## Scope and Sequence: The Sun's Effect on Climate and Seasons

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| **Unit Learning Goal:** Earth's curved surface and consistent tilt and its orbit around the Sun result in uneven heating across the planet. This difference in the sunlight's intensity causes different locations on Earth to experience different seasons at the same time of year, as well as varying average yearly temperatures. | | | |
| **Unit Central Question:** Why are some places on Earth hotter than others at different times of the year? | | | |
| **Anchoring Phenomenon:** Earth's Northern and Southern Hemispheres experience repeating, predictable seasonal changes in average temperatures. | | | |
| **Lesson** | **Lesson Focus Question** | **Main Learning Goal** | **Science Content Storyline** |
| 1 | What patterns in temperature can you find on Earth at different times of the year? | Temperatures on Earth's surface vary according to latitude (how far north or south a location is from the equator) and time of year.<br>**Science and Engineering Practices**<br>Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.<br>**Crosscutting Concepts**<br>Patterns: Graphs and charts can be used to identify patterns in data. | The Sun's light energy—solar radiation—heats the surface of Earth. In general, temperatures on Earth vary according to latitude and time of year. Related to latitude, average temperatures on Earth generally increase as the latitude decreases (from the poles toward the equator) and generally decrease as the latitude increases (from the equator toward the poles). Related to time of year, average temperatures are higher in the Northern Hemisphere from about June through September and higher in the Southern Hemisphere from about December through March. There are patterns of temperatures on Earth related to latitude and time of year. As you get closer to the equator, temperatures are typically higher and it feels warmer. As you get closer to the poles, temperatures are typically lower and it feels cooler. When temperatures are higher in the Northern Hemisphere, they are lower in the Southern Hemisphere and vice versa. The surface of Earth is heated unevenly; therefore, temperatures vary by latitude and time of year. |
| 2 | What causes the average temperatures on Earth near the equator to be higher than the average temperatures on Earth far from the equator? | Because Earth is a sphere, the Sun's light hits Earth's curved surface more directly close to the equator and less directly closer to the poles. The difference in the angle of sunlight striking Earth's surface at different latitudes causes uneven heating. | Temperatures on Earth are generally higher (warmer) closer to the equator and lower (cooler) toward the poles. The patterns seen on Earth related to varying temperatures are caused by uneven heating of Earth's surface. Earth's surface heats unevenly because the Sun's light (solar radiation and energy) hits different parts of the planet either more directly or less directly. When light hits a surface straight on (or perpendicular to it), the energy is more concentrated over a smaller area. When light hits a surface less directly (at a low angle), the energy is more spread out. The Sun's light shines most directly |

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| | | **Science and Engineering Practices**<br>Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.<br>Developing and Using Models: Evaluate limitations of a model for a proposed object or tool.<br>**Crosscutting Concepts**<br>Patterns: Graphs, charts, and images can be used to identify patterns in data.<br>Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems. | near the equator, so it provides more heat per unit area (square on the graph paper). When the Sun's light hits at a less-direct angle toward the poles, it is more spread out and does not provide as much heat per unit area. Because Earth is a sphere, sunlight hits the curved surface more directly closer to the equator and less directly as you move closer to the poles. Solar radiation is most direct at or close to the equator and thus produces higher average temperatures. As one moves farther from the equator and closer to the poles, the sunlight is less direct. Because of the less-direct angles of sunlight the farther you are from the equator, solar radiation is less intense and therefore the average temperatures are lower. The angle of the Sun's light affects the heating of Earth's surface. When the angle of sunlight is direct, the sunlight is more intense and Earth's surface will get warmer. When sunlight strikes Earth's surface less directly—when we move from the equator to the poles (increasing latitude)—then the Sun's light is less concentrated and the surface does not warm as much. Temperatures vary in the Northern and Southern Hemispheres at different times of the year. |
| 3 | Why is it summer in the United States (North America) when it is winter in Brazil (South America)? | Earth's consistent tilt toward the North Star produces opposite seasons in the Northern and Southern Hemispheres.<br>**Science and Engineering Practices**<br>Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.<br>Developing and Using Models: Evaluate limitations of a model for a proposed object or tool.<br>**Crosscutting Concepts**<br>Patterns: Graphs, charts, and images can be used to identify patterns in data.<br>Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems. | The Sun's light strikes Earth's curved surface at different angles in different locations, which causes areas with higher average temperatures (warmer areas) near the equator and areas with lower average temperature (cooler areas) as one moves toward the polar regions. Earth spins on its axis, which passes through the North and South Poles, as it orbits the Sun in a nearly circular path once a year. Earth is tilted on its axis at 23½ degrees from a line perpendicular to its orbital path. As Earth orbits the Sun, its axis always tilts in the same direction—toward the North Star. Earth's consistent tilt as it orbits the Sun causes the Northern Hemisphere to lean *toward* the Sun at certain times of year and *away* from the Sun at other times of the year. When the Northern Hemisphere is tilted toward the Sun, the Southern Hemisphere is tilted away from the Sun. Earth's Northern Hemisphere experiences summer when it leans toward the Sun while the Southern Hemisphere experiences winter. Conversely, Earth's Southern Hemisphere experiences summer when it leans toward the Sun while the Northern Hemisphere experiences winter. (Note that the seasonal variations that we call *summer* and *winter* do not occur at latitudes close to the equator.) When Earth's |

