



### Science Objectives

- Students will explore the relationship between Earth's tilt and its effect on monthly temperatures.
- Students will justify the reasons for the seasons on Earth.
- Students will use a model to analyze the effect of changing Earth's tilt on climate.

### Vocabulary

- Revolution
- Rotation
- Axis

### About the Lesson

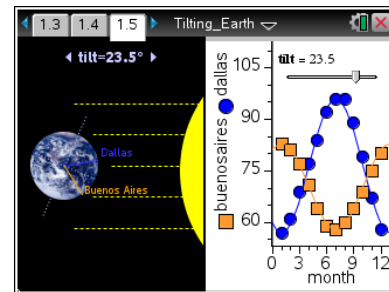
- This lesson *Tilted Earth* focuses on the impact of the tilt of Earth's axis on monthly temperatures.
- As a result, students will:
  - Discover that the tilt of Earth's axis is responsible for seasons.
  - Understand that the Northern Hemisphere receives more direct sunlight during the summer and less during the winter.
  - Manipulate the tilt of Earth's axis allowing them to observe what would happen to Earth's temperatures if the Earth had a different tilt or no tilt at all.

### TI-Nspire™ Navigator™

- Send out the .tns file.
- Monitor student progress using Screen Shots.
- Use Live Presenter to spotlight student answers.
- Enter items as appropriate for use of TI-Navigator.

### Activity Materials

- *Tilting\_Earth.tns* document
- TI-Nspire™ Technology



### TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Use a slider

### Tech Tips:

Make sure that participants understand how to adjust a slider by holding down the click button.

### Lesson Materials:

#### Student Activity

- *Tilting\_Earth\_Student.doc*
- *Tilting\_Earth\_Student.pdf*

#### TI-Nspire document

- *Tilting\_Earth.tns*



### Discussion Points and Possible Answers

Allow students to read the background information on the student activity sheet and on page 1.2 in the .tns file.

#### Move to page 1.3.

1. Before students begin, have them hypothesize why they think Earth has seasons.

Q1. Before beginning this simulation, why do you think we have seasons on Earth?

**Answer:** Answers will vary. Seasons are caused by the tilt of Earth's axis.

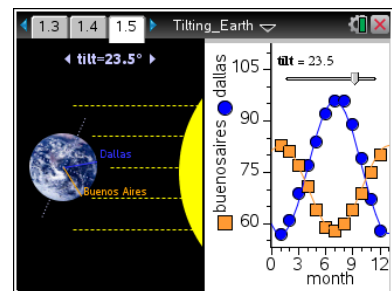
#### TI-Nspire Navigator Opportunities

Now would be a good time to use the class capture feature to formatively assess where all students are with this concept. Use class capture so you can quickly see all student responses on your computer at once.

#### Move to pages 1.4 and 1.5.

2. On page 1.4 are some directions for students to read about navigating the simulation on page 1.5.

3. Page 1.5 contains a split screen. On the left, students will see an image of the Earth, its tilt, and the Sun, while on the right, there is a graph with a tilt slider. The vertical axis, or y-axis on the graph represents temperature, while the horizontal axis, or x-axis represents months of the year.



Have students use the click button to adjust the tilt slider on the right side (graph side), which in turn will change the tilt of the Earth and the temperature on the graph. On the left side of the window, students can use the keyboard arrows, and also press the tab key `tab` to jump to 23.5 degrees, or press shift then tab (`↑shift tab`) to jump to -23.5 degrees. If the student wants to move to 0 degrees, they should press the esc key `esc`.

*(Note the short-cut commands only work when the left side of the screen is active. Students can change the focus of which pane is “active” screen by clicking on that side of the window. )*



**Move to page 1.6.**

Here students will find a spreadsheet indicating the temperature in two different cities, Buenos Aires in the Southern Hemisphere, and Dallas in the Northern Hemisphere. The spreadsheet shows the average temperature for each location throughout the 12 months of the year using the Earth's natural axis tilt of 23.5 degrees.

**Move to page 1.7 – 1.13.**

Have students answer questions 2-8 on the handheld, the activity sheet, or both.

Q2. When the Earth's axis is tilted at 23.5°, which city receives the most direct sunlight during month 7?

**Answer:** B. Dallas.

Q3. When the Earth's axis is tilted at 23.5°, what trend do you see in the temperatures for the two cities?

