

## The Sun's Effect on Climate

### Lesson 7b: Use and Apply Key Science Ideas

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| <b>Grade 6</b>   | <b>Length of lesson:</b> 45 minutes | <b>Placement of lesson in unit:</b> 7b of 7 two-part lessons on the Sun's effect on climate  |
| <b>Unit central question:</b> Why are some places on Earth hotter than others at different times of the year?  |                                     | <b>Lesson focus question:</b> How can we use what we've learned about the Sun's effect on climate to answer the unit central question? |
| <b>Main learning goal:</b> Because of Earth's curved surface and consistent tilt, the angle of sunlight hitting the surface varies at different times of the year, causing uneven heating. While latitude on Earth is a key factor influencing climate, other factors are involved, such as elevation and proximity to large bodies of water.  |                                     |  |
| <b>Science content storyline:</b> 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 sunlight (solar radiation) striking Earth's curved surface at different latitudes, and Earth's orbit around the Sun. First, the angle of sunlight, and thus the intensity of solar radiation, varies depending on latitude—the distance north or south from the equator. Second, the angle and intensity of sunlight vary by time of year. For example, when a hemisphere is tilted away from the Sun in the winter, the Sun's rays strike the surface at a less direct angle, spreading solar energy over a larger area, which results in less heating and cooler temperatures. When a hemisphere is tilted toward the Sun in the summer, sunlight strikes the surface at a more direct angle, resulting in more concentrated solar energy, increased heating, and higher temperatures. This produces seasonal temperature variations in the Northern and Southern Hemispheres. While latitude is a key factor influencing regional climates, other factors, such as elevation and proximity to large bodies of water, can cause variations in temperature patterns at the same latitude. All of these factors contribute to the uneven heating of Earth's surface, causing variations in temperature patterns and regional climates. |                                     |  |
| <b>Ideal student response to the focus question/unit central question:</b> Some places on Earth are hotter than others because they're closer to the equator. Temperatures vary depending on how far north or south a place is from the equator. Places are warmer closer to the equator and cooler moving toward the poles. Because Earth's surface is curved, the Sun's rays hit more intensely at the equator and spread out more as you move away from the equator. Earth's consistent tilt as it orbits the Sun causes more intense sunlight in some places at certain times of the year, causing these places to experience summer. At other times of the year, the sunlight is less intense in these places, and they experience winter. Temperatures are also affected if a place is close to a large body of water or is located at a higher elevation. All of these factors make some places on Earth hotter than others at different times of the year.   |                                     |  |

#### Preparation

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| <p><b>Materials Needed</b></p> <ul style="list-style-type: none"> <li>• Science notebooks</li> </ul> <p><b>Student Handouts</b></p> <ul style="list-style-type: none"> <li>• 7.1 Team Challenges—Why Are Some Places on Earth Hotter Than Others at Different Times of the Year? (from lesson 7a)</li> </ul> | <p><b>Ahead of Time</b></p> <ul style="list-style-type: none"> <li>• Review the SEC content background document as needed.</li> </ul> |
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## Lesson 7b General Outline

| Time   | Phase of Lesson  | How the Science Content Storyline Develops  |
|--------|--|---|
| 2 min  | <b>Link to previous lessons:</b> The teacher reminds students of the importance of applying the key science ideas they've learned about in this unit to their team challenges.   |   |
| 1 min  | <b>Unit central question and lesson focus question:</b> The teacher revisits the unit central question— <i>Why are some places on Earth hotter than others at different times of the year?</i> —and the focus question from the previous lesson: <i>How can we use what we've learned about the Sun's effect on climate to answer the unit central question?</i> |   |
| 6 min  | <b>Setup for activity:</b> Teams from the previous lesson meet briefly to prepare for presenting their challenge explanations to the class. The teacher explains the process for sharing their challenges.   |   |
| 20 min | <b>Activity:</b> Teams share their explanations for each challenge. Then they further refine their ideas and explanations as time allows.  | <ul style="list-style-type: none"> <li>• Temperatures on Earth vary according to latitude. Because Earth is a sphere, sunlight hits the surface at different angles based on latitude, causing variations in the intensity of solar energy. In addition, Earth's consistent tilt as it orbits the Sun produces opposite seasons in the Northern and Southern Hemispheres. Other factors, such as elevation or proximity to large bodies of water, influence climate as well.</li> </ul>   |
| 5 min  | <b>Follow-up to activity:</b> The teacher reviews the most relevant science ideas for solving each team challenge.   | <ul style="list-style-type: none"> <li>• Some places on Earth are hotter than others because they're closer to the equator. Because Earth is a sphere, the Sun's rays hit the surface at a more direct angle near the equator and at a less direct angle toward the poles. The consistent tilt of Earth as it orbits the Sun causes different locations to receive more intense solar energy at certain times of the year (summer) and less intense solar energy at other times of the year (winter). Temperatures are also affected if a place is close to a large body of water or is located at a higher elevation.</li> </ul> |
| 10 min | <b>Synthesize/summarize today's lesson:</b> Students revisit the unit central question and summarize their ideas by writing their best answers in their science notebooks.   | <ul style="list-style-type: none"> <li>• Many measurable factors cause Earth to heat unevenly, including Earth's consistent tilt, its curved surface, and its orbit around the Sun; the angle of sunlight striking the surface at different latitudes; elevation; and proximity to large bodies of water.</li> </ul>  |
| 1 min  | <b>Link to future lessons:</b> The teacher emphasizes the important conceptual foundation this unit builds for studying weather and the causes of seasonal weather patterns in future lessons.   |   |