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| | | | hemispheres lean neither toward nor away from the Sun along Earth's orbit, we experience spring and fall. As Earth orbits the Sun, the axis always tilts in the same direction, which results in different parts of Earth getting different amounts of sunlight at different times of the year. Consequently, Earth's consistent tilt produces opposite seasons in the Northern and Southern Hemispheres. |
| 4 | What causes winter in the United States to occur in December–February and summer to occur in the United States in June–August? What is happening in Brazil, and why? | Because of Earth's tilt, the angle at which sunlight strikes Earth at different times of year causes the Northern and Southern Hemispheres to experience more and less intense sunlight and thus opposite periods of higher and lower average temperatures (seasons).<br><br>**Science and Engineering Practices**<br>Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.<br>Developing and Using Models: Evaluate limitations of a model for a proposed object or tool.<br>**Crosscutting Concepts**<br>Patterns: Graphs, charts, and images can be used to identify patterns in data.<br>Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems | Earth's curved surface causes differential heating from the Sun's light. Additionally, Earth's consistent tilt toward the North Star throughout its orbit causes the Northern and Southern Hemispheres to point toward or away from the Sun at different times of year, thus experiencing winter and summer in opposite times of year. Earth is tilted on its axis at an angle of 23.5 degrees. This tilt causes Earth's surface to experience variations in temperature partly due to the changing angle at which the Sun's light strikes Earth's surface in relation to latitude. Because of Earth's tilt, the change in the angle of the Sun's light striking Earth means that an entire hemisphere receives more-direct sunlight at certain times of the year, specifically during the summer months. When the North Pole tilts toward the Sun, the Sun's energy is more concentrated in the Northern Hemisphere causing temperatures to be higher, thus it is summer. During this same time, the Southern Hemisphere is tilted away from the Sun, so the Sun's energy is less concentrated, and they experience winter. Earth's consistent tilt causes the Sun to not be directly overhead at the equator all year long. When the Northern Hemisphere points toward the Sun, the sunlight is more concentrated and temperatures increase (become warmer); conversely, when the Northern Hemisphere points away from the Sun, the sunlight is more spread out and temperatures decrease (become cooler). The same happens in the Southern Hemisphere when the South Pole points either toward or away from the Sun. Thus, the angle of sunlight related to Earth's tilt is one critical factor in determining temperatures around the globe. Because the Earth's tilt remains consistent as it orbits, the angle at which sunlight strikes Earth at different times of year causes the Northern and Southern Hemispheres to experience more and less intense sunlight and thus opposite periods of higher average (warmer) and lower average (cooler) temperatures (seasons). In June–August, the Northern |

