$y = -16t^2 + 500t$

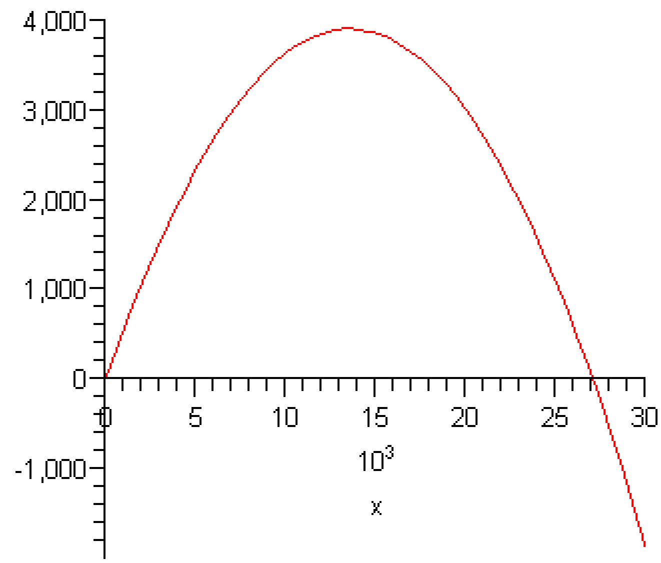
In vector physics, we represent the downward pull as a negative amount. The downward pull due to gravity is $16t^2$ (represented as $-16t^2$) and the upward thrust is 500t (represented by + 500t).

Given these two equations, x = f(t) and y = f(t), we can generate an equation for y = f(x).

Since x = f(t) = 866t, then $t = \dfrac{x}{866}$

By substitution, $y = f(x) = -16\left(\dfrac{x}{866}\right)^2 + 500\left(\dfrac{x}{866}\right)$ or $y = f(x) = -\dfrac{4x^2}{187,489} + \dfrac{250}{433}x$

This function, when graphed, is a parabola (one of the four conic sections[4]). From these equations, we can answer some very important "field" questions.



Field questions

Question 1: What is the *range* of the shell (i.e., how far from the starting point will the projectile strike the ground again)?

We know that when the shell hits the ground, the y-distance will be 0. Hence, we must solve this equation:

$0 = -16t^2 + 500t$

This explains why, when you took courses in algebra involving the solution of polynomial equations, you learned how to solve them (or, find the zeroes of the equation).

On the right side of the equation, the common factor is t:

$0 = t(-16t + 500)$

From this, we get two solutions. The first solution is t = 0. We derive the second solution as follows:

$-16t + 500 = 0$
$16t = 500$
$t = 31.25$

The two solutions are t = 0, 31.25. What does this mean? At t = 0, the projectile is in the cannon. At t = 31.25, the projectile hits the ground.

The distance traveled (on the x-axis) is governed by the equation x = 866t. At t = 31.25, x = (866)(31.25) = 27,062.5 ft (the range).

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[2] Technically, a parametric equation is one of two or more equations expressing the location of a point on a curve or surface by determining each coordinate separately.
[3] Galileo Galilee (1564-1642) discovered this function by experimenting with balls rolling down inclined planes.
[4] The other three are the ellipse, the hyperbola, and the circle.