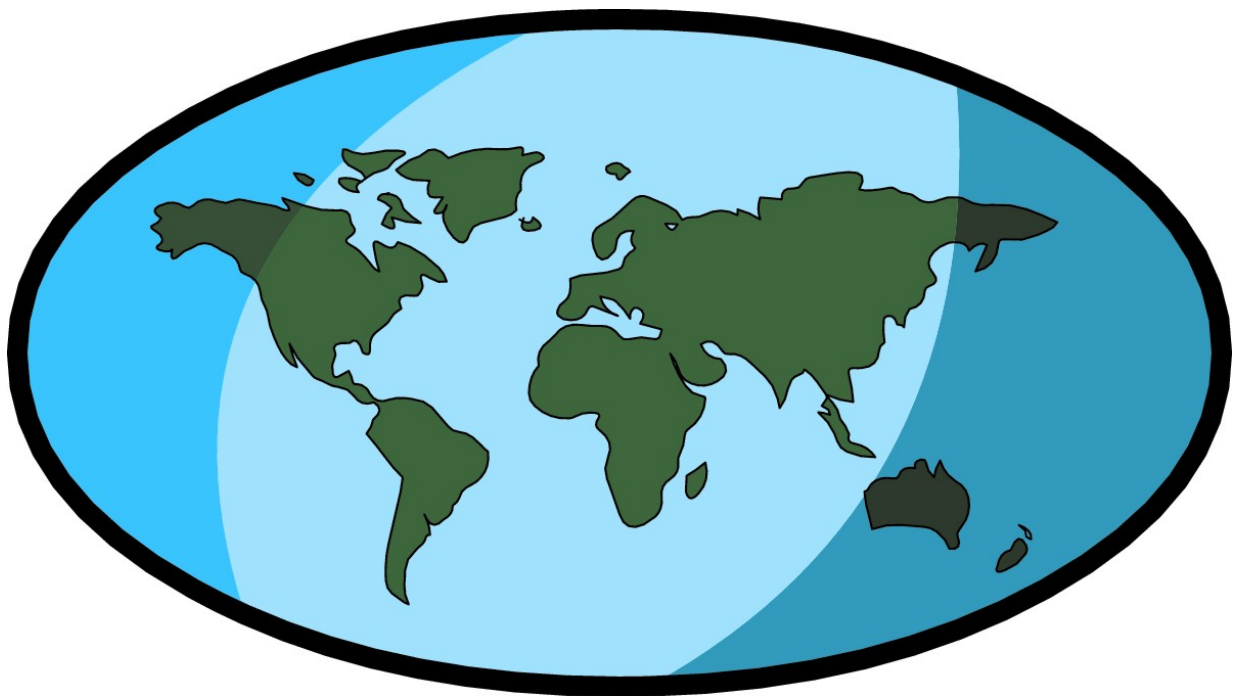


Give Your Classes a Global Perspective



<https://clipartfest.com/>

Jim Roznowski
jimroznowski@gmail.com

Finding resources

For information on the 2014 Geography Assessment visit the website: *The Nation's Report Card*
https://nationsreportcard.gov/hgc_2014/#geography

For current world maps, visit the website: *Contemporary Maps of the World*
<http://alabamamaps.ua.edu/contemporarymaps/world/world/>

Wikipedia: List of cities by longitude
https://en.wikipedia.org/wiki/List_of_cities_by_longitude

Scale drawings and photos of many monuments on the National Mall along with the White House are available on the web site of the Library of Congress in the *Historic American Buildings Survey/Historic American Engineering Record/Historic American Landscapes Survey*.

<http://www.loc.gov/pictures/collection/hh/>

Type the name of the monument in the “Search This Collection” box.

Scale drawings of the White House: images 14, 15, and 42-81

Lincoln Memorial: images 122-149

Vietnam Veterans Memorial: images 10-30

Capitol: images 79-92, 122-131, 153-162

Smithsonian Institution: images 9-89

Washington Monument: images 39, 59, 236-272

Jefferson Memorial: images 15-40

Additional information about sites in DC is also available at

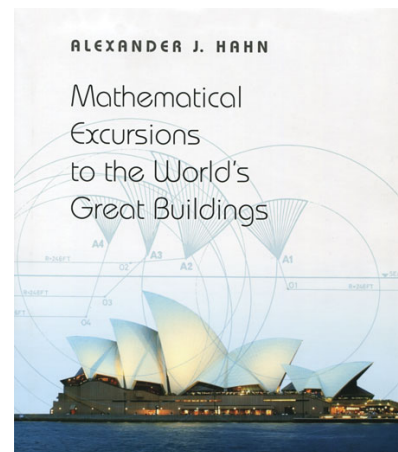
- The National Park Service – <http://www.nps.gov>
- National Coalition to Save Our Mall (includes the complete 1902 McMillan Commission Report) – <http://www.savethemall.org/>
- A View On Cities – <http://www.aviewoncities.com/washington/mall.htm>

For more information about the mathematics of The Ellipse and information on quadrarcs, check out *The Shape and History of the Ellipse in Washington, D.C.* by Clark Kimberling
<http://faculty.evansville.edu/ck6/ellipse.pdf>

The Architecture Week Great Buildings Collection
<http://www.GreatBuildings.com/gbc.html>

Excellent book with information on the Sydney Opera House and the mathematics of other buildings

Mathematical Excursions to the World's Great Buildings,
Alexander J Hahn, Princeton University Press

