



Volume of pyramids

from the Esri GeoInquiries™ collection for Mathematics

Target audience – Geometry learners

Time required – 15 minutes

Activity

Use an aerial photograph to determine the volume of the Great Pyramid of Giza.

Math Standards

CCSS: MATH.CONTENT.HSG.GMD.A.3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

CCSS: MATH.CONTENT.HSG.MG.A.1. Use geometric shapes, their measures, and their properties to describe objects.

Learning Outcomes

- Students will find the volume of a pyramid.
- Students will consider how environmental factors may affect the volume of the pyramid over time.

Map URL: <http://esriurl.com/mathGeoInquiry15>



Engage

How tall is the great pyramid?

- Click the URL above to launch the map.
- ? How tall do you believe the pyramid is? *[Today, this pyramid is 455 feet high, although it was originally thought to have been 480 feet tall.]*
- Record the height.
- ? How could you use this map to confirm your guesses? *[You could measure the length and width of the pyramid base with the Measure tool, but an aerial image alone does not help determine height.]*



Explore

What is the area of the pyramid base?

- Use the Measure tool to determine the area of the pyramid base.
- Press the Measure button. Set the tool to distance with units of feet.
- ? Measuring from the designated corner points, what is the length and width of the base? *[This pyramid is a right rectangular pyramid. All sides of the base should be about 755 feet long.]*
- Record the base length and width.



Explain

What's the volume – now and then?

- ? What is the formula for calculating the volume of a pyramid? $[(L \times W \times H) / 3]$
- Calculate the volume using the original height estimate of the pyramid (480 feet), and record the volume. *[~91 million cubic feet (based on 755-foot base lengths)]*
- Calculate the volume of the pyramid using the height of the pyramid today (455 feet). *[~86.45 million cubic feet (based on 755-foot base lengths)]*
- ? How much estimated volume has the pyramid lost? *[~4.8 million cubic feet]*

more ►

Elaborate

How can the accuracy be improved?

- Using the Measure tool, set the tool to Area measurement with units of square feet.
- Measure the entire base of the great pyramid from designated corner points. Hint: you may need to zoom out and pan the map to fit the pyramid and Measure tool into the viewable area. [*~550,000 square feet*]
- Calculate the volume, using the modern height of 455 feet.
- ? Does this method of measurement seem more accurate? Why? [*Probably not. It can be more difficult to control the pointer and get accurate measurements when outlining shapes (versus straight lines). However, the computer calculates $L \times W$, reducing human error.*]

Evaluate

Why do structures like this change over time?

- ? What natural forces may have caused this pyramid to change height and volume over time? [*Erosion and weathering of the stone by wind and rain.*]
- ? If another 6 inches of height is lost due to weathering, how many cubic feet will be lost (assuming the base lengths are 755 feet)? [*$(755 \times 755 \times 454.5) / 3 = 86,358,787$ cubic feet, so the loss is 95,004 cubic feet*]

USE THE MEASURE TOOL

- Click Measure, select the Distance button, and from the drop-down list, choose a unit of measurement.
- On the map, click once to start the measurement, click again to change direction, and double-click to stop measuring.
- Hint: Position the area of interest on the map so that it is not obscured by the Measure window.

TURN A MAP LAYER ON AND OFF

- Make sure that the Details pane is selected, and click Show Map Contents.
- To show individual map layers, select the check boxes next to the layer names.
- Hint: If a map layer name is light gray, zoom in or out on the map until the layer name is black. The layer can now be turned on.

Next Steps

DID YOU KNOW? ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.esri.com/schools>.

THEN TRY THIS...

- Tour the Nile River Valley with a story map and learn more about the history and geography of the surrounding region. Visit <http://esriurl.com/Geo32>.
- Use the Analysis tools in a school ArcGIS Online organizational account, and create a new layer or nearby pyramid points.
- Calculate the density of pyramids or even a hot spot analysis based on heights.

TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these high school texts.

- *Geometry by Holt, Rinehart & Winston — Chapter 10*
- *Geometry by Houghton Mifflin — Chapter 12*
- *Geometry by Moise & Downs — Chapter 19*