

# Tilt Our World

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How does Earth's tilt, position in orbit around the Sun, and latitude determine the season a person will experience?

Infiniscope

## What Students Do

Students explore how Earth's tilt and position in orbit, as well as their latitude on Earth determine which season is experienced. They will observe how Earth's tilt impacts solar intensity and thus temperature in the Northern Hemisphere. They apply their understanding to predict seasons in the Southern Hemisphere.



| Summative Objective                                                                                                                                                                                                                                                        | Formative Objective                                                                                                           | Standards                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Construct an explanation for seasons in the northern hemisphere using qualitative (precipitation, states of matter, life patterns, etc) and quantitative observations (such as graphical data) in order to predict and describe seasons in the southern hemisphere.</b> | <b>Use a model to investigate solar intensity and it's effect on temperature in the northern hemisphere.</b>                  | <b>Science and Engineering Practices</b> <ul style="list-style-type: none"> <li>Constructing Explanations and Designing Solutions</li> <li>Developing and Using Models</li> </ul> <b>Disciplinary Core Ideas</b> <ul style="list-style-type: none"> <li>ESS1.A. The Universe and Its Stars</li> <li>ESS1.B. Earth and the Solar System</li> </ul> <b>Crosscutting Concepts</b> <ul style="list-style-type: none"> <li>Cause and effect</li> <li>Patterns</li> </ul> |
|                                                                                                                                                                                                                                                                            | <b>Use a model to investigate tilt of Earth's axis and its effect on the pattern of the Sun's apparent motion in the sky.</b> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## Lesson Specs

### Grade Range

|                                                                                             |                                                                                                        |                                                                                               |                                                                                               |
|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
|  Elementary |  <b>Middle School</b> |  High School |  College + |
|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|

### NGSS Content Areas

|                                                                                                |                                                                                                                   |                                                                                                       |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|
|  Life Sciences |  <b>Earth and Space Sciences</b> |  Physical Sciences |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|

### Devices

|                                                                                                             |                                                                                                        |                                                                                                           |
|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|  <b>PC, Mac, Chromebook</b> |  iPad, Android Tablet |  iPhone, Android Phone |
|-------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|

### Browsers

|                                                                                                  |                                                                                          |                                                                                                    |                                                                                              |
|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
|  <b>Chrome</b> |  Edge |  <b>Firefox</b> |  Safari |
|--------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|

