float or sink in the surrounding air. (DOK 3) 5. For each investigation, develop a model to represent how the speed, spacing, and density of the molecules that make up air are affected by temperature changes. (DOK 4)
Lesson 6 - How can we explain the movement of air in a hail cloud? Core Activity: Students apply what they figured out in lessons 2-5 to explain the movement of air in a hail cloud over time. 1. Examine photos and a video of clouds that produce hail to look for patterns in the motion of air. (DOK 2) 2. Construct an explanation using evidence for the path of air movement below, within, and at the top of a cloud that tends to form hail. (DOK 3)
Lesson Set 2 (Lessons 7-13) - Why do some clouds produce precipitation and others don't?
Lesson 7 - Where did all of the water in the air come from, and how did it get into the air? Core Activity: Students read about what is in the air and carry out investigations to determine how the transfer of energy to different surfaces affects the humidity in the air above them. 1. Plan and carry out an investigation to determine where the water in the air comes from by measuring the humidity in the air over samples of different Earth surfaces. (DOK 4)
Lesson 8 - What happens to water vapor in the air if we cool the air down, and why? Lesson 9 - Why don't we see clouds everywhere in the air, and what is a cloud made of? Core Activity: Students investigate how a droplet grows when air is cooled. They model particle-level interactions in a phase change and the read about what is in the clouds. 1. Carry out investigations to explore what happens when air containing water vapor is cooled and what happens when water droplets make contact with each other. (DOK 3) 2. Use magnetic marbles to develop a model for how mutual attraction between water molecules and changes in their speed cause water to change from gas to liquid when it cools below a certain temperature. (DOK 3) 3. Read about what clouds are made of, why we can see them, the role of cloud condensation nuclei, and methods of cloud seeding. (DOK 2) 4. Argue that what happens in clouds is similar to what we see happen on the surface of a cold gel pack over humid air in our 2-L bottles. (DOK 4)

Lesson 10 - Why do clouds or storms form at some times and not others?

Core Activity: Students apply what they have figured out in lessons 2 through 9 to critique a computer simulation of thunderstorms.

1. Use the *Gotta-Have-It Checklist* to test and revise a thunderstorm simulation to produce larger and smaller storms. (DOK 3)
2. Focus on temperature and humidity conditions that are likely to produce storms. (DOK 2)
3. Think about what additional features we would like to include in the simulation and we design interfaces for those features. (DOK 4)

Lesson 11 - Why don't water droplets or ice crystals fall from the clouds all of the time?
Lesson 12 - What causes more lift in one cloud versus another?

Core Activity: Students investigate and model what causes objects to float, fall, or rise up through the air and carry out an investigation to determine the amount of lift produced from heating or cooling a fluid.

1. Try to lift or suspend different objects with air blown upward, and record the weight of different objects and the amount of force registered when air is blown toward or away from a digital scale. (DOK 2)
2. Develop a model to show how objects might be lifted, fall, or remain suspended in the air depending on the relative strength of two different forces acting on them. (DOK 3)
3. Record the air pressure using a homemade barometer and record the cloud cover and precipitation outside. (DOK 2)
4. Plan and carry out an investigation to determine what variables affect the amount of lift produced in a fluid. (DOK 4)
5. Explain how the results of our investigation help us understand how differences between air and ground temperatures can cause different amounts of lift and movement of air. (DOK 4)

Lesson 13 - Why do some storms produce (really big) hail and others don't?

Core Activity: Students apply what they have figured out in lessons 2-12 to explain (1) why some storms produce really big hail and others don't and (2) what causes a hurricane to form and grow.

1. Add to our Gotta-Have-It checklist and develop a final model to explain why some storms produce hail. (DOK 3)
2. Revisit the DQB and discuss the questions that we have now answered. (DOK 2)
3. Apply our understanding to a new phenomenon (hurricanes) and individually take an assessment. (DOK 4)

Lesson Set 3 (Lessons 14-18) - What causes large-scale precipitation events and how can we predict them?

Lesson 14 - What causes a large scale precipitation event like this to occur?

Core Activity: Students observe a video and maps from a weather forecast for a severe winter storm and argue for what ideas from lessons 2 through 13 can be used to explain this phenomena.

1. Explore video and maps from three parts of a weather report and forecast from Jan. 19, 2019. (DOK 2)
2. Develop a model to explain how what was happening in one part of the country at one point in time can be connected to what is predicted to happen in another part of the country over a day later. (DOK 3)
3. Develop questions for our Driving Question Board (DQB). We brainstorm ways we could investigate these questions. (DOK 2)

Lesson 15 - What happens with temperature and humidity of air in large storms? Lesson 16 - How do warm air masses and cold air masses interact along the boundaries between them? Lesson 17 - Is there a relationship between where the air is rising and where precipitation is falling? Core Activity: Students analyze weather data maps and develop a model for how fronts form and how they can cause precipitation. 1. Use temperature, humidity, and radar data across eight-hour increments during the timeline of the storm to track the movement of air and precipitation. (DOK 3) 2. Consider how air moves horizontally in large parcels, called air masses, and notice that precipitation and storms develop where air masses of different characteristics meet. (DOK 2) 3. Develop different ways of representing what is happening with warm air and cold air across the land. (DOK 3) 4. Carry out an investigation to explore what happens along a frontal boundary where warm air and cold air meet. (DOK 3) 5. Develop models to describe interactions between warm and cold air masses and use patterns in data to explain changes in precipitation that can occur when air masses collide. (DOK 3) 6. Analyze national pressure maps from around the time of the original forecast. (DOK 2) 7. Construct an explanation of the patterns we notice among (1) the area of lowest air pressure, (2) the locations of the fronts, and (3) where precipitation would fall. (DOK 3) 8. Apply scientific ideas to explain what is causing the three ideas to be connected to one another. (DOK 4)
Lesson 18 - How can we explain what is happening across this storm (and other large-scale storms)? Core Activity: Students apply what they figured out in Lessons 14-17 to argue for their ideas about why three other storm systems would produce certain predicted precipitation patterns in the near future. 1. Explore video and maps from three parts of a weather report and forecast from Jan. 19, 2019 (DOK 2). 2. Develop a model to explain how what was happening in one part of the country at one point in time can be connected to what is predicted to happen in another part of the country over a day later. (DOK 3) 3. Develop new questions for our Driving Question Board (DQB) and brainstorm ways we could investigate these questions. (DOK 3)
Lesson Set 4 - (Lessons 19-22) - Why do some places get more precipitation than others over time?
Lesson 19 - Are there patterns to how air masses move that can help predict where large storms will form? Lesson 20 - How do oceans affect whether a place gets a lot or a little precipitation? Core Activities: Students observe visualizations of annual precipitation around the globe and read about prevailing winds and ocean currents. 1. Observe a visualization showing precipitation movement across the United States in a predictable pattern from west to east in most locations. These predictable air movements seem to bring colder air from the north and warmer air from the south. We zoom out to a global view and notice the U.S. pattern is the same as other places in the northern hemisphere and a mirror image of the southern hemisphere. (DOK 2) 2. Come to agreement about the temperature of air masses and the direction of their movement. (DOK 2) 3. Gather additional information about the role of the ocean by observing a visualization of ocean temperatures, reading about ocean currents, and interpreting precipitation data for coastal cities. (DOK 3) 4. Revise a model for air mass interactions that explain (1) the places where certain kinds of air masses form, and (2) their predictable movements over time. (DOK 3)

