

Overview:

Students will explore the latitude and longitude coordinate system using Google Earth.

Objectives:

The student will:

- identify hemispheres of Earth;
- search locations using Google Earth;
- convert coordinate formats with Google Earth; and
- calculate the distance between degrees of latitude and longitude at different locations.

Standards:

Mathematics

A – A student should understand mathematical facts, concepts, principles and theories. A student who meets the content standard should:

- 5) construct, draw, measure, transform, compare, visualize, classify, and analyze the relationships among geometric figures.

Geography

A - A student should be able to make and use maps, globes, and graphs to gather, analyze, and report spatial (geographic) information. A student who meets the content standard should:

- A6) use spatial (geographic) tools and technologies to analyze and develop explanations and solutions to geographic problems.

Science

E – A student should understand the relationships among science, technology and society. A student who meets this content standard should:

- E1) develop an understanding of how scientific knowledge and technology are used in making decisions about issues, innovations, and response to problems and everyday events.

Materials:

- Computer with Google Earth installed
- STUDENT WORKSHEET: "Latitude and Longitude with Google Earth"
- Globe (optional)

Whole Picture:

A geographic coordinate system can be used to define a location on earth. The most common system uses latitude and longitude. Both latitude and longitude are measured in degrees symbolized with ($^{\circ}$). Degrees of latitude and longitude are divided into 60 minutes and are symbolized with ($'$). Minutes are divided into 60 seconds and are symbolized with ($''$). For example: $134^{\circ} 45' 53''$. Lines of latitude are circles that run parallel to the equator. They are also called "parallels". The equator is at 0 degrees latitude. The poles are at 90 degrees north or south of the equator.

Lines of longitude extend from the North Pole to the South Pole. They are also called "meridians". A line that runs through Greenwich, England is the internationally accepted line of 0 degree longitude, or Prime Meridian. Lines of longitude extend east or west of the Prime Meridian up to 180 degrees to the Antimeridian. The Antimeridian is the location of the International Date Line.

The equator was a logical feature to use for 0° latitude. However, deciding where 0° was more challenging. Early mapmakers often would use a prime meridian that went through locations other than Greenwich, England. Mapmakers would use Washington, D.C., Mecca, Paris, Rome, Kyoto and others as the Prime Meridian that caused a lot of confusion. In 1884, at the International Meridian Conference, Greenwich, England was selected

as the official Prime Meridian. Specifically, the Prime Meridian passed through the cross hairs of the Airy's Transit Circle at the Royal Observatory in Greenwich, England. It was referred to as the Airy Meridian. However, as this lesson will demonstrate, the Prime Meridian used in Google Earth does not pass through the Observatory. Instead it is about 100 meters to the east. The reason is because Google Earth and GPS's use the more current WGS84 datum. WGS84 is an acronym for World Geodetic Survey of 1984 and the term "datum" is the reference from which measurements are made. The WGS84 datum uses Earth's center of mass for the coordinate origin and does not rely on a physical location, which can move with plate tectonics. The WGS84 datum has become the standard for cartography and navigation.

Activity Preparation:

Google Earth should be installed on computers prior to doing the lesson.

In Google Earth Layers, Terrain and Borders should be clicked on. All the rest should be turned off. The default coordinate for Google Earth is degrees, minutes, seconds. When starting, each computer should have that setting. The option can be changed in Google Earth → Preferences. (Tools → Options for a PC)

Students should be familiar with navigating around in Google Earth before doing this lesson. If necessary, have them do the "Google Earth" lesson before this one. It can be downloaded at http://www.aktsunami.com/lessons/GIT_exercises/5-8GIT.html.

Activity Procedure:

Ask students how they would describe the location of their school to someone who is familiar with the area. Next, ask how they would describe the location to someone who is not familiar with the area. Record the different ways of describing the location on the board. Ask students which method is the most accurate way to describe the location of the school. Ask if any students have used a GPS. If so, how does a GPS describe a location?

Review with students the difference between latitude and longitude and how they are measured in degrees. If a globe is available use it to show the lines of latitude, longitude and degree measurements.

Have students launch Google Earth. Demonstrate the navigation tools, how to measure with the ruler and share some keyboard shortcuts that are useful when moving around in Google Earth.

Useful Google Earth keyboard shortcuts:

- n - moves the view so north is up.
- u - tilts the image so it is "top down" or up.
- r - rights the image so north is up and looking top down.