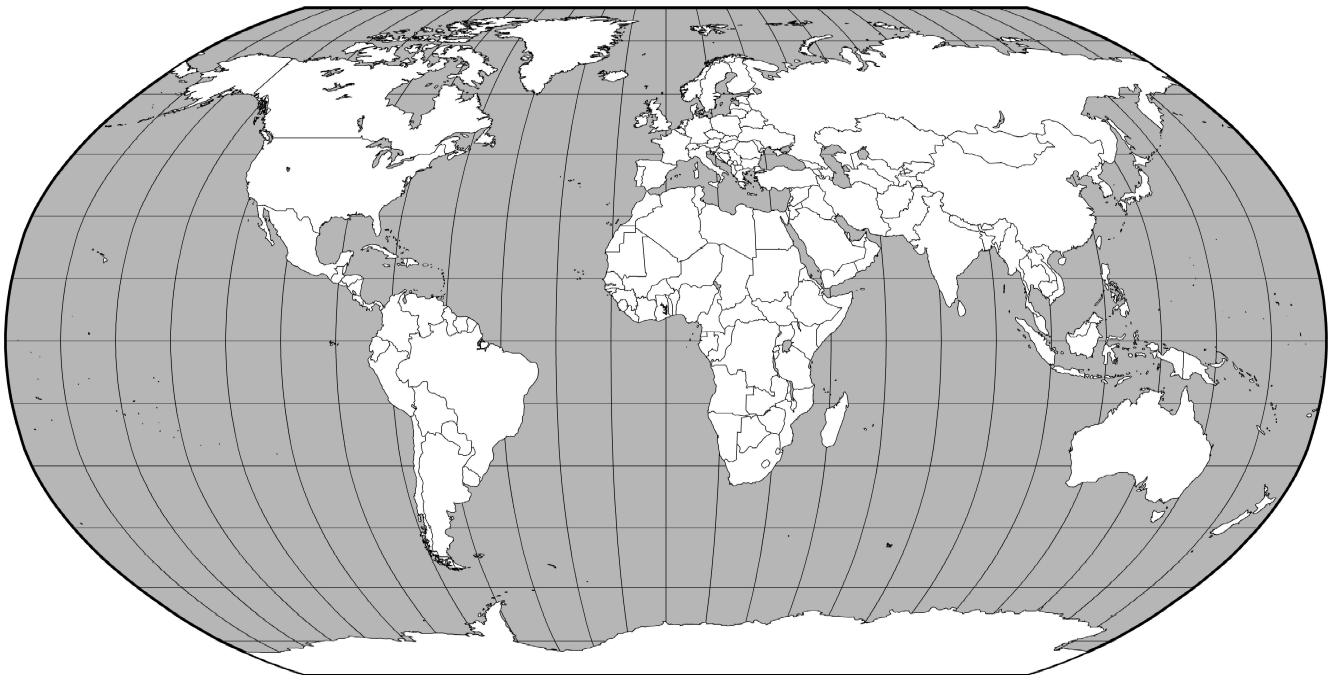


Arc Length

The following three cities are located approximately on longitude 30° E. Assuming the earth is a sphere with a radius of 3,960 miles, determine the distances between the cities. Place the city on the map below and determine in which country each city is located.

City	Latitude	Distance from previous city	Country
Saint Petersburg	59° 57' N		
Eskisehir	39° 47' N		
Pietermaritzburg	29° 37' S		

ROBINSON PROJECTION OF THE WORLD



Produced by the Cartographic Research Lab
University of Alabama

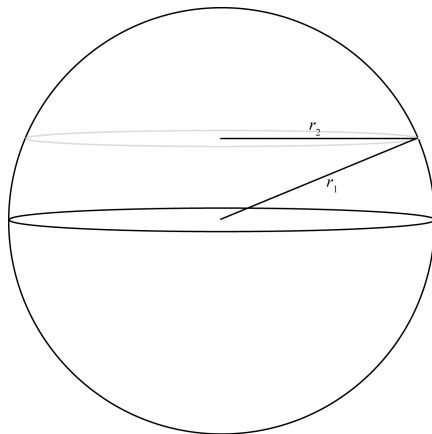
Trigonometry – Monumental Distances

Find the longitude and latitude of the White House and the U.S. Capitol.

A monument to George Washington was planned to be located directly south of the White House and directly west of the Capitol. Determine the longitude and latitude of the monument. This position is now indicated by a marker called the Jefferson Stone or Jefferson Pier.