Lesson 21 - Why is there less precipitation further inland in the Pacific Northwest then further inland from the Gulf Coast? Core Activities: Students analyze climate and elevation data and develop a model for how elevation and prevailing winds affect yearly precipitation amounts in a region. 1. Analyze precipitation, temperature, and elevation data at five locations along two different prevailing wind pathways to explore why there is less precipitation further inland in the Pacific Northwest than there is further inland from the Gulf Coast. (DOK 3) 2. Model what happens as an air mass moves from above the ocean to locations over mountains and relatively flat landforms. (DOK 3) 3. Develop a list of key ideas and data we need to explain climate patterns in places outside of the United States. (DOK 2)
Lesson 22 - How can we explain differences in climate in different parts of the world? Core Activities: Students apply what they figured out over the course of the unit to explain the locator of rainforests. 1. Use our key ideas list from Lesson 21 to explain why the rainforests are located where they are and why they have different climates. (DOK 3) 2. Revisit the Driving Question Board and discuss all of the questions that we have now answered. (DOK 2)

Words that "Might be Encountered" throughout the Unit:

air mass	deposition	humidity
air pressure, barometer, gravity	downdrafts	hurricane
altitude	downdrafts	lift force
atmosphere	evaporation	parcel of air
barometer	fluid	precipitation
climate	forecast	relative humidity
cloud condensation nuclei (CCN)	freezing/melting point	temperate rainforest
condensation	front	temperate rainforest
condensation/boiling point	gravity	updrafts
convection	hail	updrafts
currents	hailstone	weather conditions
currents, downdrafts, updrafts	higher and lower air pressure	
density	humidity	

Correctives:

1. Supplemental Teaching
   a. Since taught before the thermal transfer cup design unit, 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.

    b. MS - PS4-2: Develop and use a model to describe that waves are reflected absorbed or transmitted through various materials.
    c. Planning and carrying out an investigation, particularly related to the idea that identifying independent and dependent variables and controlling for other variables can help you conduct fair tests, which is a necessary condition for producing data that can serve as the basis for evidence in supporting or refuting a potential cause and effect relationship in a system.
2. Word Wall and Word Wall Routines
3. Provide Targeted Practice
4. Differentiate Instruction.
5. Use Formative Assessments.
6. Hands-On Remediation Activities
7. CER Scaffolding
8. Relate to Real-World Applications.
9. Extend Time and Revisit Content
10. Offer Visual and Kinesthetic Learning Opportunities.

Extensions:

Lesson 1: To strengthen local relevance, replace one of the first two videos with a video of hail with a local example. Keep the third video.
Lesson 2: Ask students to start tracking changes in local weather conditions where they live to look for additional patterns over time.
Lesson 6: Ask students to start tracking instances of vertical cloud growth they see in the weather outside.
Lesson 11: Provide interested students with the opportunity (and some of the needed materials) to build their own homemade barometer and ask them to track changes in air pressure over subsequent days.

Assessments:

Diagnostic	Formative	Summative
• Driving Question Board • Pre-assessment Initial Models • Continuous Student Self-Assessment • Peer Feedback	• Explaining the Movement of Air a Hailstorm Cloud (Lesson 6) • Air Pressure Prediction and Map Analysis (Lesson 17) • Lesson Summary Tables • Lesson Notebooks • Lesson Performance Expectations	• Student Transfer Task: Hurricane Assessment Tasks • Air Pressure Prediction and Map Analysis (Lesson 17) • Putting the Pieces Together (Lesson 18) • Student Transfer Task: Rainforest Climate

Unit 4 Curriculum Map

Overview: Mountains move, and there are ocean fossils on top of Mt. Everest! In this plate tectonics and rock cycling unit, students see that the Earth is much more active and alive than they thought. The unit launches with documentation of a 2015 Himalayan earthquake that suddenly shifted Mt. Everest to the southwest. Students also discover that Mt. Everest is steadily moving to the northeast every year and getting taller. Students wonder what could cause an entire mountain to move during an earthquake.

Students investigate other locations that are known to have earthquakes and they notice landforms, such as mountains and ridges that correspond to earthquake patterns. They read texts, explore earthquake and landform patterns using a data visualization tool, and study GPS data at these locations. Students develop an Earth model and study mantle convection motion to explain how Earth's surface could move from processes below the surface. From this, students develop models to explain different ways plates collide and spread apart, ultimately explaining how Mt. Everest could move all the time in one direction, and also suddenly, in a backward motion, during an earthquake. The unit ends with students using what they have figured out about uplift and erosion to explain how a fossil was found at Mt. Everest without having to dig for it.

Big Ideas:

- We can infer Earth's planetary history by features we observe today.
- Changes we observe on Earth are the result of energy flowing and matter cycling between interconnected systems (the geosphere, hydrosphere, atmosphere, and biosphere).
- Plate tectonics explains the past and current movements and features of the rocks at Earth's surface.