Hand out the STUDENT WORKSHEET: "Latitude and Longitude with Google Earth" and have students navigate around Google Earth to answer the questions. A separate answer sheet has also been provided for students.

Answers:

1. Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
2. 0°
3. Approximately 71° 24'
4. 141°
5. "Prime Meridian of the World"
6. No
7. Approximately 102 meters to the east

8.	Place	Eastern or Western Hemisphere	Northern or Southern Hemisphere
	Adak, Alaska	Western	Northern
	Capetown, South Africa	Eastern	Southern
	Rio De Janeiro, Brazil	Western	Southern
	Tokyo, Japan	Eastern	Northern
	Quito, Ecuador	Western	Southern
	Madrid, Spain	Western	Northern

9. a. Kodiak, AK
 b. Reno, NV
 c. Santiago, Chile.
 d. Portland, OR

10. Approximately 29 miles

11. Answers will vary.

12. Answers will vary.

13. a. Statue of Liberty
 b. State of Alaska Capitol Building
 c. Grand Canyon
 d. 38.9900, -77.0090
 e. 38°53'22", -77°02'07"

14.		Near Adak, Alaska	Near Barrow, Alaska
	Distance between one degree of latitude	70 miles	70 miles
	Distance between one degree of longitude	43 miles	22.5 miles

15. None, they are the same.

16. Near Barrow, one degree of longitude is approximately 20 miles less than it is near Adak.

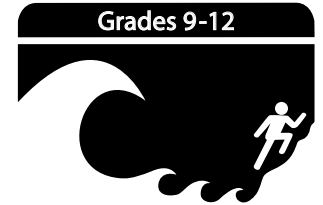
17. Lines of longitude converge, so the distance decreases towards the poles. Lines of latitude are equal distance from one another from the equator to the poles.

18. It would be about 70 miles.

19. It would be greater than the distance in Alaska. If measured, it is approximately 70 miles.

Student Worksheet (page 1 of 7)

Latitude and Longitude with Google Earth



A geographic coordinate system can be used to define a location on earth. The most common system uses latitude and longitude. Any position on earth can be described by its latitude and longitude. These two numbers are the coordinates of the location. In this lesson Google Earth will be used to explore the latitude and longitude coordinate system.

Directions: Follow the steps on the following pages. Fill in answers on pages 6 and 7 of this worksheet where indicated.

STEP 1. Launch Google Earth and select **View** → **Grid** to turn on the grid lines showing latitude and longitude.

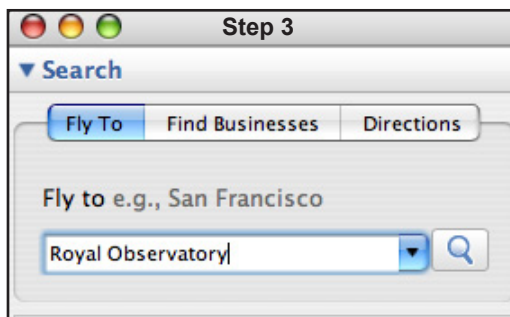
STEP 2. Use the navigation tools to move the Earth from the North Pole to the South Pole.

Answer questions 1-4 on page 6 of this worksheet.

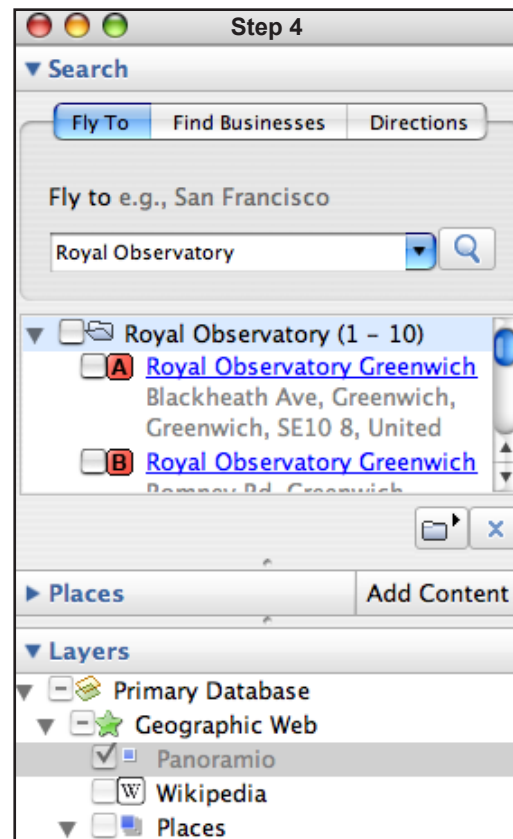
Prime Meridian

In 1884 it was decided that the Prime Meridian, or the 0 degree line for longitude, would pass through the Royal Observatory in Greenwich, England.