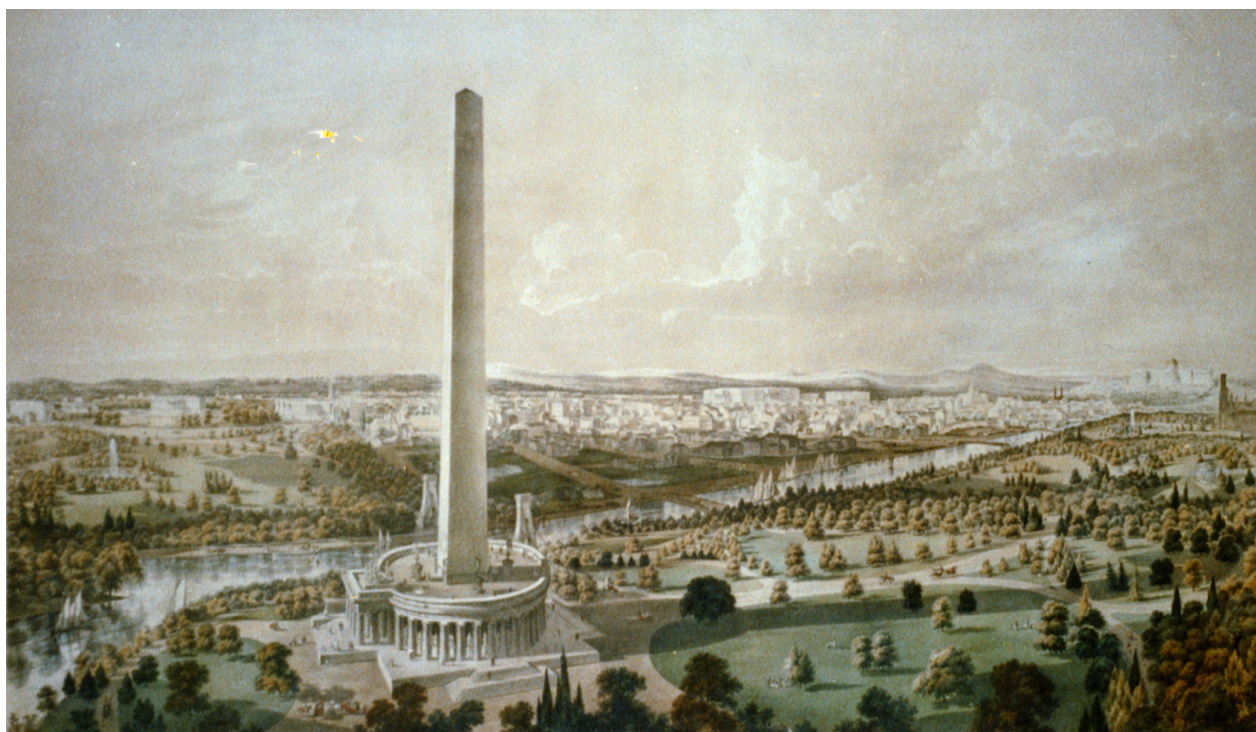
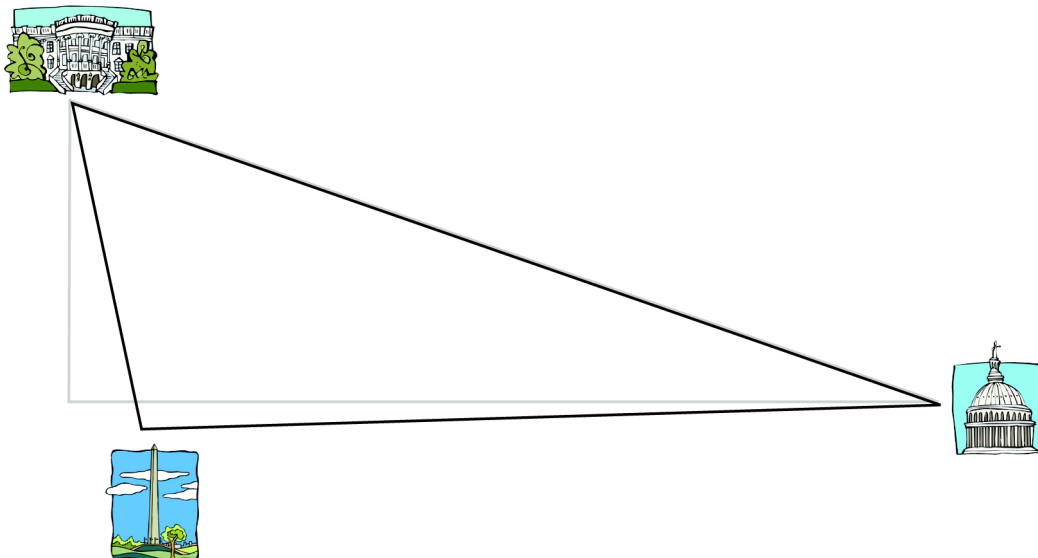


If the radius of the earth is $r_1 = 3,960$ miles, determine the distance between the White House and the monument (Jefferson Stone) in both miles and feet.



Determine the radius, r_2 , of the latitudinal circle that runs through the Capitol and use it to find the distance between the Capitol and the monument (Jefferson Stone) in both miles and feet.

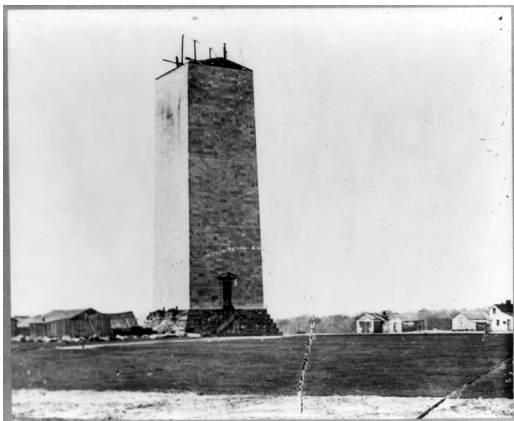
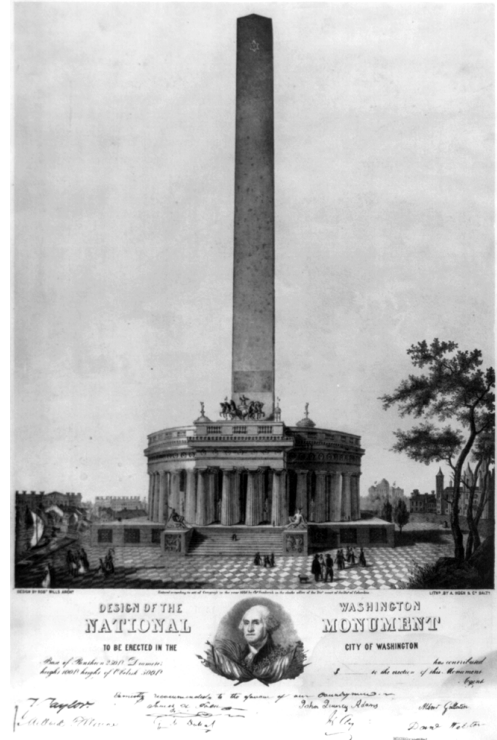
This planned location for the Washington Monument was found to be unsuitable to support the monument and it was moved 371.6 feet east and 123.2 feet south. Determine the distances and angles between the current Washington Monument, the White House, and the Capitol.



The original design for the Washington Monument. (Library of Congress)

Building the Washington Monument

The original 1791 plan for Washington, D.C., included an equestrian statue of George Washington. When construction of the Monument finally started in 1848 with the laying of the cornerstone, the proposed monument was very different from the one originally planned. The new design, however, did include a statue of Washington dressed as a Roman driving a six horse chariot.