**Answer:** C. The temperatures in the two cities are inversely related.

Q4. On page 1.5, set the tilt of Earth's axis to 23.5°. Looking at just the picture of the Earth and the location of the Sun on the left of page 1.5, which season would you conclude that Dallas is currently in?

**Answer:** D. Summer.

Q5. Adjust the tilt from 23.5° to -23.5°. What changes do you see in the temperatures?

**Answer:** During month 0 and 12 with the Earth's axis set to 23.5°, it is cooler in Dallas and warmer in Buenos Aires. When you adjust the tilt to -23.5°, the temperatures "flip." Instead of experiencing summer in Dallas during month 7, there are now cooler temperatures (winter).

Q6. Looking at Dallas, what happens to the monthly temperatures as you increase the tilt from 23.5° to 45°?

**Answer:** C. Some temperatures go up, while others go down.

Q7. Set the tilt of Earth's axis to 0°. What happens to the temperatures in Buenos Aires and Dallas over the 12 month period? Why do you think the temperatures changes in this way?

**Answer:** The temperatures in Buenos Aires and Dallas will be about the same with the axis at 0°, because both cities receive the same amount of sunlight throughout the year



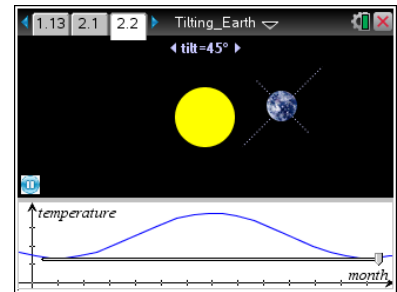
Q8. How would the climate change in your city if the Earth's axis was tilted at 45°?

**Answer:** Answers will vary, but may include more extreme temperature variations, changes in climate patterns, water availability, and crop harvesting.

### Move to pages 2.1 and 2.2.


4. On page 2.1 are some directions for students to read about navigating the simulation on page 2.2.

5. On page 2.2, students will find a model of the Earth revolving around the Sun. At the bottom, there is a graph showing temperature over time.



On the bottom of the page students will see an elongated slider. Students will be able to click on the the slider on this page the same way as on page 1.5. Students can also use the keyboard arrow keys to change the tilt, tab to jump to 23.5 degrees (and shift-tab for -23.5 degrees) when the top/image pane is active.

As the student adjusts the tilt by using the slider, the temperature along the bottom will adjust.

Students can press enter  or click the pause button  to pause the simulation at any time. This will allow the student to position the Earth in a specific location compared to the sun.

### TI-Nspire Navigator Opportunities

Now would be a good time to use live presenter and see if students understand the connection between the Earth and Sun in relation to seasons. Have all of your students set the Earth's tilt to 23.5 degrees. Then ask all of your students, including the live presenter to pause the simulation when the Northern Hemisphere experiences Fall. You can do this multiple times by providing students different scenarios.

### Move to pages 2.3 – 2.7.

Have students answer questions 9-13 on the handheld, the activity sheet, or both.

Q9. Keeping Earth's axis tilted at 23.5°, when would the Northern Hemisphere experience summer? (Where would the picture of the Earth be in relation to the sun? Remember this is a 2D Model.)

**Answer:** C. To the left



Q10. Keeping Earth's axis tilted at  $23.5^\circ$ , when would the Southern Hemisphere experience summer?  
(Where would the picture of the Earth be in relation to the sun? Remember this is a 2D Model.)

**Answer:** D. To the right

Q11. At what angle would Earth's axis have to be tilted so that there would be little, if no change in temperature throughout the year?

**Answer:** 0 degrees

Q12. As you increase the tilt of Earth's axis from  $23.5^\circ$  to  $45^\circ$ , the temperature not only goes up drastically during a certain time of the year, but it goes down drastically as well. Why do you think the temperatures vary in this way?

**Answer:** With an increased angle of tilt, the Earth would get more direct sunlight during summer and less direct sunlight during winter.

Q13. If a person tells you that the "seasons are caused by the Earth getting closer to the sun during summer, and further away from the sun during winter," how might you respond?

**Answer:** Answers will vary. Students should know that the main reason for seasons is the tilt of Earth's axis. Distance from the sun has very little to do with it.

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### Wrap Up

When students are finished with the activity, retrieve the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Slide Show.

### Assessment

- Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show will be utilized to give students immediate feedback on their assessment.
- Summative assessment will consist of questions/problems on the chapter test.