STEP 3. Type: *Royal Observatory* in the Google Earth search box. Press **Return** to “fly” to Greenwich, England.



STEP 4. In **Search** turn off the balloons by clicking the check box. In **Layers** click **Geographic Web** then click **Panoramio**.



Student Worksheet (page 2 of 7)

Latitude and Longitude with Google Earth

STEP 5. Look at the photo to locate the Royal Observatory. Click on some of the Panoramio blue squares to view photos of the Observatory (you may need to zoom in to see the individual squares).

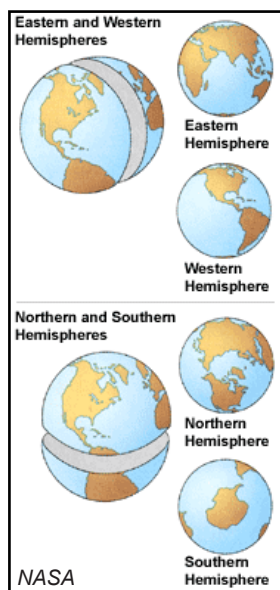


Answer question 5 on page 6 of this worksheet.

STEP 6. Zoom out to see the yellow line that marks the “Prime Meridian” in Google Earth.

Answer questions 6 and 7 on page 6 of this worksheet.

Google Earth and the Global Position System (GPS) use the center of mass of Earth, instead of a geographic location such as the Royal Observatory, as a reference point for the coordinate system. This eliminates the problem of tectonic plate movement.



Hemispheres

Locations between 0° and $+180^\circ$ are in the eastern hemisphere. Places between 0° and -180° are in the western hemisphere. Locations between the equator and the North Pole ($+90^\circ$) are in the northern hemisphere. Places between the equator and the South Pole (-90°) are in the southern hemisphere.

Answer questions 8 and 9 on page XX of this worksheet.

Coordinate Formats

Latitude and longitude can be written in several different formats. They can be in degrees, minutes and seconds; degrees, decimal minutes; or in decimal degrees. There are 60 minutes in a degree and 60 seconds in a minute. Additionally, coordinates using latitude and longitude must state whether they are east or west of the Prime Meridian and north or south of the equator. This is done by using an “N” for points north of the equator and “S” or “-” for south of the equator. Longitude east of the Prime Meridian is designated with an “E,” and a “W” or “-” for west of the Prime Meridian. North latitudes and East longitudes would be positive “+” values and the + is not usually included.

Student Worksheet (page 3 of 7)

Latitude and Longitude with Google Earth

For example, each of these coordinates describes the exact same location.

Degree minutes seconds	Degree decimal minutes	Decimal degrees
61° 51' 33.84", -147° 50' 58.2"	64° 51.564', 147 50.97'	64.8594°, -147.8495°
61° 51' 33.84" N, -147° 50' 58.2" W	64° 51.564' N, 147 50.97' W	64.8594° N, -147.8495° W

Although each of these is correct, decimal degrees is becoming more commonly used. This is because the coordinates can be used in spreadsheets.

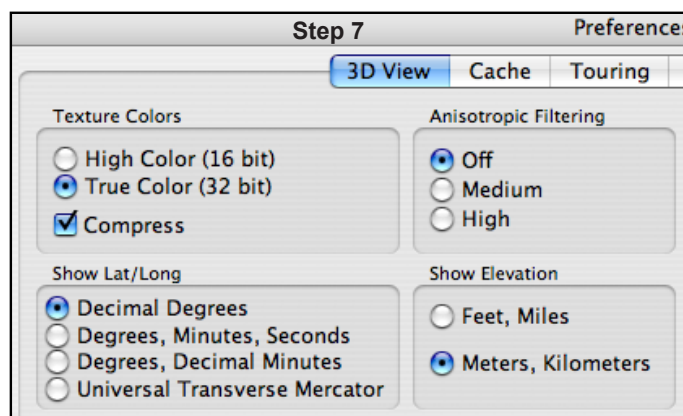
Google Earth can display each of these different formats at the bottom of the window.



