Exercise 1
Introduction to World Geography and Google Earth

Objectives

1. Learn how to use the basic features of Google Earth
2. Understand how ancient philosophers deduced the Earth's surface was curved
3. Understand how Eratosthenes calculated the circumference of the Earth and compare with modern values

Setup

Download and install the Google Earth application on your computer.

http://www.google.com/earth/index.html

Information about navigating in Google Earth and features in the main window is available on the Google Earth support webpage.

https://support.google.com/earth/bin/answer.py?hl=en&answer=148176

You will need to use many of these features to complete this and subsequent exercises. Thus, it is recommended that you spend some time experimenting with the program to familiarize yourself with how it works.

Before beginning the Questions on the next page, click on the "View" dropdown menu and make sure "Toolbar", "Sidebar", "Status Bar", "Atmosphere", and "Water Surface" are selected.

Load the "**Exercise1.kmz**" file in Google Earth. You will see the "Exercise 1" folder listed under "Temporary Places" in the Places window. Below that will be separate folders for each of the Question Topics below: Earth's Curvature, and Earth's Size. Note that at the start, "Earth's Curvature" is selected, and "Earth's Size" is deselected.

Note: deselect (uncheck) any other files or folders that may be listed within the Places window.

Name: _____ Date: _____

Questions

Investigation 1
A way that the ancient philosophers deduced that the Earth is curved involved viewing boats as they set sail across large seas or oceans.

Click on "Earth's Curvature" in the Places window for information about this topic. Close the popup window when you are finished reading.

Imagine that you are located in ancient Greece. Double-click "Go to Greece" to fly to the Mediterranean Sea off Greece's western shore.

Then double-click "View of Africa" to turn your view to the south towards Africa.

Select "Watch boat depart" (don't double-click.) You should see a model boat (it has been enlarged for clarity) and a timescale in the top left corner. Single-click the time slider's stopwatch or click and drag its right thumb piece to send the boat on its way towards the northern shore of Africa.

1. As the boat sails across the Mediterranean pay close attention to how long you can see the full image of the boat (hull + mast.)

What part of the boat disappears from view as the boat goes over the horizon to the south towards Africa? _____

Explain why this piece of information helped the ancient philosophers deduce that the Earth was curved. *Hint: compare with what you would see if the Earth was flat.*

_____

_____

_____

_____

_____

Investigation 2

Deselect (unclick) all items in the Places window, then double-click "Earth's Size". This exercise explains Eratosthenes' measurement of the Earth's circumference.

The first item in the folder displays an etching of Eratosthenes when you select (click the box next to) the item. This is a screen overlay that hovers above the surface view and doesn't change when you pan or zoom.

1. In the Places menu, under the Earth's Size exercise double-click on "Cyrene". Cyrene was the birthplace of Eratosthenes.

What is the modern name for the city of Cyrene? _____

In what modern country is this city located? _____

2. Double-click on Syene and then select "Sunbeam and Well." Eratosthenes was aware that at midday on the Summer Solstice, sunlight reflected straight up out of a deep well on Elephantine Island in the Nile River. Double-click "Sunbeam and Well" to fly into the sunbeam! He reasoned that the sun was directly overhead as this city was very close to the Tropic of Cancer (yellow line). You can verify this by temporarily turning on "Grid" in the "View" dropdown menu.

Deselect "Sunbeam and Well".

What is the modern name for the city of Syene? _____

In what modern country is this city located? _____

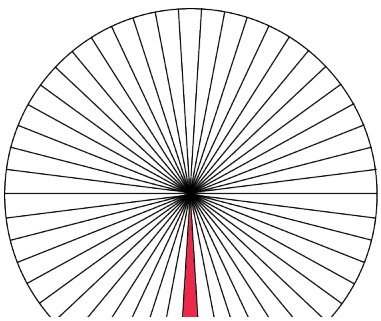
What well known engineering structure is located on the Nile river upstream (south) from Elephantine Island? _____

3. Fly to Alexandria. (*Hint: type "Alexandria, Egypt" in the Search box above the Places window.*)

This city still exists, but the famous library (for which Eratosthenes was the famous librarian) was destroyed by fire. Make sure you have "3D Buildings" selected in the Layers window.

Today, what is located on the site of the ancient library? _____
(*Hint: click on the 3D building at the site next to the water.*)

4. Double-click on "Tall Post." Eratosthenes saw that a tall post in Alexandria cast a shadow at midday on the Summer Solstice. The angle of the shadow from the vertical was 7˚ 12' (or 7.2 decimal degrees) – the red slice in this image.



Given that a circle has 360˚,
what fraction of a circle
was the shadow? _____

Knowing this fraction, Eratosthenes realized that all he needed to calculate the circumference of the Earth was the distance from Syrene to Alexandria. In equation form:

circumference = distance / fraction

In his day the unit of measure was a stade (about 185 meters), and the distance from Syrene to Alexandria was about 5000 stadia.

Based on the circumference formula (listed above) that Eratosthenes used,
what is the circumference of the Earth, in stadia? _____

Convert Eratosthenes' calculation (in stadia) for the circumference of the Earth to kilometers:
(Remember to convert from meters to kilometers in your calculation) _____

Given that the modern accepted value for the polar circumference of the Earth is 40,008 km,
what is the percent (%) deviation of Eratosthenes' calculation (in km) from the modern value? _____

One reason why Eratosthenes did so well is that some of his errors cancelled out. The Tropic of Cancer today is well south of Syene but 2,200 years ago, the tropic was closer owing to changes in the tilt of the Earth. Also, Syene is not due south of Alexandria. If you draw a line directly south from Alexandria and make it the same length as the Alexandria to Syene distance, it ends within 10 km of the then-tropic. Serendipity is often a factor in scientific discoveries.

One other issue is that we aren't quite sure of the length of Eratosthenes' stade in modern metric units. To get around this issue, we can measure the distance from Syrene to Alexandria using the Ruler tool  in Google Earth. The Ruler tool button is located in the toolbar along the top of the Google Earth window.

For help using the **ruler tool**, you can view the following video: http://youtu.be/Gc6mphjnJHE

Your measurement in Google Earth of the distance (in km) from Syrene to Alexandria: _____

Now calculate the polar circumference of the Earth using this distance: _____

What is the percent (%) deviation of your calculation from the modern value? _____