You can model the motion of a pumpkin released from a catapult using a vertical motion model. A **vertical motion model** is a quadratic equation that models the height of an object at a given time. The equation is of the form shown.

$$y = -16t^2 + v_0 t + h_0$$

In this equation, y represents the height of the object in feet, t represents the time in seconds that the object has been moving, v_0 represents the initial vertical velocity (speed) of the object in feet per second, and h_0 represents the initial height of the object in feet.

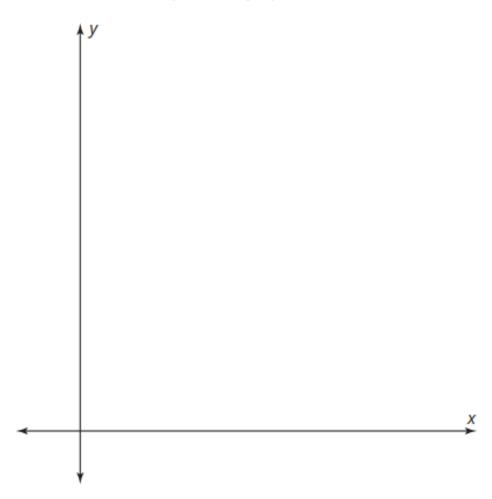1. **What characteristics of this situation indicate that it can be modeled by a quadratic function?**

Suppose that a catapult hurls a pumpkin from a height of 68 feet at an initial vertical velocity of 128 feet per second.
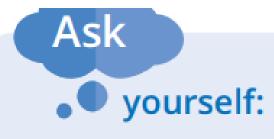
2. **Write a function for the height of the pumpkin, $h(t)$, in terms of time, t.**

3. **Does the function you wrote have a minimum or maximum? How can you tell from the form of the function?**

4. **Use technology to graph the function. Sketch your graph and label the axes.**

Punkin' Chunkin'

Ask **yourself:**

What do all the points on this graph represent?

5. Use technology to determine the maximum or minimum and label it on the graph. Explain what it means in terms of the problem situation.

6. Determine the *y*-intercept and label it on the graph. Explain what it means in terms of the problem situation.

7. **Use a horizontal line to determine when the pumpkin reaches each height after being catapulted. Label the points on the graph.**

   a. **128 feet**

   b. **260 feet**

   c. **55 feet**

8. **Explain why the *x*- and *y*-coordinates of the points where the graph and each horizontal line intersects are solutions.**

9. **When does the catapulted pumpkin hit the ground? Label this point on the graph. Explain how you determined your answer.**

Remember:

The zeros of a function are the x-values when the function equals 0.

The time when the pumpkin hits the ground is one of the x-intercepts, (x, 0). When an equation is used to model a situation, the x-coordinate of the x-intercept is referred to as a root. The **root** of an equation indicates where the graph of the equation crosses the x-axis.