For a complete set of instructions on latitude and longitude syntax in Google Earth see the Google Earth Users Guide at: http://earth.google.com/userguide/v4/ug_editing.html

STEP 7. Open the preference file by selecting Google Earth > Preferences > 3D View (Tool > Options > 3D View on a PC) and click on Decimal Degrees if it is not already selected.

The different formats can cause problems. For example, imagine you were working for your community Search and Rescue. A call comes in that a person was in trouble and needed help. The person had a GPS and by using a satellite phone they give the coordinates 58 52 52, -156 55 42 but they did not say what format was being used. The dispatch officer assumed it was in degrees, minutes and seconds, but what if it was in decimal degrees? Find the distance between 58° 52' 52", -156° 55' 42" and 58.5252, -156.5542. Note that these coordinates use the same number sequence, but are in different formats.

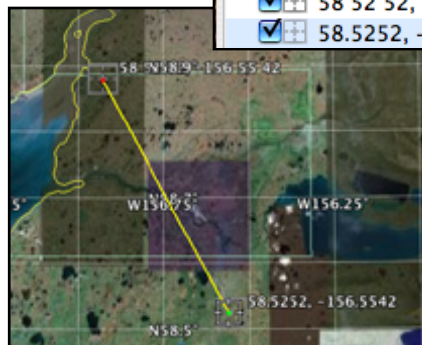
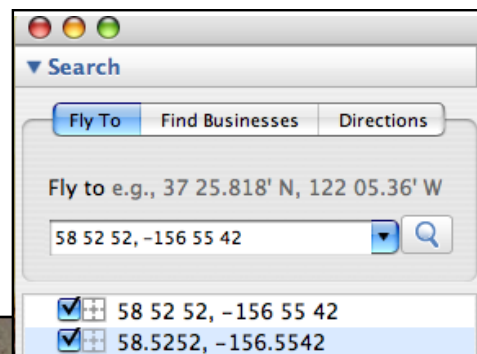


STEP 8. Enter 58 52 52, -156 55 42 in the search box of Google Earth. NOTE: Google Earth interprets the spaces as coordinates in degrees, minutes and seconds. The symbols do not need to be included.

STEP 9. Enter 58.5252, -156.5542 in the search box of Google Earth.

STEP 10. Click on both of the coordinates in the search box then use the ruler to measure the distance, in miles, between the two locations. Clear the measurement when finished.

Answer question 10 on page 6 of this worksheet.



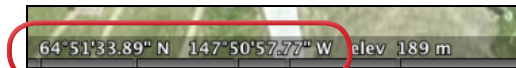
Steps 8-10

Student Worksheet (page 4 of 7)

Latitude and Longitude with Google Earth

STEP 11. Type the name of your community in the Google Earth search box. Press **Return** to fly to it.

STEP 12. Navigate in Google Earth to your school.



Step 13

STEP 13. Move the mouse pointer around and look at the bottom of the Google Earth window. Notice how the latitude and longitude change to show the current position of the mouse. Place the mouse pointer over your school.

Answer question 11 on page 7 of this worksheet.

STEP 14. In Google Earth navigate to the airstrip nearest your school.

Answer questions 12 and 13 on page 7 of this worksheet.

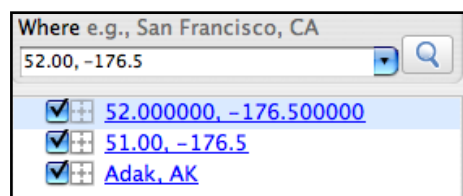
Distances between longitude and latitude

Is the distance between one degree of longitude the same in Barrow, AK as it is in Adak, Alaska? What about the distance between one degree of longitude at the two locations? Are they the same? Use Google Earth to find the answer.

STEP 15. Type: *Adak, AK* in the Google Earth search box, then press **Return** to fly to that location.

STEP 16. Type the coordinates: *51.00, -176.5* in the Google Earth search box and press **Return**.

STEP 17. Type the coordinates: *52.00, -176.5* in the Google Earth search box and press **Return**.



Step 17-18

STEP 18. Click both of the coordinates on so they are visible in the Google Earth window.

STEP 19. Use the ruler to measure the distance, in miles, between *51.00, -176.5* and *52.00, -176.5* and **write the distance of one degree of latitude in the table on page XX of this worksheet.**



Step 19

STEP 20. Type the coordinates: *52.00, -176.00* in the Google Earth search box and press **Return**.