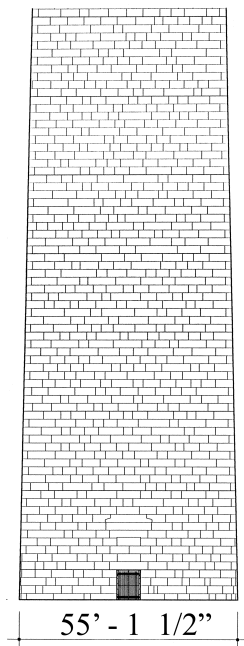
In 1854 the Washington National Monument Society ran out of money and construction on the obelisk stopped at a height of 152 feet. By the time construction resumed in 1880, research had been done on the shape of Egyptian obelisks and the design of the Washington Monument was changed again to reflect this new information.

(Library of Congress)

Starting with the 1854 section of the monument and using the following characteristics found in traditional obelisks, complete the drawing of the Washington Monument.

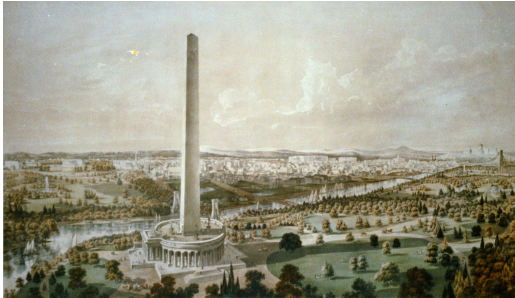
1. The overall height of the obelisk was 10 times its baseline.
2. The obelisk walls would converge at a height 20 times the baseline.
3. The angle of the pyramidion seldom varied from 73° .
4. The height of the pyramidion was equal to the baseline.
5. The obelisk walls tapered at about a quarter inch per foot.

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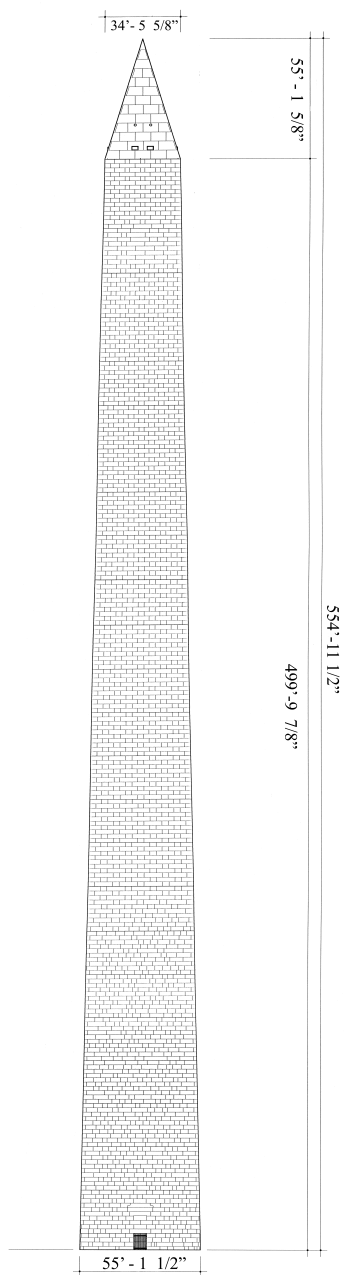
Linear Equations and the Washington Monument

An equestrian statue of George Washington was first proposed by Congress in 1783. In the original plan for Washington, D.C., the statute was to be placed directly south of the White House and directly west of the Capitol. The position was shifted a little and construction of the Washington Monument started in the 1840's and was completed (after some major redesign) in the 1880's.



The original plan for the Washington Monument.

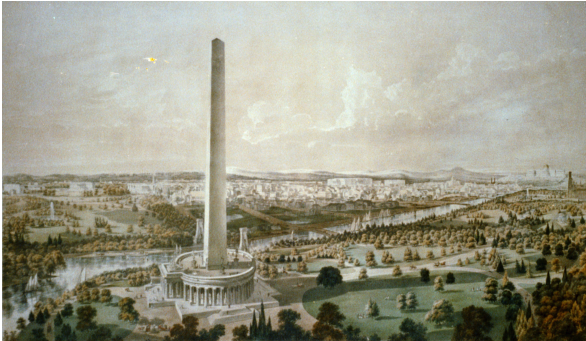
(Library of Congress)



Using the drawing, insert a set of axes and determine the equations of lines that would form the Washington Monument.

Building the Washington Monument

It took many years to build the Washington Monument. In fact the monument you see in pictures or when you visit Washington, D.C. is not the way it was originally designed.

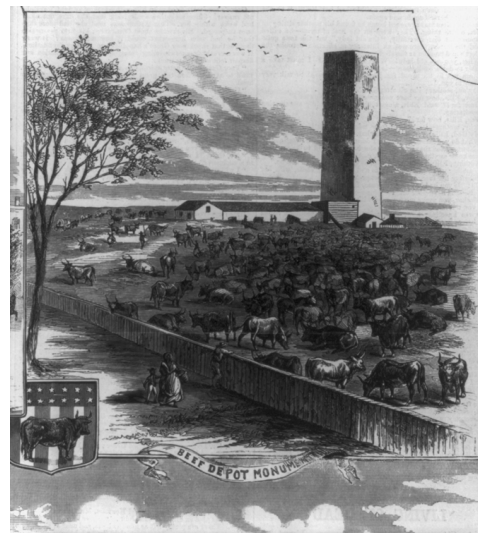
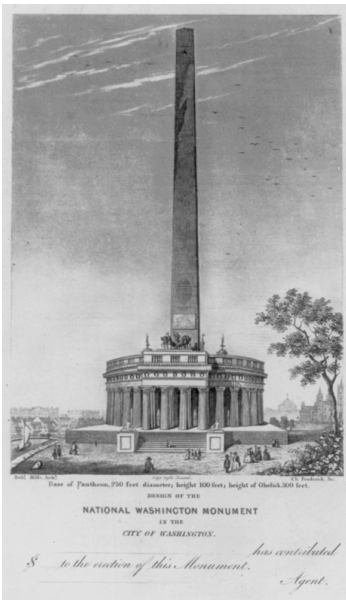


The original plan for the Washington Monument.

The Washington Monument was going to be built through donations from the American people and about \$300,000 was collected. When a person donated to the monument, they received a certificate of thanks. The amount collected did not cover the cost of the monument and when money ran out in the construction on the monument stopped for thirty years.