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| | | | Hemisphere is tilted toward the Sun, thus it is summer there but winter in the Southern Hemisphere. In December–February, it is the opposite because the Southern Hemisphere is tilted toward the Sun. |
| 5 | Why is there more daylight in the summer days than in the winter days? How does the amount of daylight affect temperature of the area? | Earth's tilted axis results in differing amounts of daylight over the course of the year. The differences in how long the Sun shines affects how much the area gets heated up by the Sun, and, thus, its temperature.<br>**Science and Engineering Practices**<br>Analyzing and Interpreting Data: Analyze and interpret data to provide evidence for phenomena.<br>Developing and Using Models: Evaluate limitations of a model for a proposed object or tool.<br>**Crosscutting Concepts**<br>Patterns: Graphs and charts can be used to identify patterns in data.<br>Cause and Effect: Use cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems | The Sun's light striking Earth's curved surface at different angles causes differential heating and temperatures. As Earth orbits, half the planet is always in sunlight and half is always in darkness. During the Northern Hemisphere's summertime, the North Pole points toward the Sun, resulting in the Northern Hemisphere getting more hours of daylight compared to the Southern Hemisphere, which gets more hours of darkness. In the height of summer in the Northern Hemisphere, the North Pole has 24 hours of sunlight and no darkness at all. As Earth orbits the Sun, the North Pole points away from the Sun in the winter, resulting in the North Pole being entirely in darkness in the wintertime with no daylight hours at all. Other areas in the Northern Hemisphere have longer periods of darkness compared to daylight hours. Longer periods of daylight allow for greater warming from the Sun. Longer periods of darkness create cooler temperatures. Earth's tilt results in two different things happening on Earth. Each factor impacts how hot it gets at different times of year in different places on the planet. The tilt causes the angle that the Sun's light hits Earth to be different at different times of year, and that impacts how intense the sunlight is. The tilt also causes the Sun to shine for longer or shorter periods during a day. If the Sun shines longer, it has more time to heat up that area of the planet. Temperatures are affected by the number of hours of sunlight in a location, as well as how direct the sunlight is in that area. |
| 6 | Why are some places on Earth hotter than others at different times of the year? How can we use what we have learned to answer our Unit Central Question? | Because of the curvature of Earth and Earth's tilt, the sunlight that strikes Earth's surface changes at different times of the year, causing uneven heating. Latitude, the distance above or below the equator, is the main factor influencing climate. Earth's tilt is consistent throughout its orbit, causing the Northern Hemisphere to tilt toward the Sun in June–August, summer. The Southern Hemisphere tilts toward the Sun during December– | Some places on Earth are hotter than others at different times of the year because of variations that result from the tilt of Earth on its axis, the angle of the Sun's light (solar radiation) striking Earth's surface, and Earth's orbit around the Sun. The angle of the Sun's light, and thus the intensity of the solar radiation, depends on how far north or south of the equator a place is, its latitude. The angle and intensity of the Sun's light also varies by time of year. For example, when a hemisphere is tilted away from the Sun during its winter, the Sun's rays strike at a less direct angle which spreads the sunlight over a larger area and results in less heating and cooler temperatures. When |

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| | | February, causing it to be summer opposite of the Northern Hemisphere. Winter in each hemisphere occurs oppositely for the same reason.<br><br>**Science and Engineering Practices**<br><br>Constructing Explanations and Designing Solutions: Construct an explanation using models or representations. Apply scientific ideas, principles, and/or evidence to construct, revise, and/or use an explanation for real-world phenomena, examples, or events.<br><br>Engaging in Argument from Evidence: Respectfully provide and receive critiques about one's explanation, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.<br><br>**Crosscutting Concepts**<br><br>Patterns: Graphs and charts can be used to identify patterns in data.<br><br>Cause and Effect: Cause and effect relationships may be used to predict phenomena in natural ~~or designed~~ systems. | a hemisphere is tilted toward the Sun during its summer, the solar radiation strikes Earth more directly, resulting in more concentrated energy and thus more heating of Earth's surface and higher temperatures. Because Earth's tilt is consistent throughout its orbit, summer in the Northern Hemisphere occurs in June–August and winter in December–February. The Southern Hemisphere is opposite, experiencing summer during December–February and winter in June–August. Earth is heated unevenly, causing some places to be hotter than others due to many measurable factors, including consistent tilt, orbit, and angle of the Sun's energy striking the surface of Earth. |

