



# 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]*

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## 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*