Quadratic Applications

For the half time entertainment at a basketball game, a student agrees to be shot out of a cannon through an enlarged basketball hoop and into a tub of water. The person in the cannon is 3 feet off of the ground. The basketball hoop is 55 feet away and 14 feet off of the ground. The surface of the tub of water is 60 feet away and 3 feet off of the ground.

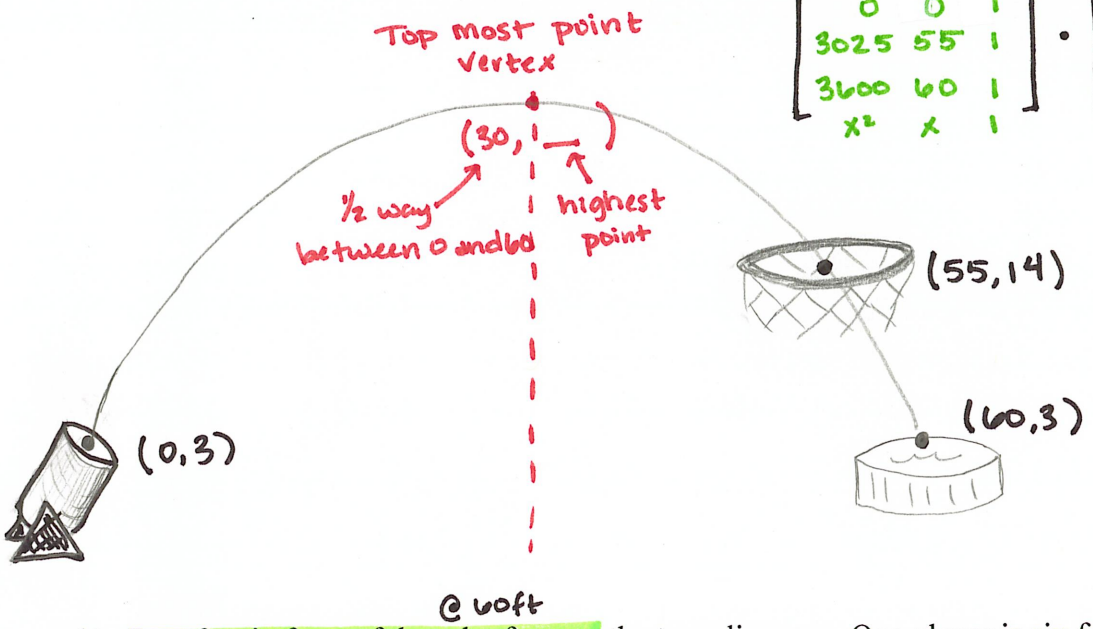
a) Another student, being a curious young mathematician, quickly finds the equation for this function.

What kind of function is this? Parabola - Quadratic

Sketch a graph with the given points and then find the equation → $y = -0.04x^2 + 2.4x + 3$

Matrix A

$$\begin{bmatrix} 0 & 0 & 1 \\ 3025 & 55 & 1 \\ 3600 & 60 & 1 \\ x^2 & x & 1 \end{bmatrix}^{-1} \cdot \begin{bmatrix} 3 \\ 14 \\ 3 \end{bmatrix} = \begin{bmatrix} -0.04 \\ 2.4 \\ 3 \end{bmatrix}$$



b) Four feet in front of the tub of water, the team lines up. One player is six feet six inches tall. Is he in danger of being hit?

60 − 4 → $x = 56$ ⇒ $y = -0.04(56)^2 + 2.4(56) + 3$

$y = 12$ ft

NO, the basketball player is not in danger of being hit. The human cannon ball will be 5.5 ft above him.

c) The roof is at 35 feet. Is the student being shot from the cannon safe?

$x = 30$ is halfway between 0 and 60 the y-value will be the highest pt the student will go.

$y = -0.04(30)^2 + 2.4(30) + 3$

$y = 39$ ft

OR

put it into vertex form

$y = -0.04x^2 + 2.4x + 3$

$y - 3 = -0.04x^2 + 2.4x$

$y - 3 + \underline{-36} = -0.04(x^2 - 60x + \underline{900})$

$\frac{-60}{2} = (-30)^2 = 900$

$y - 39 = -0.04(x - 30)^2$

vertex Form

(30, 39) Vertex

NO, the student is not safe. They will hit the ceiling

Extended Practice:

1. Assume that the number of liters of water remaining in the bathtub varies quadratically with the number of minutes, which have elapsed since you pulled the plug.

   a) If the tub has 38.4, 21.6, and 9.6 liters remaining at 1, 2, and 3 minutes respectively, since you pulled the plug, write an equation expressing liters in terms of time.

   $y = 2.4x^2 - 24x + 60$

   b) How much water was in the tub when you pulled the plug?

   $y = 60$ Liters

   c) When will the tub be empty?

   $X = 5$ minutes

   d) Why is a quadratic function more reasonable for this problem than a linear function would be?

2. Suppose that you are an actuary for an insurance agency. Your company plans to offer a senior citizen's accident policy, and you must predict the likelihood of an accident as a function of the driver's age. From previous accident records, you find the following information:

Age	Accidents per 100 million kilometers driven
20	440
30	280
40	200

You know that the number of accidents per 100 million kilometers driven should reach a minimum then go up again for very old drivers. Therefore, you assume that a quadratic function is a reasonable.

a) Write the particular equation expressing accidents per 100 million kilometers in terms of age.

$y = 0.4x^2 - 36x + 1000$

b) How many accidents per 100 million kilometers would you expect for an 80-year-old driver?

$y = 680$ accidents

c) Based on your model, who is safer; a 16-year-old driver or a 70-year-old driver?

The 70 year old

d) What age driver appears to be the safest?

45 years old

e) Your company decides to insure licensed drivers up to the age where the accident rate reaches 830 per 100 million kilometers. What is the domain of this quadratic function?

The insurance company would cover 16-85 year olds