| NGSS STANDARDS | TENNESSEE STANDARDS |
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| **Performance Expectations** | **Standard and Explanation** |
| **5-ESS1-2**<br>Represent data in graphical displays to reveal patterns of daily changes in ~~length and direction of shadows,~~ day and night, ~~and the seasonal appearance of some stars in the night sky.~~<br><br>**Disciplinary Core Ideas**<br><br>**ESS1.B** The orbits of Earth around the sun ~~and of the moon around Earth~~, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; ~~daily changes in the length and direction of shadows;~~ and different positions of the sun, ~~moon, and stars~~ at different times of the day, month, and year. | **Standard: 5.ESS1-5**<br>Relate the tilt of the Earth's axis, as it revolves around the sun, to the varying intensities of sunlight at different latitudes. Evaluate how this causes changes in day-lengths and seasons.<br><br>**Explanation**<br>In 4.ESS1.2, students were first introduced to the phenomenon of day and night as patterns that they experience daily, having origins in the motion of the earth. The cause of the seasons is rooted in the tilt of the earth's axis combined with the effects of variations in the sun's intensity based on the angle that the sun's rays strike the earth. Due to the tilt of the Earth's axis, the duration of daylight hours and intensity of sunlight changes over the course of the year. Rotating a sphere about a tilted axis in front of a fixed light source can begin to demonstrate the effect of the tilt on daylight hours. If this demonstration is carried out at four different positions (90-degree progressions through a circle relative to the first position), it is possible to track and record the differences in the amount of time that a position on the earth receives sunlight based on the location of the sphere relative to the light source. This same activity can be carried out as an investigation where students record the percentage of the ball that would be illuminated at varying positions throughout a "year" on the model. |

| Science and Engineering Practices | Science and Engineering Principle |
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| **Analyzing and Interpreting Data**<br>• Represent data in graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.<br><br>**Developing and Using Models**<br>• Develop and use a model to describe phenomena. | **Planning and Carrying Out Controlled Investigations**<br>• Students carry out investigations in groups, where conditions and variables are controlled, utilize appropriate instruments, and ~~deliberately plan multiple trials.~~<br><br>**Analyzing and Interpreting Data**<br>• Students organize data (observations and measurements) in a way that facilitates further analysis and comparison.<br><br>**Developing and Using Models**<br>• Student models begin to become abstract and metaphorical, incorporating relationships between events and predictive aspects for recurring events.<br>• Students can identify specific limitations of their models. |
| **Crosscutting Concepts** | **Crosscutting Concepts** |
| **Patterns**<br>• Similarities and differences in patterns can be used to sort, classify, communicate, and analyze simple rates of change for natural phenomena.<br>• Patterns can be used to identify cause and effect relationships.<br>• Patterns can be used to make predictions.<br>• Patterns can be used as evidence to support explanations.<br><br>**Cause and Effect**<br>• Cause and effect relationships are routinely identified, testes, and used to explain change. | **Systems and System Models**<br>• Students group and describe interactions of the components that define a larger system. |

# "The Sun's Effect of Climate and Seasons" Kit Materials and Handouts

## Materials

| Item | Lesson | | | | | | Notes | Descriptor |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | | |
| Communicating in Scientific Ways poster | X | X | X | X | X | X | color poster | 1 per classroom; provided to teacher |
| Inflatable globe | X | X | X | X | | | 12-inch inflatable globe | 1 per pair of students |
| Globe on stand (if available – if, not use inflatable) | | | X | X | | | | 1 per teacher |
| Plastic tray | | X | | | | | 10" × 14" plastic tray or cardboard sheet | 1 per pair of students |
| Graph paper | | X | | | | | 8.5" × 11" sheets of small-scale graph paper | 2 per pair of students |
| Flashlight | | X | | | | | flashlight with a concentrated beam | 1 per pair of students |
| Ruler | | X | | | | | 12-inch ruler | 1 per pair of students |
| 1 light setup<br>Note: Any extension cord or power strip will work. The light needs to be connected to a power source and have the bulb vertically stand up. | | | X | X | X | | lightbulb (40W),<br>socket w/plug,<br>extension cord | 1 set for each group of 4-5 students |
| Hula hoop | | | X | X | X | | 36-inch hula hoops | 1 for each group of 4-5 students |
| Styrofoam ball | | | X | X | X | | 4-inch Styrofoam balls | 1 for each group of 4-5 students |
| Rubber band | | | X | X | X | | color rubber band | 1 for each Styrofoam ball |
| 2 pushpins | | | X | X | X | | Red pushpin for United States and blue push pin for Argentina | 1 set for each group of 4-5 students<br>Only one pushpin is used in Lesson 5. |

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| A stand for Earth's axis | | | **X** | **X** | **X** | | 4x5 inch square pieces of wood drilled to fit a dowel at 23½ degrees exactly | 1 for each group of 4-5 students |