Textbook and Supplemental Resources: OpenSciEd 6.4 Plate Tectonics and Rock Cycling, Science Fusion Textbook

Unit 4: Plate Tectonics and Rock Cycling

Essential Questions:	• How do people reconstruct and date events in Earth's planetary history? • How do Earth's major systems interact? • How and why is Earth constantly changing? What causes Earth's surface to change? • Why do the continents move, and what causes earthquakes and volcanoes?
Standards (by number)	
Science:	3.3.6-8.D Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6 billion-year-old history. 3.3.6-8.F Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. 3.3.6-8.E Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying times and spatial scales. 3.3.6-8.G Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions.

	3.3.6-8.J Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process. 3.3.6-8.K Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying times and spatial scales. 3.3.6-8.L Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of past plate motions.
Technology and Engineering:	3.5.6-8.W (ETS) Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
Environmental Literacy and Sustainability:	

Students will know…. (DCI)	Students will be able to… (SEP)	Students will apply…(CCC)
The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not an absolute scale. All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms. The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. Water's movements— both on the	Constructing Explanations and Designing Solutions: Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Developing and Using Models: Develop and use a model to describe phenomena. Constructing Explanations and Designing Solutions: Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories. Construct a scientific explanation based on valid and reliable	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. Stability and Change: Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale. Patterns: Patterns in rates of change and other numerical relationships can provide information about natural systems.

land and underground—cause weathering and erosion, which change the land's surface features and create underground formations. Tectonic processes continually generate new ocean seafloor at ridges and destroy old seafloor at trenches. (secondary) Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.	evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe nature operate today as they did in the past and will continue to do so in the future. Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena. Connections to Nature of Science: Science findings are frequently revised and/or reinterpreted based on new evidence.	

Core Activities and Corresponding Instructional Methods

Be specific. List activities related to materials/resources, include links, article titles etc.

Core Activities / Corresponding Instructional Methods
Driving Question - What causes Earth's surface to change?
Lesson Set 1 (Lessons 1-9) - What causes mountains to grow and move?
Lesson 1 - What is causing Mt. Everest and other mountains to move, grow, or shrink? Core Activity: Students read an article about scientists discovering that Mt. Everest has an increased elevation. Then they analyze data about different mountains around the world and find that others are also growing and moving. 1. Read about how Mt. Everest is getting taller and moving yearly to the northeast. (DOK 1) 2. Analyze other mountain peaks around the world and find that other mountains are also getting taller, but others are shrinking. (DOK 2) 3. Develop an initial model explaining how mountains grow, move, and shrink. (DOK 3) 4. Brainstorm related phenomena, ask questions and generate a list of data and information we need to better understand how mountain peaks can grow, shrink, and move. (DOK 3)
Lesson 2 - How are earthquakes related to where mountains are located? Lesson 3 - How does what we find on and below Earth's surface compare in different places? Lesson 4 - What is happening to the Earth's surface and the material below it during an earthquake? Lesson 5 - How does plate movement affect the land around mountains such as Mt. Everest? Lesson 6 - How could plate movement help us explain how Mt. Everest and other locations are changing in elevation? Lesson 7 - What happens at mountains where we see volcanic activity?

Lesson 8 - What is occurring at locations where two plates are moving away from each other?
Lesson 9 - What causes mountains to change?

Core Activity: Students investigate what would cause a mountain to form by figuring out more about Earth's surface and what is below the surface.

1. Look at data sources from Ridgecrest, CA before and after an earthquake. (DOK 1)
2. Use Seismic Explorer to determine that there seems to be a pattern with greater earthquake activity at mountains that are increasing in elevation. (DOK 2)
3. After figuring out that earthquakes are correlated to mountain changes, wonder what is happening underground where earthquakes occur and what we will find at and below the surface in different places around Earth. (DOK 2)
4. Develop models and gather data from various media and investigations about the structure and composition of materials at and below the surface. (DOK 3)
5. Share observations and data and update our Progress Trackers. (DOK 2)
6. Develop a profile view model of Ridgecrest. We use a foam board to model the bedrock and determine the break in the land must go all the way through the bedrock. (DOK 3)
7. Analyze the area of the earthquake by making a cross section in Seismic Explorer. (DOK 2)
8. Develop a profile model of North America. (DOK 4)
9. Determine that the big sections of Earth between long fault lines are plates. (DOK 2)
10. Look at a world map for where there could be other plates on the map. (DOK 2)
11. Look for patterns in GPS data to examine land movement around Mt. Mitchell, and use a physical model to demonstrate that the entire North American plate moves at a constant speed and in a specific direction. (DOK 3)
12. Revise a cross-section model of the North American plate from the previous lesson to connect its movement to the behavior of the deeper, hotter bedrock. (DOK 4)
13. Use Seismic Explorer to investigate the movement of all plates on Earth's surface. (DOK 3)
14. Use models of plates and plate movement to identify and describe in detail the results of plate interactions between plates of similar or differing densities, and develop drawn models to communicate our findings. (DOK 3)
15. Use the models developed to help explain what might cause the elevation changes and other changes at Mt. Everest. (DOK 3)
16. Consider how earthquakes could be a result of uneven plate movement. (DOK 3)
17. Answer questions from the DQB. (DOK 2)
18. Use map images to determine that most volcanoes occur along the boundary between oceanic and continental plates. (DOK 1)
19. Observe and describe what happens when a denser oceanic plate collides with a less dense continental plate. (DOK 2)
20. Revisit our mountain cards from Lesson 1, and read to figure out that volcanic eruptions can either add new earth material to existing landforms or destroy them. (DOK 1)
21. Update our Potential Causes for Mountain Movement Chart. (DOK 2)
22. Make claims about what could be occurring at the Mid-Atlantic Ridge. (DOK 3)
23. Collect evidence to determine if the claims are supported or refuted by evidence. (DOK 3)
24. Use our knowledge of the ridge, volcanoes, and the presence of magma to update our Potential Causes for Mountain Movement chart. (DOK 4)
25. Revisit our Potential Causes for Mountain Movement chart to take stock of what we have figured out. (DOK 2)
26. Revise this chart to capture the causal chain of events that need to occur for a mountain to move or grow. (DOK 4)
27. Revisit the DQB to see what questions we can answer and we make predictions about what we think the Andes mountains and the Mid-Atlantic Ridge will look like in the future and what it looked like in the past. (DOK 3)

