

Hyperbolic Functions and the Gateway Arch ¹

The Gateway Arch in St. Louis has the shape of an inverted catenary. Rising 630 feet at its center and stretching 630 feet across its base, the arch's shape can be described by

$$y = -127.7 \cosh(x/127.7) + 757.7 \text{ for } -315 \leq x \leq 315.$$

1. Enter the following sequence of commands:

(a) `syms x`

(b) `f = -127.7 * cosh(x / 127.7) + 757.7`

(c) `ezplot(f, -315, 315)`

Does the graph look like an arch?

2. To compute the area beneath the Gateway Arch enter the following sequence of commands:

(a) `int(f, -315, 315)`

(b) `double(ans)`

3. To compute the length of the Gateway Arch enter the following sequence of commands:

(a) `int(sqrt(1+diff(f)^2), -315, 315)`

(b) `double(ans)`

Are you surprised that the symbolic answer is expressed in terms of exponential functions rather than hyperbolic functions? Why or why not?

4. On a separate piece of paper, prepare a brief written report describing what happened and answering all the questions. Include the results of all of the computations. Use complete sentences and use standard mathematical notation. Do **not** hand-in a printout.

Students may have little or no exposure to hyperbolic functions in their calculus courses. This assignment gives a real-life application of hyperbolic functions.

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