### Student Handouts

| Item | Lesson | | | | | | Notes | Descriptor |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | |
| HO1.1 *Map of United States with Average Temperatures, Dec–Feb* | X | | | | | | 1 per student | 1 page, color |
| HO1.2 *Map of United States with Average Temperatures, Jun–Aug* | X | | | | | | 1 per student | 1 page, color |
| HO1.3 *Average Temperatures around the World, January and July* | X | | | | | | data table<br>1 per pair of students | 1 page, black and white |
| HO1.4 *World Map Record Page* | X | | | | | | 2 per pair of students: one for January and one for July | 1 page, black and white |
| HO1.5 *Bar Graph of January Temperatures* | X | | | | | | 1 per student | 1 page, black and white |
| HO1.6 *Bar Graph of July Temperatures* | X | | | | | | 1 per student | 1 page, black and white |
| HO2.1 *Energy Angles* | | X | | | | | 1 per student | 4 pages, single sided, stapled, black and white |
| HO2.4 *Sun's Incoming Energy* | | X | | | | | 1 per pair of students | 1 page, black and white |
| HO3.1 *Earth's Orbit around the Sun* | | | X | | | | 1 per student | 1 page, black and white |
| HO4.3 *Angle of Sunlight and Seasons on Earth* | | | | X | | | 1 per student | 3 pages, single sided, stapled, black and white |
| HO4.4 *Sun's Incoming Energy with Tilt--Position 1* | | | | X | | | 1 per student | 1 page, black and white |
| HO4.5 *Sun's Incoming Energy with Tilt--Position 3* | | | | X | | | 1 per student | 1 page, black and white |
| HO4.6 *Data Table: Number of Sun's Incoming Rays by Season at Different Latitudes* | | | | X | | | 1 per student | 1 page, black and white |
| HO5.1 *Daylight Hours on December 21* | | | | | X | | 1 per student | 1 page, black and white |
| HO5.2 *Approximate Number of Daylight Hours: December 21* (data table) | | | | | X | | 1 per student | 1 page, black and white |

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| HO5.3 *Discussion Questions* | | | | | X | | 1 per group of 4–5 students or projected for class | 1 page, black and white |
| HO6.1 *Team Challenges* | | | | | | X | 1 per group of 3 students | 2 pages, double sided, black and white |

**Teacher Resources**

| Item | Lesson | | | | | | Notes | Descriptor |
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| | 1 | 2 | 3 | 4 | 5 | 6 | | |
| TE2.2 *Tray and Globe Example* | | X | | | | | Found in lesson PowerPoint | Display PowerPoint slide to class. |
| TE2.3 *The Sun's Incoming Energy—Angle Related to Latitude* | | X | | | | | Found in lesson PowerPoint | Display PowerPoint slide to class. |
| TE3.2 *North Star* | | | X | | | | 1 per teacher | Print on cardstock. |
| TE4.1 *The Sun's Incoming Energy--Angle Related to Latitude at Position 1* | | | | X | | | Found in lesson PowerPoint | Display PowerPoint slide to class. |
| TE4.2 *The Sun's Incoming Energy--Angle Related to Latitude at Position 3* | | | | X | | | Found in lesson PowerPoint | Display PowerPoint slide to class. |
| TE5.4 *Earth's Orbit around the Sun* | | | | | X | | Found in lesson PowerPoint | Display PowerPoint slide to class. |
| HO5.3 *Discussion Questions* | | | | | X | | Found in lesson PowerPoint | *Optional: display PowerPoint slides to class |

**General Supplies**

| Item | Lesson | | | | | | Notes |
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| | 1 | 2 | 3 | 4 | 5 | 6 | |
| Student notebooks/ journals | X | X | X | X | X | | One per student |
| Chart paper, markers, painter's tape | X | X | X | X | X | | Available for teacher and student use |
| Colored markers | | | | X | X | | Bulk markers<br>1 set per group of 3 |
| Plain, white paper, 8.5" × 11" | | | X | | | | 2 pieces per group of 3 |
| Transparent tape | | X | X | | | | 1 per pair or group of 3. A less desirable alternative: the teacher can distribute a length of tape to each group. |
| Fine-point markers for students (dark colors: black or dark blue; Sharpies work well) | X | X | X | X | X | | These are used by students to write questions they have on sticky notes to place on the DQB. They need to be markers so that the words are visible to all. |
| Sticky notes | X | X | X | X | X | | Students may use these in each lesson to add questions to the DQB and for other tasks. The 3" × 3" ones are fine. |
| Scissors | | X | | | | | Available for student use |
| Power strips (if necessary in classroom) | | | X | X | | | Need an electrical source to plug light setup into |