Lesson Set 2 (Lessons 10-14): What can cause other changes to mountain elevation and location?
Lesson 10 - Where were Africa and South America in the past? Lesson 11 - Where were the other plates located in the distant past? Lesson 12 - Where did mountains that aren't at plate boundaries today, like the Applachains and Urals, come from? Core Activity: Students figure out where continents could have been and what mountains looked like in the past. 1. Use math to determine that Africa and South America could have been together 146 million years ago and reason out data from this time period will be found underground. (DOK 3) 2. Look for patterns in mapped data across the continents from this period. (DOK 2) 3. Complete an exit ticket to make a claim about the two plates touching. (DOK 1) 4. Use multiple types of data from models of all the land masses as evidence to develop a flat map model that predicts where the land masses used to be located relative to each other millions of years ago. (DOK 3) 5. Identify and discuss the strengths and weaknesses of the evidence supporting our model. (DOK 3) 6. Diagram our model and the data that supports it, and articulate our reasoning to explain the positions of the land masses millions of years ago that are predicted by the model. (DOK 3) 7. Use map images and data to compare the mountain sites we are studying. (DOK 2) 8. Remember that the Appalachians are decreasing in elevation, while the Urals are neither increasing nor decreasing. Colliding plates cause mountains to form and increase in elevation, but the Appalachians and the Urals are not located near plate boundaries. (DOK 1) 9. Use evidence from an online simulation to construct an explanation for how and when the Appalachians and the Urals were formed. (DOK 3)
Lesson 13 - What causes mountains to shrink in elevation? Lesson 14 - How is there an exposed marine fossil on Mt. Everest? And what other remaining questions from our Driving Question Board can we now answer? Core Activity: Students investigate erosion rates and figure out that the elevation of different parts of the Earth is affected by both erosion and uplift rates. When erosion rates are higher than uplift rates, mountains can shrink. Students apply what they have figured out about how Earth's surface changes to explain how a fossil can be found exposed at the top of Mt. Everest. 1. Recall what we already know about erosion and weathering, we read about erosion rates and how scientists use these rates to determine how erosion is changing the surface. (DOK 1) 2. Using both the erosion rates and uplift rates for Mt. Everest and Mt. Mitchell, develop a representation of each model and how these two processes are affecting them. (DOK 3) 3. Determine that when erosion rates are higher than uplift rates, like at Mt. Mitchell, a mountain will shrink in elevation. (DOK 2) 4. Revisit our Driving Question Board and determine what questions we have made progress on. (DOK 2) 5. Explain our related phenomena. (DOK 3) 6. Revisit our mountain cards to determine that we still need to explain the presence of marine fossils on mountains. (DOK 2) 7. Gather evidence to help support what is occurring for marine fossils to end up on mountains and take an assessment. (DOK 3) 8. Revisit our Driving Question Board and answer our unit question. (DOK 3)

Words that "Might be Encountered" throughout the Unit:

bedrock	destructive	magnitude
causation	earthquake	mantle
constructive	earthquake depth	oceanic
continental	epicenter	plate
correlation	erosion rate	sediment

Correctives:

1. Supplemental Teaching Topics -
    a. Students may need additional support in the ideas of how thermal energy is transferred between particles. Specifically, particles of a material at a higher temperature transfer energy faster than particles of a material at a lower temperature. This will aid students in visualizing what is happening to solid rock as it gets heated to very high temperatures under the surface of the Earth.
    b. Students may need additional support about density in relation to energy being absorbed by particles and then being transferred between particles. Students will need to understand what it means at a particle level when one section of material is denser or less dense than another section of material.
2. Word Wall and Word Wall Routines
3. Provide Targeted Practice
4. Differentiate Instruction.
5. Use Formative Assessments.
6. Hands-On Remediation Activities
7. CER Scaffolding
8. Relate to Real-World Applications.
9. Extend Time and Revisit Content
10. Offer Visual and Kinesthetic Learning Opportunities.

Extensions:

<u>Lesson 1:</u> Swap out one of the mountain cards and create one for your local location if there are mountains or interesting landforms that students could analyze to help figure out how Earth's surface changes. Instead of swapping out a mountain card, an extra could also be added for this purpose.

<u>Lesson 1:</u> Each of the mountains on the mountain cards come from different parts of the world and have numerous names dependent on the cultures that live in the area. For students who are interested, they could research more about the history of the different names of the mountains and the people who live there. Usually these names identify what the people have experienced from living near a mountain - such as the movement of the mountain, or shaking from earthquakes, etc.

<u>Lesson 13:</u> Data about erosion rates for your local area could be added to this lesson along with plate movement if the landforms in your area lend themselves to this analysis.

Assessments:

Diagnostic	Formative	Summative
● Initial Models ● Driving Question Baord ● Student Self-Assessment ● Peer Feedback	● Mt. Everest and Mt. Mitchell Prediction (Lesson 13) ● Student Notebooks ● Summary Tables ● Progress Tracker	● Future Plate Tectonics (Lesson 11) ● Mt. Everest and Mt. Mitchell Prediction (Lesson 13) ● Fossil Phenomena Explanation (Lesson 14)

Unit 5 Curriculum Map

Overview: This unit begins with students experiencing, through text and video, a devastating natural event that caused major flooding in coastal towns of Japan. This event was the 2011 Great Sendai or Tōhoku earthquake and subsequent tsunami that caused major loss of life and property in Japan. Through this anchoring phenomenon, students think about ways to detect tsunamis, warn people, and reduce damage from the wave. As students design solutions to solve this problem, they begin to wonder about the natural hazard itself: what causes it, where it happens, and how it causes damage.

The first part of the unit focuses on identifying where tsunamis occur, how they form, how they move across the ocean, and what happens as they approach shore. The second part of the unit transitions students to consider combinations of engineering design solutions and technologies to mitigate the effects of tsunamis. Finally, students apply their understanding to consider how to communicate about another natural hazard to stakeholders in a community.

Big Ideas:

- Natural processes can cause sudden or gradual changes to Earth's systems, some of which may adversely affect humans.
- Useful modern technologies and instruments have been designed based on an understanding of waves and their interactions with matter.