| Time  | Phase of Lesson and How the Science Content Storyline Develops   | STeLLA Strategy  | Teacher Talk and Questions  | Anticipated Student Responses | Possible Probe/Challenge Questions |
|-------|--|--|---|-------------------------------|------------------------------------|
| 2 min | <p><b>Link to Previous Lessons</b></p> <p><b>Synopsis:</b> The teacher reminds students of the importance of applying the key science ideas they’ve learned about in this unit to their team challenges.</p>   | <p>Make explicit links between science ideas and activities.</p>       | <p><b>Show slides 1 and 2.</b></p> <p>This is the final lesson in our unit on the Sun’s effect on climate.</p> <p>Last time, you applied what you’ve learned in previous lessons to solve some team challenges.</p> <p>Your team shared your ideas and explanations with another team that worked on the same challenge, and then you revised and refined your explanations based on what you learned from these discussions.</p> <p>During our presentations today, it’s <i>very important</i> that you apply key science ideas from this series of lessons on climate not only to show how much you’ve learned but also to make sure we come up with the best answer for our unit central question.</p> |                               |                                    |
| 1 min | <p><b>Unit Central Question and Lesson Focus Question</b></p> <p><b>Synopsis:</b> The teacher revisits the unit central question—<i>Why are some places on Earth hotter than others at different times of the year?</i>—and the focus question from the previous lesson: <i>How can we use what we’ve learned about the Sun’s effect on climate to answer the unit central question?</i></p> | <p>Set the purpose with a <u>focus question</u> or goal statement.</p> | <p><b>Show slide 3.</b></p> <p>By now we’ve gathered a lot of evidence to help us answer our unit central question, <i>Why are some places on Earth hotter than others at different times of the year?</i></p> <p><b>Show slide 4.</b></p> <p>That evidence and the science ideas we’ve explored will also help us answer our focus question, <i>How can we use what we’ve learned about the Sun’s effect on climate to answer the unit central question?</i></p>   |                               |                                    |

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|-------|--|---|--|-------------------------------|------------------------------------|
| 6 min | <p><b>Setup for Activity</b></p> <p><b>Synopsis:</b> Teams from the previous lesson meet briefly to prepare for presenting their challenge explanations to the class. The teacher explains the process for sharing their challenges.</p> | <p>Make explicit links between science ideas and activities <b>before</b> the activity.</p> | <p><b>Show slide 5.</b></p> <p>Now let’s review the challenges from our last lesson and talk about the process we’ll follow for the team presentations.</p> <p><b>NOTE TO TEACHER:</b> <i>Briefly review the four team challenges on handout 7.1 (Team Challenges—Why Are Some Places on Earth Hotter Than Others at Different Times of the Year?). Then explain the process you’d like teams to use for sharing their ideas and explanations. For example, you might ask all teams that completed Challenge 1 to give their presentations (without interruptions) and then engage other teams in a discussion of all relevant science ideas for that challenge. Or you might invite one team to present their explanation for the assigned challenge and then engage other teams in adding to that team’s ideas rather than inviting every team to make a presentation.</i></p> <p>Before we begin the presentations, meet briefly with your team and review your explanations for your assigned challenge. Decide whether you’ll designate one team member to present your team’s ideas or have everyone share in some way during the presentation.</p> <p>If you have diagrams or drawings to share, please let me know so I can project them on the document camera.</p> |                               |                                    |