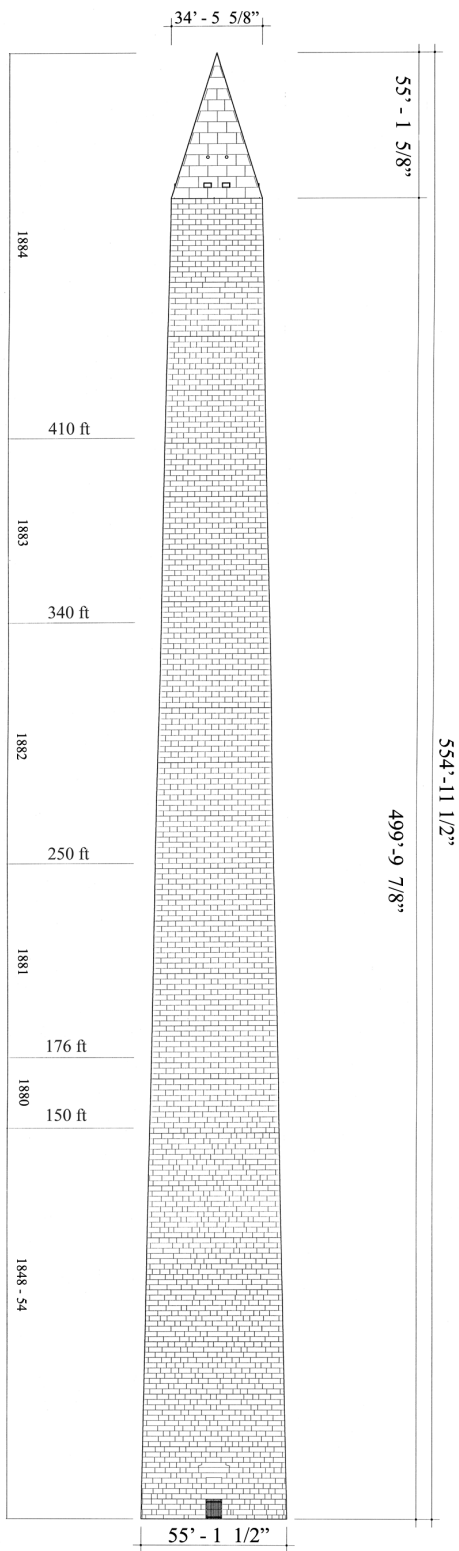
1854,

almost

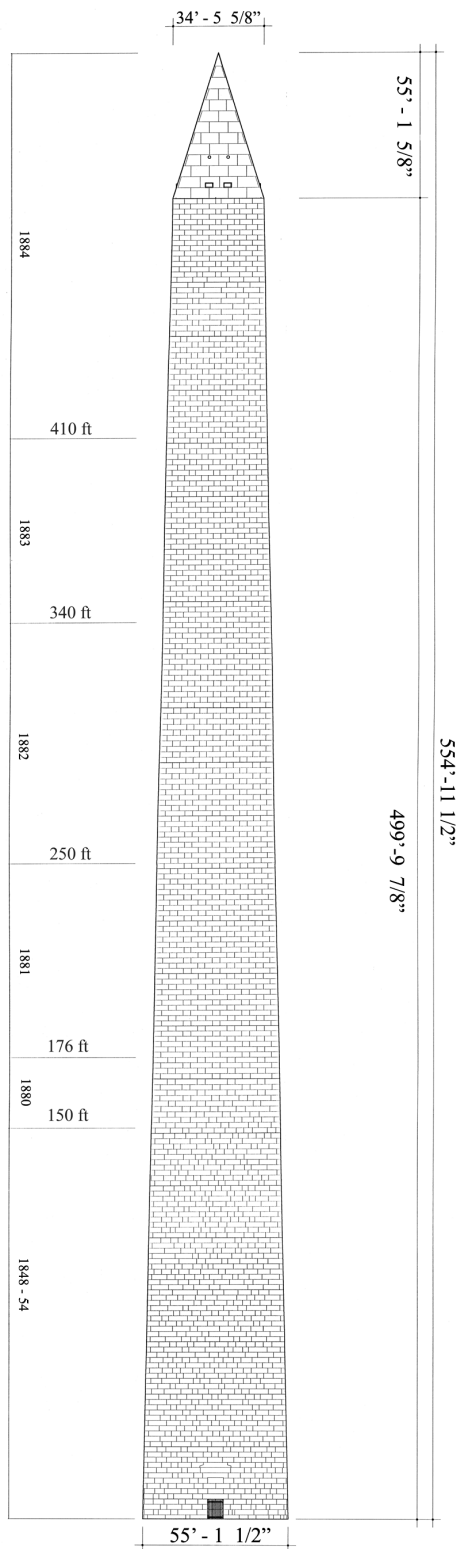


This is one proposal, submitted by Vinnie Ream Hoxie, on how to finish the monument when construction stopped in 1854.

After the Civil War, Congress appropriated \$1,000,000 to complete the Washington Monument the way it currently stands. Additions to the Monument, such as fountains and gardens were proposed in 1902 but were not completed. The ring of flags that currently surround the Monument were added in 1959.



The drawing provides a timeline of the construction of the monument. Determine what percentage of the Monument's finished height was completed during each of the indicated time frames.