Textbook and Supplemental Resources: **OpenSciEd 6.5 Natural Hazards**, Science Fusion Textbook

Unit 5: Natural Hazards

Essential Questions:	● How do natural hazards affect individuals and societies? ● How are instruments that transmit and detect waves used to extend human senses? ● Where do natural hazards happen and how do we prepare for them?
Standards (by number)	

Science:	3.3.6-8.L Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects 3.3.6-8.M Apply scientific principles to design a method for monitoring and minimizing human impact on the environment 3.3.6-8.N Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's system
Technology and Engineering:	3.5.6-8.W (ETS) Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions 3.5.6-8.C Hypothesize what alternative outcomes (individual, cultural, and/or environmental) might have resulted had a different technological solution been selected. 3.5.6-8.H Evaluate trade-offs based on various perspectives as part of a decision process that recognizes the need for careful compromises among competing factors. 3.5.6-8.T Create solutions to problems by identifying and applying human factors in design.
Environmental Literacy and Sustainability:	3.4.6-8.C Develop a model to describe how watersheds and wetlands function as systems, including the roles and functions they serve 3.4.6-8.D Gather, read, and synthesize information from multiple sources to investigate how Pennsylvania environmental issues affect Pennsylvania's human and natural systems

Students will know…. (DCI)	Students will be able to… (SEP)	Students will apply…(CCC)
Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces can help forecast the locations and likelihoods of future events. Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	Analyzing and Interpreting Data: Analyze and interpret data to determine similarities and differences in findings. Information Technologies and Instrumentation (Engineering Practice) - Digitized signals (sent as wave pulses) are a more reliable way to encode and transmit information.	Patterns: Graphs, charts, and images can be used to identify patterns in data. Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region

		to region and over time. Structure and Function: Structures can be designed to serve particular functions.

Core Activities and Corresponding Instructional Methods

Be specific. List activities related to materials/resources, include links, article titles etc.

Core Activities / Corresponding Instructional Methods
Driving Question - Where do natural hazards happen ands how do we prepare for them?
Lesson Set 1 (Lessons 2-4) - What causes tsunamis and other natural hazards to form, and how can we predict which communities are at risk?
Lesson 1 - What happens to a community when a tsunami occurs? Core Activity: Students watch, read, and discuss the 2011 Japan tsunami and brainstorm ways to protect people and property. 1. Read about and watch the 2011 tsunami triggered by an earthquake off the eastern coast of Japan, causing devastating loss of life and structural damage. (DOK 1) 2. Develop initial engineering ideas intended to detect tsunamis, provide warning of their approach, and reduce their impact. (DOK 3) 3. Think about what makes some engineering ideas more promising or challenging than others. (DOK 2) 4. Brainstorm related natural hazards and ask questions to generate a list of data and information we need to better understand where these hazards occur and how we can prepare for them. (DOK 2)
Lesson 2 - Where do tsunamis happen and what causes them? Lesson 3 - What causes a tsunami to form and move? Lesson 4 - How can we forecast where and when tsunamis will happen and which communities are at risk? Core Activity: Students investigate where tsunamis happen, how they form, how they move, and who is at risk. 1. Investigate historical tsunami data and figure out spatial patterns for where tsunamis occur and that most are caused by earthquakes. (DOK 2) 2. Use digital tools, analyze maps and graphs, and notice that only certain types of earthquakes cause tsunamis. (DOK 3) 3. Establish a cause-and-effect relationship between types of earthquakes and tsunami formation. (DOK 3) 4. Use this relationship to forecast the locations that may be at risk for future tsunamis. (DOK 4) 5. Analyze three wave models to make sense of how an earthquake-driven tsunami forms and moves to shore. (DOK 3) 6. Use different perspectives to understand various aspects of the phenomena, and then we identify benefits and limitations of each model. (DOK 3) 7. Using the Tsunami Chain of Events poster as evidence from previous lessons, construct an explanation that describes the geologic changes that cause a tsunami. (DOK 3)

8. Use what we know about tsunamis--where they happen and what causes them--to consider how to protect people and property from their effects. (DOK 4)
9. Revisit the DQB to determine which questions we are now able to answer and document responses for each question. (DOK 2)

Problematize - Now that we know who is at risk, what can we do to mitigate the effects of tsunamis?

Lesson Set 2 (Lessons 5-10) - How can we design systems to detect, warn communities, and reduce damage from tsunamis and other natural hazards?

Lesson 5 - How can we reduce damage from a tsunami wave?
Lesson 6 - How are tsunamis detected and warning signals sent?
Lesson 7 - What are ways we can communicate with people before and during a tsunami?
Lesson 8 - Which emergency communication systems are the most reliable in a hazard?
Lesson 9 - How can we model the systems put in place to protect communities?

Core Activity: Students investigate structural, technological, and communication systems designed to protect communities.

1. Revisit the coastal communities of Japan that were affected by the 2011 tsunami to evaluate existing solutions. (DOK 3)
2. Define our problem, identify criteria and constraints, and evaluate each solution using a systematic process. (DOK 4)
3. Consider what it means for a solution to be promising for one community versus another. (DOK 3)
4. Read about how tsunamis are detected using a complex system of instruments set up on land (seismometers), on the ocean surface (surface buoys), on the ocean floor (tsunameters), and in space (satellites). (DOK 2)
5. Read that tsunami warnings are sent only when specific sets of criteria are met, first regarding the location, strength, and depth of the earthquake that is detected, and then regarding whether the tsunami is expected to reach land. (DOK 2)
6. Listen to a tsunami warning signal and read accounts of tsunami survivors from Japan. (DOK 1)
7. Identify stakeholders who the warning signal must work for, and then develop criteria and constraints for tsunami communication. (DOK 3)
8. Evaluate different communication options based on stakeholder needs. (DOK 4)
9. Learn that there are many ways to communicate with different stakeholders before and during a tsunami event. (DOK 2)
10. Consider the ways in which people are alerted during a hazard and what would make a warning system reliable. (DOK 3)
11. Read about analog and digital signals and discuss what forms of communication best meet the needs and are most reliable for multiple stakeholder groups. (DOK 2)
12. Develop a tsunami system model. (DOK 4)
13. Analyze the model to determine the importance and interactions of the various subsystems. (DOK 3)
14. Develop a process engineers use to solve problems and determine we can use our ideas to prepare for a hazard that is important to us. (DOK 4)

Lesson 10 - How can we effectively prepare our communities for a natural hazard?

Core Activity: Students apply science and engineering ideas in a culminating project on another hazard.

