

Motion of the Sun

Student Page

Purpose

To examine the path of the Sun across the sky at different times of the year from different locations on the Earth, and study its effects at different locations.

Before You Begin

1. How many days each year does the Sun rise due East and set due West?
2. What is the effect of the number of hours of daylight you receive if you move closer to the Earth's poles?

A.J.J.A.R. Programs Required

Motion of the Sun

Motion of the Sun/Zenith view

Questions

1. Set the simulation for today's date and look toward the East to view the location of sunrise. What effect does changing your latitude have on the location the Sun rises?
2. From your latitude, what direction is the Sun when it is at its highest in the sky? Change to several different dates. Does the direction of highest altitude change?
3. Set the simulation for the winter solstice, December 21. Facing South, what is the northernmost latitude that the Sun is visible? How many degrees is this latitude from the North Pole? What is the relationship between this angle and the tilt of the Earth's axis with respect to its orbital plane?
4. Now set the simulation for the summer solstice, June 21. What is the northernmost latitude that the Sun still has a setting or a rising location? What is the relationship between this latitude and the one you found in the previous problem?
5. What observation can you make about the shape of the Sun's path across the sky as you get closer to the poles?

Advanced Question

The following data table lists the average number of hours of daylight received each day at various locations on the Earth each month.

Average Number of Hours of Daylight Received each Day

	Chicago	Quito	South Pole	Rio de Janeiro	Helsinki
January	9.5	12.1	24	13.4	6.8
February	10.6	12.1	24	12.9	9.1
March	12.0	12.1	17	12.2	11.9
April	13.4	12.1	0	11.6	14.7
May	14.6	12.1	0	11.0	17.3
June	15.2	12.1	0	10.8	18.8
July	14.9	12.1	0	10.9	18.0
August	13.8	12.1	0	11.4	15.6
September	12.5	12.1	8	12.0	12.8
October	11.0	12.1	24	12.6	10.1
November	9.8	12.1	24	13.2	7.5
December	9.2	12.1	24	13.5	6.0

Using graph paper, a spreadsheet program, or a graphing calculator, plot all of the values for each location on the same sheet. Use either different colored pencils for each plot, or different symbols.

1. Explain any patterns you see in your graphed data.
2. What is the relationship between the average daily amount of sunlight at a location and the location's position on the Earth? Formulate a reason for this.
3. Compare Chicago with Rio de Janeiro. Explain why the plots for these two cities look different.

Teacher Page

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Possible Answers to Before you Begin

1. The Sun rises due East and sets due West on two days each year: the Spring Equinox and the Vernal Equinox.
2. The answer depends on the time of year. During the Northern Hemisphere's summer, the number of hours you receive will increase as you move closer to the North Pole. The number of hours will decrease as you move closer to the South Pole. The reverse occurs when it's the Southern Hemisphere's summer.