## Using an Anchoring Phenomenon
## Lesson 1 in a STeLLA Lesson Set

**What is an anchoring phenomenon?**
An anchoring phenomenon ("anchor") is a naturally occurring event that causes one to wonder and ask questions. An effective anchor requires an explanation involving the application of multiple science concepts (core ideas), crosscutting concepts, and science or engineering practices--the three dimensions of science learning described by the Next Generation Science Standards (NGSS). The anchor motivates the learning for several if not all lessons in a lesson set. For an engineering-focused lesson, the anchor could be a meaningful design problem. These anchoring phenomena are used to draw students into the storyline by presenting the natural challenge of explaining something or solving a problem grounded in the real world.

**What is an anchor lesson, and what is its purpose?**
The anchor lesson is used to kick off a lesson set and drive student motivation to learn throughout the lesson set. The purpose of the anchor lesson is to build a shared mission for a learning community to figure out phenomena or solve design problems. More specifically, the anchor lesson serves to ground student learning in a common experience and then use that experience to elicit and feed student curiosity, which will drive learning throughout the lesson set. The anchor lesson also serves as a critical place to elicit students' initial ideas, which are important for both for the students and the teacher. For teachers, this is an opportunity for pre-assessment.

The anchor lesson
- motivates a need for students to know more than they already know.
- sparks student interest and curiosity.
- creates a sense of puzzlement and sets students up for a "need to know" more to either explain a phenomenon, design a solution, or solve a challenge.
- allows the teacher to get a sense of what students already understand about the phenomenon that can be leveraged throughout the unit.
- elicits questions that the students want to investigate and answer throughout the lesson set.

**How do students typically represent their thinking as part of the lesson?**
The anchor lesson pushes students to represent their initial thinking by writing, drawing, and/or sharing their own initial ideas, models, explanations, or design solutions. These might be represented in their science notebooks. In the anchor lesson, students also raise questions they have about the phenomenon.

**What are the main learning goal and focus question for the anchor lesson?**
As the launching point for the lesson set, the purpose of the anchor lesson is unique. The anchor lesson is a full lesson designed to draw out students' initial ideas and questions about the phenomenon. Therefore, the main learning goal (MLG) used by teachers and the focus question (FQ) that students will answer should reflect that there is not a specific science

concept that students should learn in the lesson (Strategies A and B in the Science Content Storyline Lens further describe MLG and FQ). Main learning goals for subsequent lessons are the science ideas students should learn to build the science content storyline of the lesson set. These later lessons are designed in a way that students work with their initial ideas to figure out important science ideas or design solutions in the science content storyline of the lesson set.

Typical learning goals and focus questions for the anchor lesson will be similar to this structure:

> **MLG:** Students have many ideas and questions about *(insert overarching science concept or the phenomenon or problem)* that they can work with to figure out a more scientifically accurate way of thinking.
>
> **FQ:** What do we know and wonder about *(insert overarching science concept or phenomenon or problem)*?

**Typical Design Elements of the Anchor Lesson**

*Introduce Communicating in Scientific Ways*

The anchor lesson will introduce STeLLA Strategy 4, Communicating in Scientific Ways (CSW), to students, if this is new to them. If students have used CSW before, they will find opportunity in the anchor lesson to reacquaint themselves with the strategy and to practice using the sentence starters to communicate with the teacher and their peers. Teachers are asked to display the CSW poster in the room and give students a copy of the poster to attach to their notebook. Sentence starters are introduced or used with students for select rows of the CSW poster the first time students encounter CSW in the lesson. Appropriate rows of the CSW poster to use for the anchor lesson are suggested in the Elements below.

*Element 1: Explore the Anchoring Phenomenon*

Students are introduced to a puzzling phenomenon that they experience and explore in some way. In this initial exploration, the question the class focuses on is "What do we notice?" For example, students might make observations, look for patterns, or create a timeline of events that occurred. The purpose of this element is for students to recognize the interesting events going on and to publicly, as a learning community, acknowledge aspects of the phenomenon that requires explanation. Students also access their prior knowledge related to the phenomenon that might be useful in exploring and explaining the phenomenon.

| **Appropriate CSW sentence starters to suggest** | | |
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| 2. Observe. |  | I see ….<br>I noticed ….<br>I measured …. |

*Element 2: Attempt to Make Sense*

In the “making sense” element, students try to come up with an initial explanation, model, or some other reasoning to explain their thinking about why or how the phenomenon under investigation is happening. The point of this element in the anchor lesson is for students to voice their initial ideas about the phenomenon, no matter how inaccurate or far-fetched they may be. The purpose is to lay a foundation to leverage student ideas and student thinking for the investigations they will conduct throughout the lesson set to help them figure out the scientific explanation or design a solution for a problem. By trying to make sense of the phenomenon, students generate ideas that lead to questions and new ideas that they will want to investigate.