The drawing provides a timeline of the construction of the monument. For each time frame (except the top), the completed section would be a truncated pyramid or frustum. If a and b represent the base and top side lengths and h is the height, the volume of the truncated pyramid can be calculated using

$$V = \frac{1}{3}h(a^2 + ab + b^2)$$

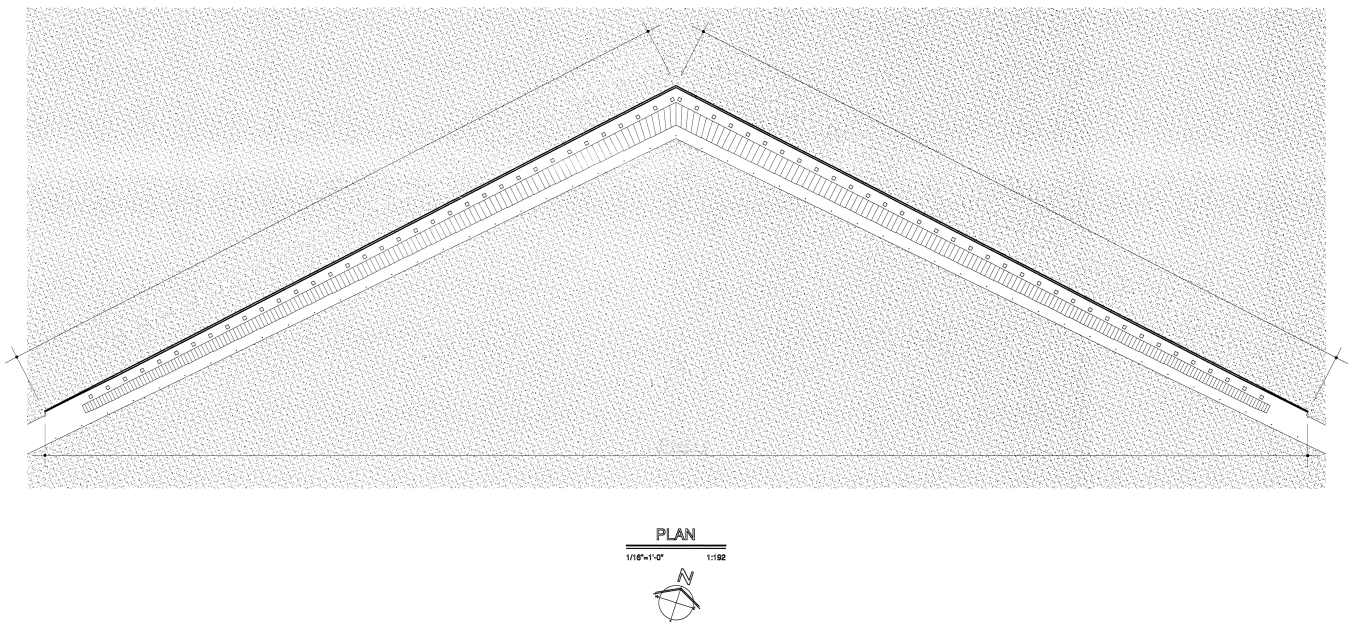
Determine what percentage of the Monument's finished volume was completed during each of the indicated time frames.

Trigonometry – The Vietnam Veterans Memorial

The Vietnam Veterans Memorial was designed by Maya Ying Lin and consisted of two long triangular black walls. The vertex of the walls formed an obtuse angle, with one wall pointing to the north-east corner of the Lincoln Memorial and the other wall pointing to north-west corner of the Washington Monument. The names of more than 58,000 Americans who died or remain missing from the Vietnam War are inscribed on the walls.



If the two walls form an angle of 125° and are each $246' 8 \frac{5}{8}"$ long, what is the distance between the ends of the walls.

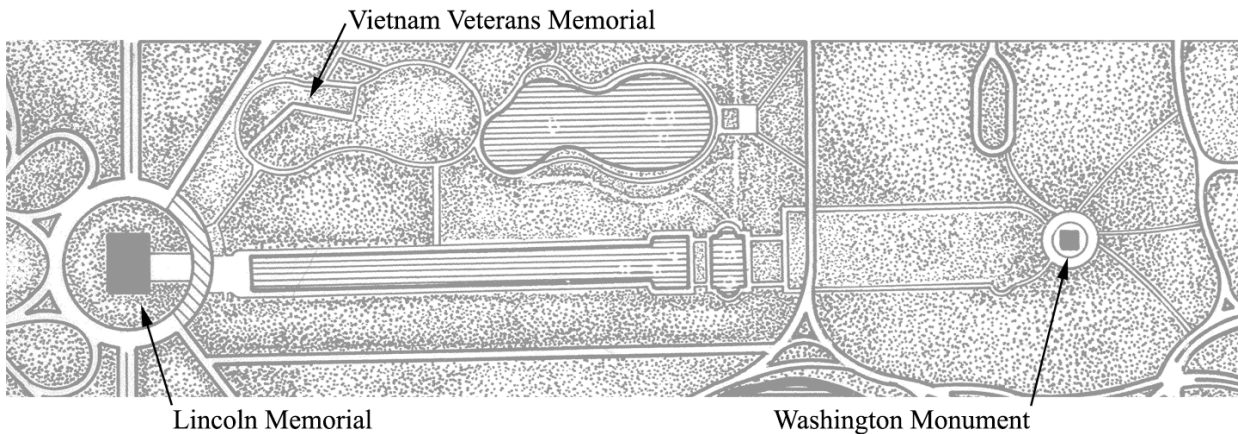


Trigonometry – The Vietnam Veterans Memorial and the Mall



The Vietnam Veterans Memorial was designed by Maya Ying Lin and consisted of two long triangular black walls. The vertex of the walls formed an obtuse angle, with one wall pointing to the north-east corner of the Lincoln Memorial and the other wall pointing to north-west corner of the Washington Monument. The names of more than 58,000 Americans who died or remain missing from the Vietnam War are inscribed on the walls.

The two walls form an angle of 125° and are each $246' 8 \frac{5}{8}"$ long. The west wall points to the north-east corner of the Lincoln Memorial 900 ft. away from the end of the wall. The east wall points to the north-west corner of the Washington Monument 3500 ft. away from the end of the wall. Find the distance between the northeast corner of the Lincoln Memorial and the northwest corner of the Washington Monument.



The footprint of the Lincoln Memorial is a rectangle 201 ft. 10 in by 132 ft. The footprint of the Washington Monument is a square with sides of length 55 ft. 1.5 in. If both the Washington Monument and the Lincoln Memorial are on a north-south axis, how far apart are the two monuments?