1. Investigate the general patterns of risk of other natural hazards in the United States and determine our local level of risk for each hazard. (DOK 3)
2. Choose a natural hazard, gather information, and plan for communication to an identified stakeholder community at risk for the hazard. (DOK 4)

3. Evaluate our final plans and products using constraints and criteria for effective communication with our stakeholder groups. (DOK 4)

Words that "Might be Encountered" throughout the Unit:

amplitude	systems	sonar
primary criteria	subsystem	reliability
secondary criteria	seismometer	transmitter
stakeholders	satellite	analog
trade offs	tsunameter	digital

Correctives:

1. Supplemental Teaching
    a. support will need to be included for helping students identify a design problem and defining criteria and constraints. The current unit assumes students have already done some initial work in this area during the *Cup Design Unit*.
    b. additional support may be needed in Lesson 3 in developing ideas about energy and energy transfer as the tsunami forms, moves, and interacts with the shore and/or structural design solutions.
2. Word Wall and Word Wall Routines
3. Provide Targeted Practice
4. Differentiate Instruction.
5. Use Formative Assessments.
6. Hands-On Remediation Activities
7. CER Scaffolding
8. Relate to Real-World Applications.
9. Extend Time and Revisit Content
10. Offer Visual and Kinesthetic Learning Opportunities.

Extensions:

Lesson 5: Have students jigsaw the different design solutions and research more about them and how they are used in Japan.
Lesson 8: If students have done substantial work with middle school wave properties (PS4.A), then this lesson is an opportunity to apply more sophisticated ideas about waves to better understand 'wave pulses' in PS4.C.
Lesson 10: Have students present their projects to community members for feedback and revision prior to releasing the final product to the community.
All lessons: Remove scaffolds provided with Science and Engineering Practices as a way to give students more independent work with the elements of these practices.

Assessments:

Diagnostic	Formative	Summative
● Initial Design Solutions ● Driving Question Board ● Student Self-Assessment ● Peer Feedback	● Explaining and Forecasting Tsunami Risk (Lesson 4) ● Lesson Performance Expectations ● Summary Tables	● Assessing Hazards and Risk (Lesson 10) ● Determining Stakeholder Needs (Lesson 10) ● Hazard Communication and Planning (Lesson 10) ● Stakeholder Criteria and Constraints Peer Feedback Form (Lesson 10)

Unit 6 Curriculum Map

Overview: This unit on Earth's resources and human impact begins with students observing news stories and headlines of drought and flood events across the United States. Students figure out that these drought and flood events are not normal and that both kinds of events seem to be related to rising temperatures. This prompts them to develop an initial model to explain how rising temperatures could cause both droughts and floods and leads students to wonder what could cause rising temperatures, too. This initial work sets students up to ask questions related to the query: How do changes in Earth's system impact our communities and what can we do about it?

Students spend the first lesson gathering evidence for how a change in temperature affects evaporation, precipitation, and other parts of Earth's water system. They use evidence to support a scientific explanation that two climate variables (temperature and precipitation) are changing precipitation patterns in the case sites they investigated. Students figure out that the rising temperatures are caused by an imbalance in Earth's carbon system, resulting in a variety of problems in different communities. The unit ends with students evaluating different kinds of solutions to these problems and how they are implemented in communities. Students work through a systematic evaluation process to consider (1) each solution's potential to solve the carbon imbalance, (2) tradeoffs associated with solutions based on student-identified constraints, and (3) whether the solution in question makes sense for their community's stakeholders.

Big Ideas:

- All materials, energy, and fuels that humans use are derived from natural sources, some of which are renewable over time and others are not.
- Human activities in agriculture, industry, and everyday life has an impact on the land, rivers, ocean, and air.
- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things.

Textbook and Supplemental Resources: [OpenSciEd 7.6: Earth's Resources & Human Impact], Science Fusion Textbook

Unit 6: Earth's Resources and Human Impact

Essential Questions:	• How do Earth's surface processes and human activities affect each other? • How do humans depend on Earth's resources? • How do humans change the planet? • What regulates weather and climate? • How do changes in the Earth's system impact our communities and what can we do about it?
Standards (by number)	
Science:	3.3.6-8.K 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. 3.3.6-8.M Apply scientific principles to design a method for monitoring and minimizing human impact on the environment. 3.3.6-8.N Construct an argument supported by evidence for how increases in human population and per capita consumption of natural resources impact Earth's Systems. 3.3.6-8.O Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.
Technology and Engineering:	3.5.6-8.D Analyze how the creation and use of technologies consume renewable, non-renewable, and inexhaustible resources; create waste; and may contribute to environmental challenges.
Environmental Literacy and Sustainability:	3.4.6-8.D Gather, read, and synthesize information from multiple sources to investigate how Pennsylvania environmental issues affect Pennsylvania's human and natural systems 3.4.6-8.G Obtain and communicate information to describe how best resource management practices and environmental laws are designed to achieve environmental sustainability. 3.4.6-8.H Design a solution to an environmental issue in which individuals and societies can engage as stewards of the environment. 3.4.6-8.I Construct an explanation that describes regional environmental conditions and their implications on environmental justice and social equity.

Students will know…. (DCI)	Students will be able to… (SEP)	Students will apply…(CCC)
Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or	Constructing Explanations and Designing Solutions: Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own	Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural or designed systems. Connections to Engineering,

replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes. Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. Typically as human populations and per capita consumption of natural resources increase, so do the negative impacts on Earth, unless the activities and technologies involved are engineered otherwise. Human activities, such as the release of greenhouse gasses from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities.	experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Constructing Explanations and Designing Solutions: Apply scientific principles to design an object, tool, process or system. Engaging in Argument from Evidence: Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. Asking Questions and Defining Problems: Ask questions to identify and clarify evidence of an argument.	Technology, and Applications of Science: All human activity draws on natural resources and has both short and long term consequences, positive as well as negative, for the health of people and the natural environment. Cause and Effect: Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. Connections to Engineering, Technology, and Applications of Science: The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. Connections to Nature of Science: Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. Stability and Change: Stability might be disturbed either by sudden events or gradual changes that accumulate over time.

Core Activities / Corresponding Instructional Methods
Driving Question - How do changes in Earth's system impact our communities and what can we do about it?
Lesson Set 1 (Lessons1-6) - What is causing changes to water resources in these communities?

Lesson 1 - Why are floods and droughts happening more often?