## Key Details

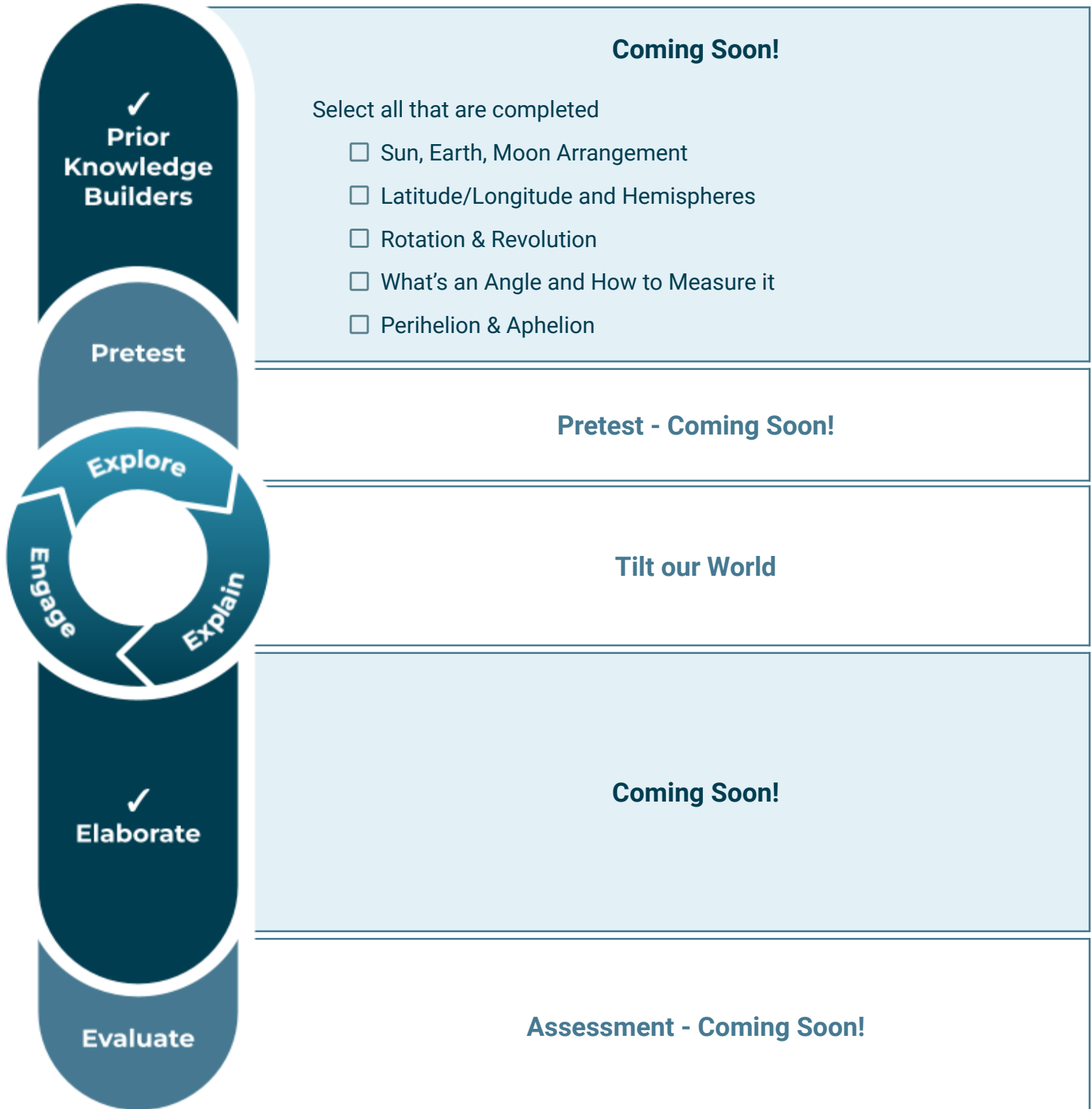
### Provided by Educator

|                             |                                                                                                                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <b>Prep Time</b>            | ~10 min                                                                                                                    |
| <b>✓ Prior Skills</b>       | <input type="checkbox"/> Use models<br><input type="checkbox"/> Construct explanations of phenomena                        |
| <b>✓ Required Materials</b> | <input type="checkbox"/> Computer or laptop<br><i>1 per student</i><br><input type="checkbox"/> Access to Ethernet or wifi |

### Provided by Infiniscope

|                       |                                                                                                                                                                                                                                                                            |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Lesson Time</b>    | ~65 min                                                                                                                                                                                                                                                                    |
| <b>Skill Building</b> | <ul style="list-style-type: none"> <li>• Observe patterns</li> <li>• Cite patterns as evidence to help explain phenomena</li> <li>• Use models to simulate the phenomena of seasons</li> <li>• Use models to generate data to support explanations of phenomena</li> </ul> |

# 5E Inquiry Model



# Misconceptions

Below are a list of misconceptions that students commonly hold about seasons and their cause. Beneath each misconception is information for the instructor on how that misconception was addressed in the learning experience.



## Misconception Alert

### Misconception #1

*We experience seasons because of the Earth's changing distance from the Sun (closer in the summer, farther in the winter)*

- ➡ To address this misconception, students investigate the relationship between light intensity and temperature, then use the simulation to explore how Earth's tilt causes changes in the intensity of the sunlight at different locations, thus causing seasons.

### Misconception #2

*Seasons change because Earth's tilt itself changes (rather than the direction of the axis always remaining pointing towards the North Star as we orbit the Sun).*

- ➡ To address this misconception, students investigate the relationship between light intensity and temperature, then use the simulation to explore how Earth's tilt causes changes in the intensity of the sunlight at different locations, thus causing seasons.