Conics – White House Ellipse

One major section of the President's Park, south of the White House is an area commonly known as The Ellipse. The Ellipse is a 52 acre (210,000 m²) park which is the location for a number of monuments and memorials as well as the National Christmas Tree. The real ellipse is the road that surrounds the park area. The length of the road is usually given as 5 furlongs.



The National Park Service's survey of the Ellipse gives:

major axis 1058:26 feet
minor axis 902:85 feet
area 751071:67 square feet
perimeter 3086:87 feet

All measurements were taken from face to face of the curb line.

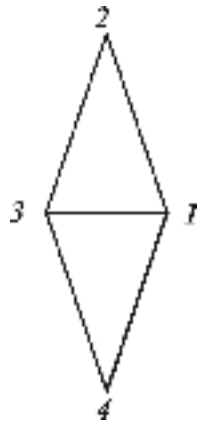
Determine an equation for The Ellipse and verify the area and circumference provided by the NPS are correct.



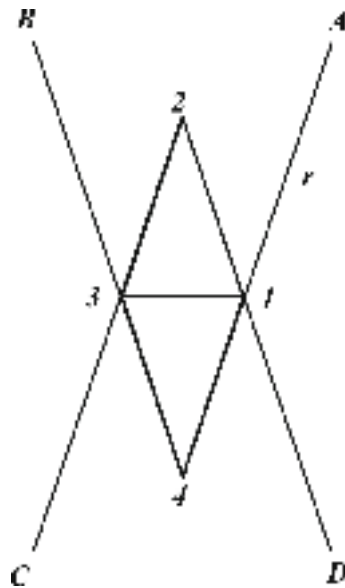
In 1890 the *Meridian Stone* was set at the center of the Ellipse. It is an 18-inch-square (46 cm) granite post set flush with the ground. National Geological Survey gives its location as $38^{\circ} 53.636' \text{ N}, 77^{\circ} 02.193' \text{ W}$. The Meridian Stone is on a line running from the center of the White House to the original location planned for the Washington Monument, now marked by The Jefferson Pier. For more information about the mathematics of The Ellipse, check out "The Shape and History of the Ellipse in Washington, D.C." by Clark Kimberling (<http://faculty.evansville.edu/ck6/ellipse.pdf>)

Calculus – Roman Colosseum

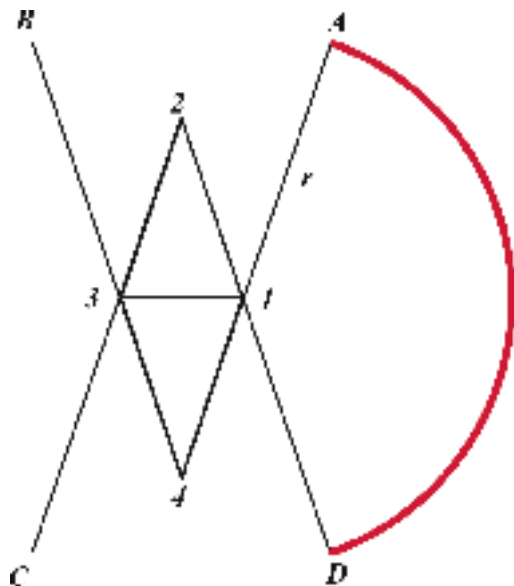
Not every oval is necessarily an ellipse. Although Wikipedia refers to the structure as an ellipse, many experts believe the Roman Colosseum is a combination of circular arcs or a quadrarc.



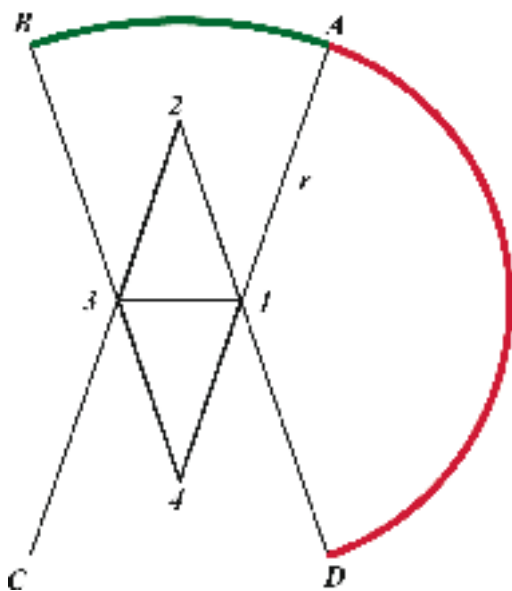
Start with two congruent isosceles triangles.



Extend the sides of the triangles an arbitrary distance r .

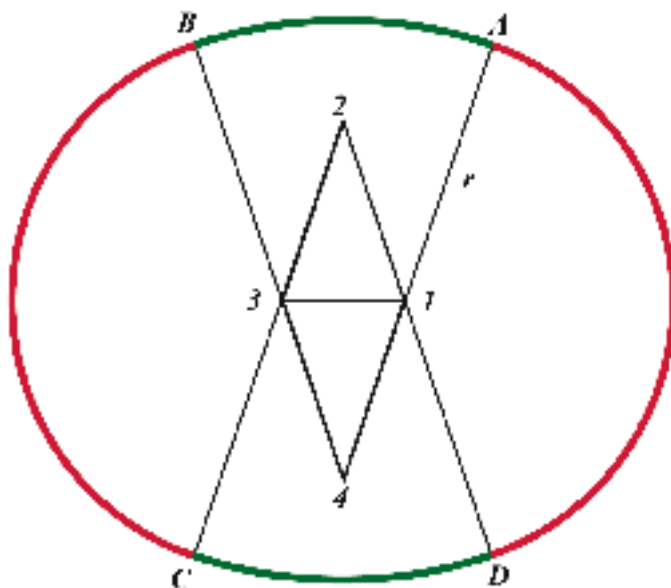


Using point 1 as the center, draw an arc of radius r to connect points A and D .



Using point 4 as the center, draw an arc to connect point A and B.

Complete the oval by drawing an arc from point B to C using point 3 as the center and an arc from point C to D using point 2 as the center.