Core Activity: Students watch two stories about communities experiencing droughts and floods, analyze headlines, and notice there is a pattern that many communities are experiencing water changes.

1. Observe two news clips of extreme flood and drought events and share our own water stories. (DOK 2)
2. Examine headlines that show a "new normal" of increased floods and droughts and notice a pattern of rising temperatures. (DOK 3)
3. Develop an initial model explaining what could be causing warmer temperatures and how warmer temperatures could lead to both droughts and floods. (DOK 3)
4. Develop a Driving Question Board (DQB) and brainstorm investigations and sources of data that could help us figure out answers to our questions. (DOK 4)

Lesson 2 - What would we normally expect for these places and how do we know its really changing?
Lesson 3 - How would increased temperatures affect evaporation?
Lesson 4 - Are rising temperatures affecting anything else in Earth's water system?

Core Activity: Students analyze multiple data sets to collect evidence to explain how and why water is changing in communities.

1. Develop a systems model to describe Earth's water system. (DOK 3)
2. Analyze data to determine what is normal and not normal about temperature and precipitation as it relates to floods and droughts. We do this with our community and six case sites in the United States. (DOK 4)
3. Create bottle setups to test how increased temperatures affect evaporation rates. (DOK 3)
4. View visualizations of water vapor movement across the US and ocean temperatures in an open system. (DOK 2)
5. Obtain additional scientific and technical information about other components of Earth's water system and how those components are changing as temperatures increase. (DOK 3)
6. Conclude that all components and processes in the system have been affected by a temperature rise. (DOK 3)
7. Update our model and add an entry to our Progress Tracker. (DOK 4)

Lesson 5 - How are rising temperatures changing water stories in these communities?
Lesson 6 - How are rising temperatures connected to two seemingly different phenomena?

Core Activity: Students use this evidence to explain one of the case sites, and then apply these ideas to changes occurring in a new case in Alaska.

1. Use our key model ideas from previous lessons to construct explanations, using evidence, about how changes in temperature are having impacts on the water stories in our case site communities. (DOK 3)
2. Peer review our explanations and revise them using the feedback from our peers. (DOK 3)
3. Revisit our Alaskan headlines about wildfires and also learn about another community in Alaska that is experiencing multi-year sea ice loss. (DOK 2)
4. Apply our key model ideas in a transfer task to explain how an increase in temperatures is causing both phenomena to occur. (DOK 4)

Problematize: Students wonder why all communities are having increasing air temperatures.

Lesson Set 2 (Lessons 7-12) - What is causing rising temperatures in all communities?

Lesson 7 - Are there any changes in the air that could be related to rising temperatures?
Lesson 8 - Are changes in carbon dioxide and methane related to or causing temperatures to increase?

Core Activity: Students investigate the composition of the atmosphere, how the composition is changing, and how the changes to greenhouse gasses affect air temperatures. 1. Wonder if changes in the air are related to the rise in temperatures. By looking at data, we build our understanding of the meaning of parts per million and figure out how to find the percent change in the quantity of these gases over time. (DOK 1) 2. Notice that, while some gases have not changed at all, some have changed very little, and other gases show an unusual increase over the 100-year period. (DOK 2) 3. Use molecular models to investigate the way molecules move in response to energy transfer. (DOK 2) 4. Investigate this idea further using an interactive showing how molecules move when energy is absorbed. (DOK 2) 5. Using these ideas and the ideas from a reading, we figure out that because greenhouse gases absorb, vibrate, and release energy, they keep our atmosphere warm. (DOK 3) 6. Apply these ideas to what we learned about GHGs increasing in our atmosphere to figure out that increasing GHGs are why temperatures are currently increasing. (DOK 3)
Lesson 9 - Are the changes in the amount of CO_2 in the atmosphere part of the normal cycles that the Earth goes through? Lesson 10 - What is happening in the world to cause the sharp rise in CO_2? Core Activity: Students investigate normal patterns of CO_2 change over time, but establish that recent rises in CO2 are related to the combustion of fossil fuels emitting extra carbon into the atmosphere. 1. Carry out an investigation to determine if gas can be trapped in ice. (DOK 3) 2. Find out more about how scientists use ice core samples from locations on Earth that have very old ice to determine the amounts of carbon dioxide in the air over time. (DOK 2) 3. Focus on carbon dioxide because we know that recently it has been rising the most. (DOK 1) 4. Examine the last 200 years of Earth's history to understand what led to a rapid increase in CO_2 emissions. (DOK 2) 5. Watch a visualization and read about key innovations in human history that transformed the types of energy used to power our communities. (DOK 2)
Lesson 11 - Why would burning fossil fuels create a problem for CO_2 in the atmosphere? Lesson 12 - How are changes to Earth's carbon system impacting Earth's water system? Core Activity: Students use a carbon system model to explain why there is a carbon system imbalance. They develop a cause-and-effect diagram to explain the changes in air temperatures rising, and apply these ideas to revise tweets. 1. Modify an Earth's Carbon System model to represent the locations of carbon and processes that move carbon around. (DOK 3) 2. Simulate these processes using a kinesthetic activity. (DOK 2) 3. Figure out that photosynthesis cannot take up CO_2 at the same rate that burning fuels puts CO_2 in the atmosphere and that this is creating a buildup of CO_2 in the atmosphere. (DOK 3) 4. Model the causal relationship between fossil fuel use and changing water resources. (DOK 3) 5. Review a tweet regarding climate change and its impacts, break the tweet down into claims, and clarify the information as a class. (DOK 2) 6. Take an assessment identifying claims made in another tweet and refute any inaccurate claims by providing an explanation of the causal relationships between human activities and climate change. (DOK 4) Problematize: Now that students have the causal mechanism behind the problem, that are ready to investigate solutions to correct the carbon imbalance.

Lesson Set 3: How can communities use a mix of solutions to correct the carbon imbalance in the atmosphere and adapt to changes they are experiencing now?

Lesson 13 - Why is solving the climate change problem so challenging?

Core Activity: Students clearly define the problem for how much CO_2 must be reduced to correct the problem.

1. Determine that the problem of increasing temperatures is due to the CO_2 imbalance in the atmosphere caused by human combustion. (DOK 3)
2. Use a simulation to determine what cuts are needed to emissions rates to reach equilibrium. (DOK 3)

Lesson 14 - What things can people do to reduce carbon dioxide going into the atmosphere?
Lesson 15 - How can large-scale solutions work to reduce carbon in the atmosphere?