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|--------|---|---|---|---|------------------------------------|
| 20 min | <p><b>Activity</b></p> <p><b>Synopsis:</b> Teams share their explanations for each challenge. Then they further refine their ideas and explanations as time allows.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>• Temperatures on Earth vary according to latitude. Because Earth is a sphere, sunlight hits the surface at different angles based on latitude, causing variations in the intensity of solar energy. In addition, Earth’s consistent tilt as it orbits the Sun produces opposite seasons in the Northern and Southern Hemispheres. Other factors, such as elevation or proximity to large bodies of water, influence climate as well.</li> </ul> | <p>Engage students in using and applying new science ideas in a variety of ways and contexts.</p> <p>Engage students in communicating in scientific ways.</p> | <p><b>Show slide 6.</b></p> <p>We’ll begin our presentations with Challenge 1 and continue in order through Challenge 4. Listen carefully without interrupting as each team presents their explanations. Be thinking about whether you agree or disagree with an explanation, have a question to ask or an idea to add, or have evidence to challenge and idea.</p> <p>After each presentation, you’ll have a chance to share your comments and questions. Make sure to talk in scientific ways.</p> <p><b>Show slide 7.</b></p> <p><i>Challenge 1: Why do Big Bear Lake, Santa Monica, and Pomona have different average temperatures throughout the year, even though they’re close to one another?</i></p> <p><b>NOTE TO TEACHER:</b> <i>As teams share their ideas and explanations, highlight key science ideas from column 5 (Anticipated Student Responses), if appropriate. As the class discusses each team’s explanation, encourage students to communicate in scientific ways by listening to the ideas and asking questions to clarify, agreeing or disagreeing with the ideas, adding to an idea, giving evidence to challenge an idea, and proposing other ideas.</i></p> | <p><i>Ideal response to Challenge 1:</i></p> <p>Big Bear Lake has cooler temperatures because it’s located in the mountains at a higher elevation. Santa Monica’s temperatures are steadier all year long because it’s located right next to the Pacific Ocean.</p> <p>Compared to the other cities, Pomona has</p> |                                    |

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|      |  |                 | <p><b>Show slide 8.</b></p> <p>Now let's move on to <i>Challenge 2</i>: How might you explain the temperature pattern in Belém, Brazil?</p> <p><b>Show slide 9.</b></p> <p>Next, we'll hear the presentation for <i>Challenge 3</i>: Why do Santa Rosa, Argentina, and Richmond, Virginia, experience opposite temperatures (warm versus cool) at different times of the year?</p> | <p>hotter temperatures in the summer and is cooler in the winter because it isn't located near the ocean or in the mountains.</p> <p><i>Ideal response to Challenge 2:</i></p> <p>The temperatures in Belém, Brazil, change only one degree all year long because sunlight is more direct or concentrated near the equator. Since the angle of sunlight doesn't change much, the temperatures in Belém would stay consistently warm all year long.</p> <p><i>Ideal response to Challenge 3:</i></p> <p>Santa Rosa, Argentina, is in the Southern Hemisphere,</p> |                                    |

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|      |  |                 |                            | <p>and Richmond, Virginia, is in the Northern Hemisphere. When it's winter in the Northern Hemisphere, the Southern Hemisphere experiences summer because the Southern Hemisphere is tilted toward the Sun (position 3 of Earth's orbit). Sunlight hits the Southern Hemisphere at a more direct angle during the summer, so the Sun's energy is less spread out and more intense. This means that Earth's surface warms up more in Argentina at this time of year. When Earth is in position 1, the reverse happens. The Northern Hemisphere tilts toward the Sun, causing the Sun's energy to be more intense in Richmond. While Richmond is having summer, Santa Rosa is having winter because the Southern Hemisphere is tilted</p> |                                    |

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|-------|---|------------------------------|--|--|------------------------------------|
|       |   |                              | <p><b>Show slide 10.</b></p> <p>Finally, let's hear the presentation for <i>Challenge 4: Why is it warmer in the summer than in the winter?</i></p> <p><b>NOTE TO TEACHER:</b> <i>Students may still cling to the misconception that Earth is closer to the Sun in the summer than in the winter. If that's the case, it might be helpful to revisit lesson 3 and the Earth-Sun model.</i></p> | <p>away from the Sun.</p> <p><i>Ideal response to Challenge 4:</i></p> <p>Raul's answer is the only answer that works. It's warmer in the summer than in the winter because Earth's tilt changes the angle of sunlight hitting the surface. Summers are warmer because that's when one hemisphere is tilted toward the Sun, and it's colder in the winter because that's when one hemisphere is tilted away from the Sun. The Northern and Southern Hemispheres have opposite seasons because one hemisphere tilts toward the Sun while the other tilts away from the Sun.</p> |                                    |
| 5 min | <p><b>Follow-Up to Activity</b></p> <p><b>Synopsis:</b> The teacher</p> | Summarize key science ideas. | Let's wrap up our team challenges by reviewing the key science ideas that relate to each challenge.  |  |                                    |