STEP 21. Type the coordinates: *52.00, -177.00* in the Google Earth search box and press **Return**.

Student Worksheet (page 5 of 7)

Latitude and Longitude with Google Earth

STEP 22. As in STEP 17–STEP 18 click on both the coordinates so they are visible in Google Earth and use the ruler to measure the distance of one degree of longitude. **Write the distance of one degree of latitude in the table on page 7 of this worksheet.**

STEP 23. Type: *Barrow, AK* in the Google Earth search box and press **Return** to fly there.

STEP 24. Type the coordinates: *71.00, -156.8* in the Google Earth search box and press **Return**.

STEP 25. Type the coordinates: *72.00, -156.8* in the Google Earth search box and press **Return**.

STEP 26. Click on both coordinates, and then use the ruler to measure the distance between one degree of latitude near Barrow. **Write this information in the table (question 14) on page 7 of this worksheet.**

STEP 27. Enter the coordinates: *71.5, -156.0* in the Google Earth search box and press **Return**.

STEP 28. Enter the coordinates: *71.5, -157.0* in the Google Earth search box and press **Return**.

STEP 29. Click on both coordinates, and then use the ruler to measure the distance between one degree of longitude near Barrow. **Write this information in the table (question 14) on page 7 of this worksheet.**

Answer questions 15-19 on page 7 of this worksheet.

Name: _____

Student Worksheet (page 6 of 7)

Latitude and Longitude with Google Earth

Directions: Use the step-by-step instructions on the preceding pages of this worksheet to answer the following questions.

1. List the five major lines of latitude going from north to south.

_____	_____
_____	_____
_____	_____

2. What is the equator's degree latitude? _____

3. What degree latitude is the northern most point in Alaska? _____

4. What degree longitude is the eastern border between Alaska and Canada? _____

5. What does the poster on the Royal Observatory say? _____

6. Does the Prime Meridian pass through the Royal Observatory? _____

7. Use the ruler to measure the distance, in meters, from the Prime Meridian used in Google Earth to the one used in 1884. Record the distance measured. _____

8. Use the grid in Google Earth to complete the chart. Fill in the correct hemispheres for each location.

Location	Eastern or Western Hemisphere	Northern or Southern Hemisphere
Adak, Alaska		
Capetown, South Africa		
Rio de Janeiro, Brazil		
Tokyo, Japan		
Quito, Ecuador		
Madrid, Spain		

9. Refer to the grid lines in Google Earth. Circle the correct answer to the following questions.

- a. Which is farther south? Juneau, Alaska or Kodiak, Alaska?
b. Which is farther west? Reno, Nevada or Los Angeles California?
c. Which is farther east? Santiago, Chile or New York, New York?
d. Which is farther north? Portland, Oregon or Boston, Massachusetts?

10. What is the distance, in miles, between $58^{\circ} 52' 52''$, $-156^{\circ} 55' 42''$ and 58.5252 , -156.5542 ?

Name: _____

Student Worksheet (page 7 of 7)

Latitude and Longitude with Google Earth

11. In the chart below, fill in the coordinates for your school in each format.

Format	School Coordinates
Decimal degrees	
Degrees, decimal minutes	
Degrees, minutes, seconds	

12. What are the coordinates, in decimal degrees, for each end of the airstrip? _____

13. Use Google Earth to answer the following questions.

- What famous statue is at 40.6891, -74.0446 (hint: look at the shadow)? _____
- What is the building at 58.3021, -134.4104 (hint: turn on places)? _____
- What feature is at 36.0901, -113.2283 (hint: tilt the view)? _____
- What are the coordinates, in decimal degrees, of the U.S. Capitol? _____
- What are the coordinates, in degrees, minutes, seconds, of the Washington Monument in Washington D.C.?

14.

Distance between:	Near Adak, AK	Near Barrow, AK
one degree of latitude		
one degree of longitude		

15. What is the difference between one degree of latitude between Adak, AK and Barrow, AK?

16. What is the difference between one degree of longitude between Adak, AK and Barrow, AK?

17. Why is there a difference between measurements of one degree of longitude and latitude at the two locations?

18. What would you estimate the distance between one degree of latitude near the equator to be?

19. What would you estimate the distance between one degree of longitude near the equator to be?