### Misconception #3

*Seasons happen at the same time everywhere on Earth*

- ➡ To address this misconception, after students investigate the pattern of seasons in the Northern Hemisphere, students are asked to predict and then use the simulation to verify the pattern of seasons in the Southern Hemisphere.

# Vocabulary

Below is a list of vocabulary words, found in this learning experience, and their definitions. The definitions are provided here for the educator to use as they prepare students for the experience.

|                              |                                                                              |
|------------------------------|------------------------------------------------------------------------------|
| <b>intensity</b>             | how bright or concentrated light from the Sun as it hits the Earth           |
| <b>latitude</b>              | measurement in degrees north or south of the equator                         |
| <b>sextant</b>               | a tool use to measure the angle between an object in the sky and the horizon |
| <b>solar elevation angle</b> | the angle between the horizon and the Sun                                    |
| <b>Tropic of Cancer</b>      | the northernmost point where the Sun appears directly overhead in the summer |

# Next Generation Science Standards

## Core Questions

| Core Question                                                                                                                                      |                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>What is the universe, and what is Earth's place in it?</b></p> <p><i>NGSS Core Question: ESS1: Earth's Place in the Universe</i></p>         |                                                                                                                                                                                                                                                                                             |
| Component Questions                                                                                                                                | Performance Expectations                                                                                                                                                                                                                                                                    |
| <p><b>What is the universe, and what goes on in stars</b></p> <p>NGSS ESS1.A:<br/>Earth Materials and Systems</p>                                  | <p><b>MS-ESS1-1.</b></p> <p>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.</p> <p><b>Clarification Statement</b></p> <p>Examples of models can be physical, graphical, or conceptual.</p> |
| <p><b>What are the predictable patterns caused by Earth's movement in the solar system?</b></p> <p>NGSS ESS1.B:<br/>Earth and the Solar System</p> | <p><b>MS-ESS1-1.</b></p> <p>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.</p> <p><b>Clarification Statement</b></p> <p>Examples of models can be physical, graphical, or conceptual.</p> |

# NGSS Objectives

| Objective                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| <b>Summative Objective</b><br><br><b>Construct an explanation for seasons in the northern hemisphere using qualitative (precipitation, states of matter, life patterns, etc) and quantitative observations (such as graphical data) in order to predict and describe seasons in the southern hemisphere.</b>                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                |
| NGSS SEP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | NGSS DCI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | NGSS CCC                                                                       |
| <b>Constructing Explanations and Designing Solutions</b><br><br>Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.<br><br><b>Developing and Using Models</b><br><br>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. <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena</li> </ul> | <b>ESS1.A.</b><br><br>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.<br><br><b>ESS1.B.</b><br><br>This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over 4 the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. | <b>Patterns</b><br><br>Can be used to identify cause-and-effect relationships. |

| Objective                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| <b>Formative Outcome 1</b><br><br><b>Use a model to investigate solar intensity and it's effect on temperature in the northern hemisphere.</b>                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                |
| NGSS SEP                                                                                                                                                                                                                                                                                                                | NGSS DCI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | NGSS CCC                                                                       |
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| Objective                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                |
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| <b>Formative Outcome 2</b><br><br><b>Use a model to investigate tilt of Earth's axis and its effect on the pattern of the Sun's apparent motion in the sky.</b>                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                |
| NGSS SEP                                                                                                                                                                                                                                                                                                                | NGSS DCI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | NGSS CCC                                                                       |
| <b>Developing and Using Models</b><br><br>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. <ul style="list-style-type: none"> <li>Develop and use a model to describe phenomena</li> </ul> | <b>ESS1.A.</b><br><br>Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.<br><br><b>ESS1.B.</b><br><br>This model of the solar system can explain eclipses of the sun and the moon. Earth's spin axis is fixed in direction over4 the short-term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year. | <b>Patterns</b><br><br>Can be used to identify cause-and-effect relationships. |