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|------|---|-----------------|--|-------------------------------|------------------------------------|
|      | <p>reviews the most relevant science ideas for solving each team challenge.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>Some places on Earth are hotter than others because they're closer to the equator. Because Earth is a sphere, the Sun's rays hit the surface at a more direct angle near the equator and at a less direct angle toward the poles. The consistent tilt of Earth as it orbits the Sun causes different locations to receive more intense solar energy at certain times of the year (summer) and less intense solar energy at other times of the year (winter). Temperatures are also affected if a place is close to a large body of water or is located at a higher elevation.</li> </ul> |                 | <p><b>NOTE TO TEACHER:</b> <i>If time allows, you might use the graphics and model of Earth's orbit from previous lessons to illustrate the key science ideas related to each challenge. These visual images may help students solidify their understandings of these ideas.</i></p> <p><b>Show slide 11.</b></p> <p><i>Challenge 1:</i> While latitude is a key factor that influences regional climates, elevation and/or being close to large bodies of water can also cause temperature differences at the same latitude.</p> <p><b>Show slide 12.</b></p> <p><i>Challenge 2:</i> Sunlight is more direct or concentrated near the equator throughout Earth's orbit around the Sun. That's why temperatures are warmer all year long in places that are close to the equator.</p> <p><b>Show slide 13.</b></p> <p><i>Challenge 3:</i> The curved surface of Earth and its consistent tilt as it orbits the Sun cause the angle and intensity of sunlight hitting Earth at different latitudes to vary according to the time of year. These factors produce seasonal temperature differences in the Northern and Southern Hemispheres.</p> <p><b>Show slide 14.</b></p> <p><i>Challenge 4:</i> Earth's consistent tilt changes the angle of sunlight hitting the surface during Earth's</p> |                               |                                    |

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|--------|---|--|--|-------------------------------|------------------------------------|
|        |   |  | orbit around the Sun. Summers are warmer because one of Earth’s hemispheres is tilted toward the Sun, and the angle of sunlight hitting the surface is more direct and intense. Winters are colder because one of Earth’s hemispheres is tilted away from the Sun, and the angle of sunlight hitting the surface is less direct and intense.   |                               |                                    |
| 10 min | <p><b>Synthesize/Summarize Today’s Lesson</b></p> <p><b>Synopsis:</b> Students revisit the unit central question and summarize their ideas by writing their best answers in their science notebooks.</p> <p><b>Main science idea(s):</b></p> <ul style="list-style-type: none"> <li>• Many measurable factors cause Earth to heat unevenly, including Earth’s consistent tilt, its curved surface, and its orbit around the Sun; the angle of sunlight striking the surface at different latitudes; elevation; and proximity to large bodies of water.</li> </ul> | Engage students in making connections by synthesizing and summarizing key science ideas. | <p><b>Show slide 15.</b></p> <p>Now let’s return to our unit central question, <i>Why are some places on Earth hotter than others at different times of the year?</i></p> <p><b>Think-Pair-Share-Write:</b> Look over the science ideas you recorded in your science notebooks throughout this series of lessons about the Sun’s effect on climate.</p> <p>First, think about how you would answer the unit central question now based on these science ideas.</p> <p>Think specifically about two parts of this question:</p> <ol style="list-style-type: none"> <li>1. Why are some places hotter than others in general?</li> <li>2. Why are some places hotter at different times of the year?</li> </ol> <p><b>Show slide 16.</b></p> <p>Then share your ideas with a partner and write your <i>best answer</i> to the unit central question in your science notebooks. Make sure to use science ideas from all of the lessons and include evidence to support your answers. Be prepared to share your ideas and evidence with the class.</p> |                               |                                    |

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|-------|--|--|--|-------------------------------|------------------------------------|
|       |  |  | <p><b>Whole-class share-out:</b> Let's have a few of you share your answers and evidence with the class.</p>   |                               |                                    |
| 1 min | <p><b>Link to Future Lessons</b></p> <p><b>Synopsis:</b> The teacher emphasizes the important conceptual foundation this unit builds for studying weather and the causes of seasonal weather patterns in future lessons.</p> | Link science ideas to other science ideas. | <p><b>Show slide 17.</b></p> <p>All the lessons in this unit explored how the Sun's energy heats Earth unevenly.</p> <p>So far we've been looking only at long-term temperature patterns and climates. But in future lessons, you'll learn about daily weather patterns.</p> <p>Daily weather is greatly influenced by climate and temperature patterns at certain times of the year. While climate tells us about average conditions on Earth over a long period of time, such as years, decades, or even centuries, weather describes conditions on Earth over short periods of time, such as hours or days. In other words, climate tells us what to expect, and weather is what we get.</p> <p>Now that you understand why temperature patterns and climates vary in different locations, it will be easier to understand and predict daily weather patterns on Earth in future lessons.</p> |                               |                                    |