Use the method described above to draw a quadrarc. Determine its circumference and area.



Parametric Functions

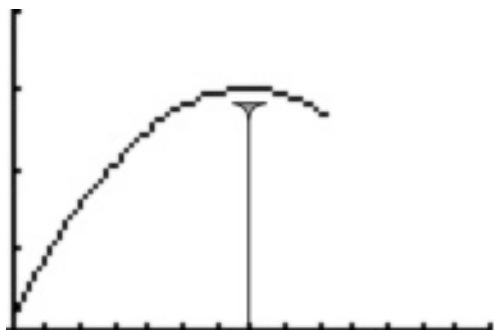


To open the 1992 Summer Olympics in Barcelona, paralympic archer Antonio Rebollo lit the Olympic torch with a flaming arrow. Suppose that the arrow was released at a height of 6 ft above ground level at an angle of 40° and an initial velocity of 150 ft/sec.

Determine the parametric equations that will describe the path of the arrow.



The equation for y is a quadratic function in terms of t . The value of t that would produce the highest y -value is the time the arrow would reach its maximum height. Determine this time to the nearest second. (Determine the vertex of this quadratic function.)



$$x_{scl} = 50, y_{scl} = 50$$

Rebollo wanted the arrow to reach a maximum height exactly 4 ft above the center of the cauldron where it would ignite a plume of natural gas. Determine the height of the torch above the stadium floor and its horizontal distance from Rebollo's position.

Bonus:

The video of the lighting of the torch is available on YouTube: <http://uk.youtube.com/watch?v=N42BivbrUC4>. Tell me the name and title of the "woman in white" who appears at the end of the clip.

Volume by Slicing – Duomo di Firenze

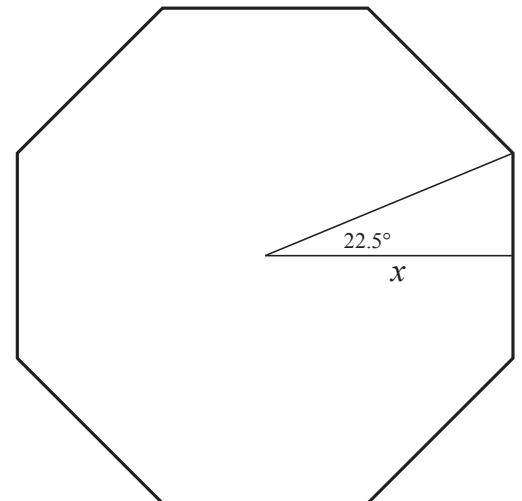
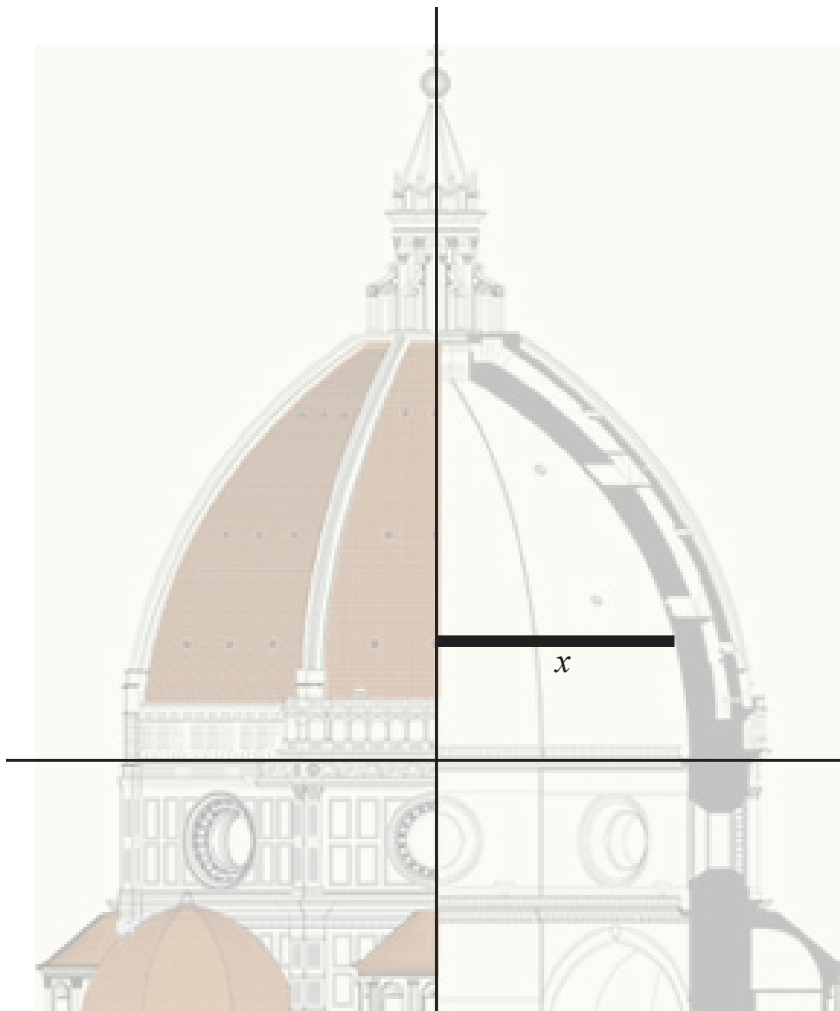
The **Basilica di Santa Maria del Fiore** is the cathedral church (Duomo) of Florence, Italy. One of its main features is its octagonal dome, designed by Filippo Brunelleschi. The dome consists of separate exterior and interior domes and has a height of approximately 31.5 feet and a span of between 42 and 45 feet.

Use octagonal slices to approximate the volume of the interior dome. The shape of the interior dome fits the equation for the upper half of the ellipse.

$$\frac{x^2}{21^2} + \frac{y^2}{31.5^2} = 1$$



<http://www.paradoxplace.com>



<http://www.aboutflorence.com/Museums-in-Florence/duomo-the-cathedral-of-florence.html>