Core Activity: Students evaluate individual and community solutions and develop criteria and constraints for larger-scale solutions designed to solve the carbon imbalance problem.

1. Calculate our daily carbon footprint and create a class Carbon Scoreboard. (DOK 2)
2. Calculate the average carbon footprint for someone in our class and compare it to the average American's footprint. (DOK 2)
3. Revisit our footprint and choose carbon reduction activities and behaviors we are willing to make that would reduce our carbon emissions and would benefit our family in other ways. (DOK 3)
4. Compound the effects of these changes if everyone in our classroom, school, and community are willing to make changes. (DOK 3)
5. Use a Design Matrix to organize the different solutions for reducing CO_2 in the atmosphere that we evaluated last class. (DOK 2)
6. Determine our constraints for the solutions in trying to meet the criteria of reducing the imbalance of carbon in the air. (DOK 3)
7. Reevaluate each solution using our constraints and decide that multiple solutions would need to be implemented to meet our criteria. (DOK 4)

Lesson 16 - How are these solutions working in our communities?
Lesson 17 - What solutions work best for our school and community?

Core Activity: Students evaluate community resilience plans and then develop their own, which include a mix of solutions to solve the carbon imbalance and adapt to current and future changes in the community.

1. Obtain information from community plans to determine how the solutions are being used in the communities and how they rebalance carbon and/or help the community to become more resilient to changes already occurring in the community. (DOK 2)
2. Use these plans as examples to help motivate the need to evaluate and/or develop a plan for their own community. (DOK 3)
3. Create a checklist for what a resilience plan for our school and local community should include. (DOK 2)
4. Work in groups to design resilience plans that contribute to the long-term rebalancing of carbon and also prepare the community for change. (DOK 4)
5. Provide feedback to other groups and evaluate the plans by asking questions. (DOK 3)
6. Brainstorm how to communicate our plans to other audiences. (DOK 3)
7. Argue for the one best for our community. (DOK 4)

Lesson 18 - What can we explain now, and what questions do we still have?

Core Activity: Students close out their DQB, reflect on their learning across 6th grade, and develop new DQB for questions they want to explore in future science classes.

1. Identify the questions from our DQB that we can now answer. (DOK 2)
2. Celebrate all that we have learned in this unit and across the school year. (DOK 1)
3. Identifying the questions that we did not answer and building a new DQB of these questions. (DOK 3)
4. Create a plan to answer some of them on our own and in school next year and beyond. (DOK 4)

Words that "Might be Encountered" throughout the Unit:

aquifer	flash floods	resilience
average annual temperature	flood	sea ice
carbon footprint	fossil fuel	sea level
carbon solutions	greenhouse effect	short-term viability
carbon solutions	greenhouse gases	snow water equivalent
climate change	groundwater	snowpack
combustion	ice core	storm events
community plans	long-term trend	streamflow
community resilience	Palmer Drought Severity Index (PDSI)	tides
drought	parts per million (could be a "word we earn")	vary
drought, flood	per-capita consumption	water adaptation solutions

Correctives:

1. Supplemental Teaching
    a. Students' understanding of Earth's carbon system is heavily dependent upon students learning of conservation of matter through reactions (the *Bath Bombs Unit*), cellular respiration in living organisms (the *Inside Our Bodies Unit*), and photosynthesis and matter cycling in ecosystems (the *Maple Syrup Unit*). This unit is being taught prior to these units which will further illustrate the conversions of carbon, which will be provided in seventh and eighth grade, students may require instruction on the element carbon and matter conservation. This is essential for students to understand prior to Lesson 10 when students will make sense of combustion of fossil fuels and Lesson 11 where they make sense of how combustion results in a carbon imbalance in the whole system. If teaching this unit out of order, Lesson 10 and 11 may need to be modified to better support students in articulating what is happening to carbon during the different carbon transforming processes. For example, students may need more support tracing atoms and conserving the atoms through reactions.
    b. This unit is highly dependent on 6th-grade math concepts, such as rate, percent, and proportion. If this unit is taught in 6th grade, it is suggested to work very closely with a 6th-grade math teacher to understand when students will learn the mathematical concepts and process (listed below) so that this unit can reinforce those concepts in a real-world problem context but not come before students have developed these ideas in their math classes (or working in conjunction with math and science simultaneously).

2. Word Wall and Word Wall Routines
3. Provide Targeted Practice
4. Differentiate Instruction.
5. Use Formative Assessments.
6. Hands-On Remediation Activities
7. CER Scaffolding
8. Relate to Real-World Applications.
9. Extend Time and Revisit Content
10. Offer Visual and Kinesthetic Learning Opportunities.

Extensions:

Lesson 7: Have students read about common ideas related to the warming atmosphere using *Exploring Possible Causes of Warming*.
Lesson 8: Use the full PhET simulation for students to more fully explore ideas; however, please note that this simulation uses high school level ideas and should only be offered to students who have fully mastered the middle school ideas.
Lesson 9: Have students explore the long-term (800,000 years) CO_2 data using the Tuva platform.
Lesson 10: Have students explore the more recent CO_2 data using the Tuva platform.
Lesson 10: Include the uneven distribution of fossil fuel extension in *Extension Opportunity: Uneven Distribution of Fossil Fuel Resources*, *Fossil Fuel Formation Illustrations*, and *Fossil Fuels Long Ago and Today*.
Lesson 15: Create and include any locally utilized or considered carbon solutions to the *Solutions Cards*. These can sometimes be found in local community plans.
Lesson 17: Create and include any locally utilized or considered local water or heat solutions to the *Water Adaptation Solutions*.
Lesson 17: This project can be extended as time is available for students to fully develop and communicate their plan to community members.

Assessments:

Diagnostic	Formative	Summative
• Initial Models in Science Notebooks • Driving Question Board • Self-Assessment • Peer-Feedback	• Revised Water Story Explanation (Lesson 5) • Case Site Explanations (Lesson 5) • Lesson Performance Expectations • Summary Tables	• Alaska Wildlife and Sea Ice Transfer Task (Lesson 6) • Social Media Post Assessment (Lesson 12) • Community Resilience Plan, All Parts (Lesson 17)