A.J.J.A.R. Programs Required

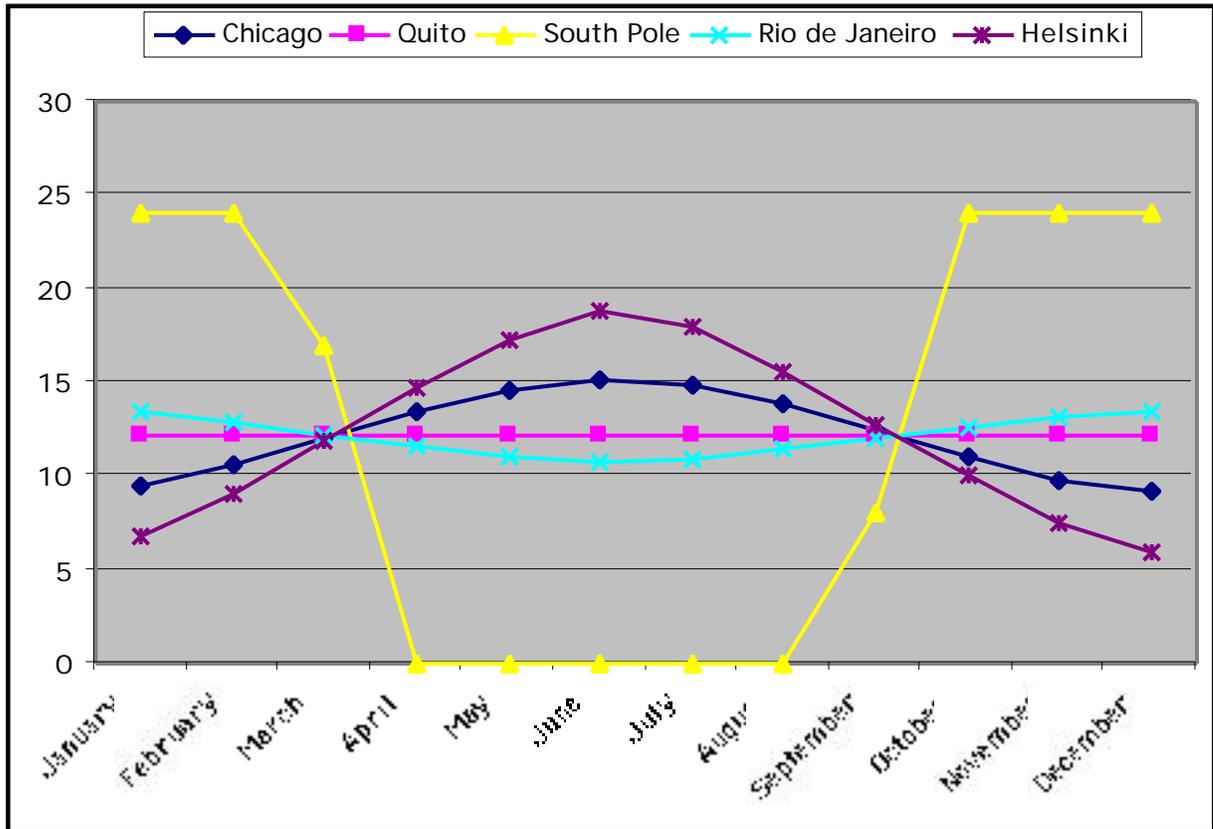
Motion of the Sun

Motion of the Sun/Zenith view

Answers to Questions

1. Regardless of the date, there is no change in the location of sunrise as you change your latitude.
2. Regardless of the date, the direction of the Sun's highest altitude will always be in the South for the Northern Hemisphere and in the North for the Southern Hemisphere.
3. On December 21, the northernmost latitude that the Sun is visible is 66° N. This is 24° from the North Pole. This angle is nearly the same as the tilt of the Earth's axis with respect to its orbital plane (23.5°).
4. On June 21, the northernmost latitude that the Sun still has a rising and setting location is 66° N. This is the exact same latitude found in the previous problem.
5. As you get closer to the Earth's poles, the Sun's path across the sky becomes more and more parallel to the horizon.

Answer to Advanced Question



- Possible patterns may include
 - The shapes of the Northern and Southern Hemisphere plots are reversed from one another.
 - The farther the location is from the equator, the greater the variation throughout the year.
 - The crests and troughs in the graph coincide with the dates of the solstices.
- The farther the location's distance from the pole, the greater the variation in the amount of sunlight received throughout the year. The actual reason for this is due to the Earth's tilt on its axis. Because the poles are the points on the Earth furthest from the points on the Earth below the Sun's location (i.e., between the Tropic of Cancer and the Tropic of Capricorn), they experience the greatest extremes in the amount of daylight. As you get closer to the equator, there is much less variability in the amount of daylight received.

3. Chicago is in the Northern Hemisphere and Rio de Janeiro is in the Southern Hemisphere. Therefore, the shapes of the plots are reversed from one another. Also, Chicago is farther from the equator, which means it will experience greater variability in the amount of sunlight it receives during the year.

Additional Internet References

Earth and Moon Viewer

<http://www.fourmilab.ch/earthview/vplanet.html>

You can view a map of the Earth showing the day and night regions at this moment. You can also view the Earth from the Sun, the Moon, the night side of the Earth, above any location on the planet specified by latitude, longitude and altitude, from a satellite in Earth orbit, or above various cities around the globe.

Sun Position Calculator

<http://www.cs.ucla.edu/~simonw/sunpos/>

This Java®-based Sun position calculator will give the time of sunrise and sunset for any date and location.