It’s important that each student tries individually to make sense of the phenomenon or problem and then go public with his or her ideas. Diversity of ideas and ways of making sense is very productive and exciting! It helps create the sense that we are not all on the same page and that there are things here that beg to be figured out. The role of the teacher in this part of the process is twofold: (1) to help students get their thinking down on the page, regardless of whether it’s right or wrong, and (2) to encourage students to come up with their initial ideas for a mechanistic explanation about what’s going on. Encourage students to go deeper if they think they know the answer. More likely than not, even students who use correct vocabulary to explain what they think is going on cannot really tell you what those words mean in a mechanistic way.

| **Appropriate CSW sentence starters to suggest** | | |
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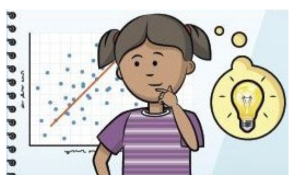
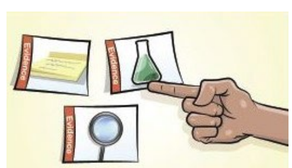
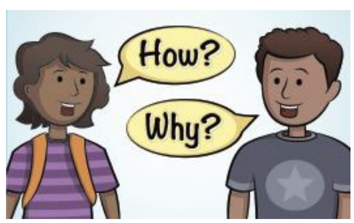
| 4. Think of an idea that explains your data and observations |  | My idea is ….<br>I predict ______ will happen because ….<br>I think what causes this is ….<br>I could draw a picture or diagram to show …. |
| 5. Give evidence for your idea or claim. |  | My evidence is ….<br>The reason I think that is ….<br>I think it’s true because …. |
| 6. Listen to others’ ideas and ask clarifying questions. |  | Are you saying that …?<br>What do you mean when you say …?<br>What is your evidence?<br>Can you say more about …? |
| 7. Agree or disagree with others’ ideas; add onto someone else’s ideas. |  | I agree/disagree with _____ because ….<br>I want to add to what _______ said. |

*Element 3: Pose Questions to Resolve and Discuss Next Steps*
In the third element, the class uses a Driving Question Board (DQB) to create a class list of student questions. These are questions that students have about the phenomenon or problem. Generally, answering these questions should help students figure out the mechanism behind the phenomenon, explain the phenomenon, or design a solution to a problem. What's unique about three-dimensional learning is the opportunity for students to be involved in the thought process and decision-making about what the class should be figuring out. It is important for each student to participate in generating a question to be explored and for those questions to be made public so that the class, as a whole, owns and drives their learning.

*Connecting to the anchor in subsequent lessons*
The class returns to DQB at the end of lessons as appropriate. Returning to the DQB is a way to link what students figured out in the current lesson (or questions on the DQB that they have answered) and what question makes sense to answer next (from those on the DQB or additional questions they add).

This is an example sequence of this element:

- The teacher asks, "What do we want **to know** next?"
    - Students write individual questions.
    - Students share questions aloud.
    - The class organizes the questions on the DQB.

| **Appropriate CSW sentence starters to suggest** | | |
|---|---|---|
| 1. Ask why and how questions. |  | How come …?<br>I wonder how …?<br>I wonder why …?<br>How do they know that …? |

*Element 4: Introduce the Unit Central Question as an Overarching Question from Their DQB*

After student questions are posted on the DQB, the class helps the teacher organize the questions into categories. The teacher has the main learning goals and focus questions for the upcoming lessons in mind and, as appropriate, groups the DQB questions according to those focus questions. Students' questions won't always fit with the upcoming lesson sequence. They still belong on the DQB but remain as unanswered questions at the end of the lesson set. As you continue to work with new experiences in the lesson set, new questions will emerge that students can add to the DQB.

The unit central question should be one that most questions relate to in some way. Teachers introduce the unit central question and write it across the top of the DQB.

*Adapted from Open SciEd Teacher Handbook.*