Flight of a Ball *A baseball is hit with upward velocity 48 feet per second when* $t = 0$*, from a height of 4 feet.*[1]

a. *Find the function that models the height of the ball as a function of time.*

Suppose an object is shot or thrown into the air and then falls. From physics, we know that if air resistance is ignored, the height of the object after t seconds can be modeled by

$$S(t) = a_0t^2 + v_0t + h_0$$

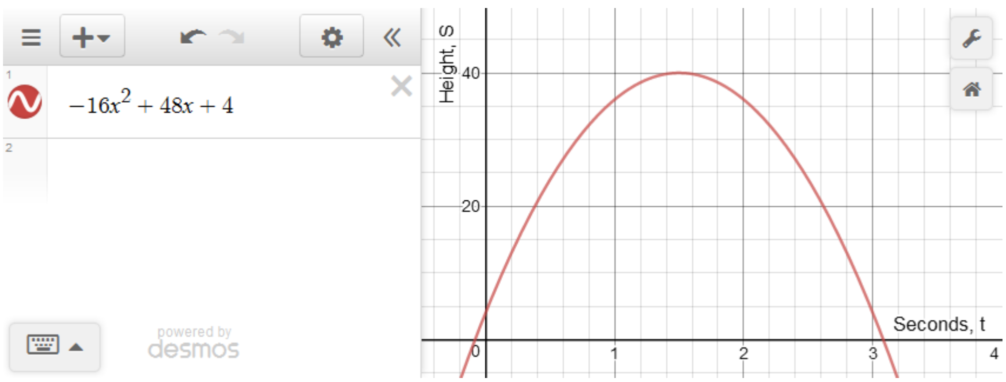
where a_0 is the acceleration due to gravity, v_0 is the initial velocity, and h_0 is the initial height of the object.

When height is given in feet and time in seconds, $a_0 = -16$ ft/sec^2, the units for acceleration will be ft/sec, and the units for height will be ft.

In this problem, $a_0 = -16$, $v_0 = 48$, and $h_0 = 4$. The function that models the height of the ball as a function of time is

$$S(t) = -16t^2 + 48t + 4.$$

And here's how the graph of $S(t)$ looks:



b. *Find the maximum height of the ball and in how many seconds the ball will reach that height.*

Algebraically, the vertex is at the point $\left(\frac{-b}{2a}, S\left(\frac{-b}{2a}\right)\right)$. Substituting $a = -16$ and $b = 48$ we get...

$$\begin{aligned}\frac{-b}{2a} &= \frac{-48}{2(-16)}\\ &= \frac{-48}{-32}\\ &= 1.5\end{aligned}$$

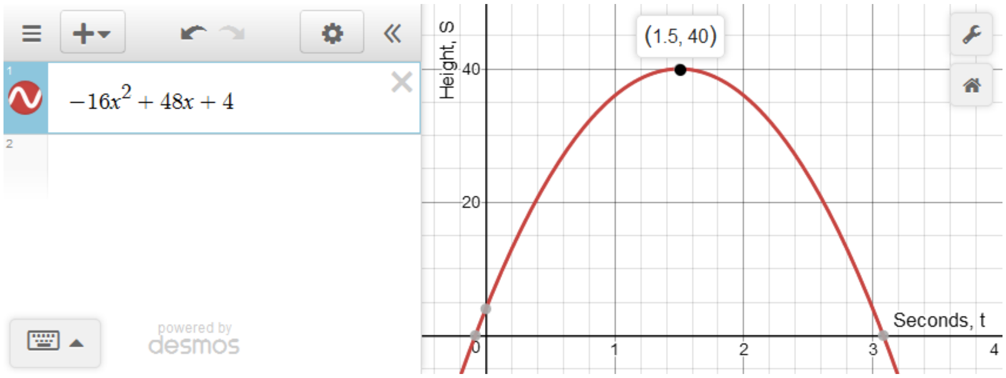
And...

$$\begin{aligned}S(1.5) &= -16(1.5)^2 + 48(1.5) + 4\\ &= -36 + 72 + 4\\ &= 40\end{aligned}$$

The vertex of the graph of this quadratic function is $t = 1.5$ and $S = 40$, or $(1.5, 40)$.

[1]Harshbarger/Yocco, *College Algebra In Context*, 5e, p. 180, #72.

We can also find the vertex on the graph.



Remember, this graph does NOT show the path of the ball. Each point on the graph tells us the height of the ball some number of seconds after it is thrown.

The vertex, $(1.5, 40)$, tells us that it takes 1.5 seconds for the ball to reach its maximum height of 40 feet.