Objectives: Our goal is to be able to interpret quadratic functions and apply them to real world scenarios.

Important Note (Physics students might already know this):
When you are dealing with the motion of an object, the general format of the equation is:

$$h(t) = -\frac{1}{2}gt^2 + v_0t + h_0$$

Where g is the gravity (Gravity on Earth is $-32\frac{feet}{second^2}$ or $-9.8\frac{meters}{second^2}$. Because our "a" value is ½ of gravity, we often use -16 when dealing with feet and -4.9 when dealing with meters. v_0 is the initial velocity of the object in motion, and h_0 is the initial height of the object.

h_0 V_0

Example 1: Jamie jumps off a 12-foot high diving board with an initial velocity of 12ft per second.

1. Write a quadratic equation to represent this scenario.

$h(t) = -16t^2 + 12t + 12$

2. After Jamie jumps, how high does she get?

Maximum - vertex

(h,k) $h = \frac{-b}{2a} = \frac{-12}{2(-16)} = \frac{+12}{+32} = 0.375$

$k = ?$ $k = h(h) = h(0.375) = -16(0.375)^2 + 12(0.375) + 12 = 14.25$ ft

3. How long will it take her to hit the water?

t $h = 0$ "x-int"

$0 = -16t^2 + 12t + 12$

$\frac{0}{-4} = \frac{-4(4t^2 - 3t - 3)}{-4}$

$0 = 4t^2 - 3t - 3$

$a=4 \quad b=-3 \quad c=-3$

$x = \frac{+3 \pm \sqrt{(-3)^2 - 4(4)(-3)}}{2(4)}$

ac: 12 → 4, 3 → 2, 6 → 1, 12

$x = \frac{3 \pm \sqrt{57}}{8}$

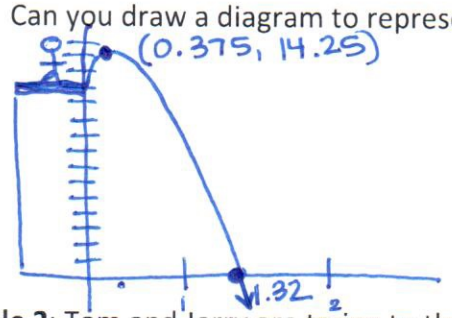
$x = \frac{3 + \sqrt{57}}{8}$ $x = \frac{3 - \sqrt{57}}{8}$

$x = 1.32$ sec

$x = -0.57$ sec

x-int.

4. Can you draw a diagram to represent this scenario?



Example 2: Tom and Jerry are trying to throw a ball over the top of a 25-foot-high building. Jerry is only 5 feet tall, and throws with an initial velocity of 30 feet per second. Will Jerry be able to throw the ball over the building?

h_0 V_0

Maximum??
vertex??
(h,k)

$h(t) = -16t^2 + 30t + 5$

$h = \frac{-b}{2a} = \frac{-30}{2(-16)} = \frac{+30}{+32} = 0.938$ ft

$k = h(0.938) = -16(0.938)^2 + 30(0.938) + 5 = 19.06$ ft

The ball will not clear the building! ∴

Example 3: You have designed a new style of sports bicycle! Now, you want to make a lot of them and sell them for a profit. You determine that the profit is modeled on the equation $P(x) = -200x^2 + 92000x - 8{,}400{,}000$ where x is the number of bikes sold.

1. How many bikes would you have to sell to make the maximum profit?

solve for x.

vertex (h, k)

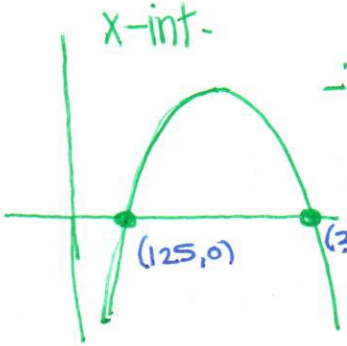
$h = \frac{-b}{2a} = \frac{-92000}{2(-200)} = \frac{+92000}{+400} =$ **230 bikes**

2. What is the maximum profit?

$P = ?$ $\quad P(230) = -200(230)^2 + 92000(230) - 8400000$

$P = \$2{,}180{,}000$

3. When will you "break even"? solve for x, when P = $0



$\frac{0}{-200} = \frac{-200x^2}{-200} + \frac{92000x}{-200} - \frac{8400000}{-200}$

$0 = x^2 - 460x + 42000$

$a=1 \quad b=-460 \quad c=42000$

$x = \frac{+460 \pm \sqrt{(460)^2 - 4(1)(42000)}}{2(1)}$

$x = \frac{460 \pm \sqrt{43600}}{2}$

$x = \frac{460 + 208.8}{2}$

$x = 334$ bike

$x = \frac{460 - 208.8}{2}$

$x = 125$ bikes.

4. For what values of x do you make a profit?

when you sell more than 126 bikes but less than 334 bikes.

$126 \leq x \leq 333$

5. For what values of x do you suffer a loss?

if you sell between 0 and 124 bikes OR greater than 335 bikes.