# Height of a Zero Gravity Parabolic Flight

Math 1010 Intermediate Algebra Group Project

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Have you ever wondered what it might feel like to float
weightless in space? One way to try it out is to fly on a special
aircraft that astronauts use to train for their trips to space.
Both NASA and the Russian Space Agency have been flying
these for years.  The way this is accomplished is to fly to a high
altitude, drop down to gain speed, and then start a large
parabolic path up in the sky.  For a time ranging from 10 to 20 seconds, along the top part of the
parabolic flight, an environment simulating zero gravity is created within the plane.  This effect can
cause some nausea in the participants, giving rise to the name "Vomit Comet", the plane used by NASA
for zero-G parabolic training flights.  Currently there is a private company that will sell you a zero-G ride,
though it is a bit expensive, around $5000.

This lab will have you take a look at the parabolic path to try to determine the maximum altitude the
plane reaches. First, you will work with data given about the parabola to come up with a quadratic
model for the flight.  Then you will work to find the maximum value of the model.  Now for the data:

**Height of a Zero-G Flight t Seconds After
Starting a Parabolic Flight Path**

| Time $t$ in seconds | 2 | 10 | 20 |
|---|---|---|---|
| Height $h$ in feet | 30,506 | 31,250 | 29,300 |

To find the quadratic model, you will be plugging the data into the model $h = at^2 + bt + c$.
The data points given are just like x and y values, where the x value is the time $t$ in seconds and
the y value is the altitude $h$ in feet.  Plug these into the model and you will get equations with a,
b and c.

Part 1:  Write your 3 by 3 system of equations for a, b, and c.

$$h = a(2)^2 + b(2) + c = 30506 \rightarrow 4a + 2b + c = 30506$$

$$h = a(10)^2 + b(10) + c = 31250 \rightarrow 100a + 10b + c = 31250$$

$$h = a(20)^2 + b(20) + c = 29300 \rightarrow 400a + 20b + c = 29300$$

Part 2: Solve this system. Make sure to show your work.

$$\begin{bmatrix} 4 & 2 & 1 & 30506 \\ 100 & 10 & 1 & 31250 \\ 400 & 20 & 1 & 29300 \end{bmatrix} \begin{matrix} (-25)R_1 + R_2 \to R_2 \\ (-100)R_1 + R_3 \to R_3 \end{matrix} \begin{bmatrix} 4 & 2 & 1 & 30506 \\ 0 & -40 & -24 & -731400 \\ 0 & -180 & -99 & -3021300 \end{bmatrix} \begin{matrix} (-8)R_2 \to R_2 \\ (-9)R_3 \to R_3 \end{matrix} \begin{bmatrix} 4 & 2 & 1 & 30506 \\ 0 & 5 & 3 & 91425 \\ 0 & 20 & 11 & 335700 \end{bmatrix} (-4)R_2 + R_3 \to R_3$$

$$\begin{bmatrix} 4 & 2 & 1 & 30506 \\ 0 & 5 & 3 & 91425 \\ 0 & 0 & -1 & -30000 \end{bmatrix} \begin{matrix} R_3 + R_1 \to R_1 \\ 3R_3 + R_2 \to R_2 \\ (-1)R_3 \to R_3 \end{matrix} \begin{bmatrix} 4 & 2 & 0 & 506 \\ 0 & 5 & 0 & 1425 \\ 0 & 0 & 1 & 30000 \end{bmatrix} \begin{matrix} \frac{1}{2}R_1 \to R_1 \\ \frac{1}{5}R_2 \to R_2 \end{matrix} \begin{bmatrix} 2 & 1 & 0 & 253 \\ 0 & 1 & 0 & 285 \\ 0 & 0 & 1 & 30000 \end{bmatrix} R_1 - R_2 \to R_1$$

$$\begin{bmatrix} 2 & 0 & 0 & -32 \\ 0 & 1 & 0 & 285 \\ 0 & 0 & 1 & 30000 \end{bmatrix} \frac{1}{2}R_1 \to R_1 \begin{bmatrix} 1 & 0 & 0 & -16 \\ 0 & 1 & 0 & 285 \\ 0 & 0 & 1 & 30000 \end{bmatrix} \longrightarrow \boxed{a = -16 \quad b = 285 \quad c = 30,000}$$

check:
$$h(2) = -16(2)^2 + 285(2) + 30000 \to 30506 \checkmark$$
$$h(10) = -16(10)^2 + 285(10) + 30000 \to 31250 \checkmark$$
$$h(20) = -16(20)^2 + 285(20) + 30000 \to 29300 \checkmark$$

Part 3: Using your solutions to the system from part 2 to form your quadratic model of the data.

$$\boxed{h = -16t^2 + 285t + 30000}$$

Part 4: Find the maximum value of the quadratic function. Make sure to show your work.

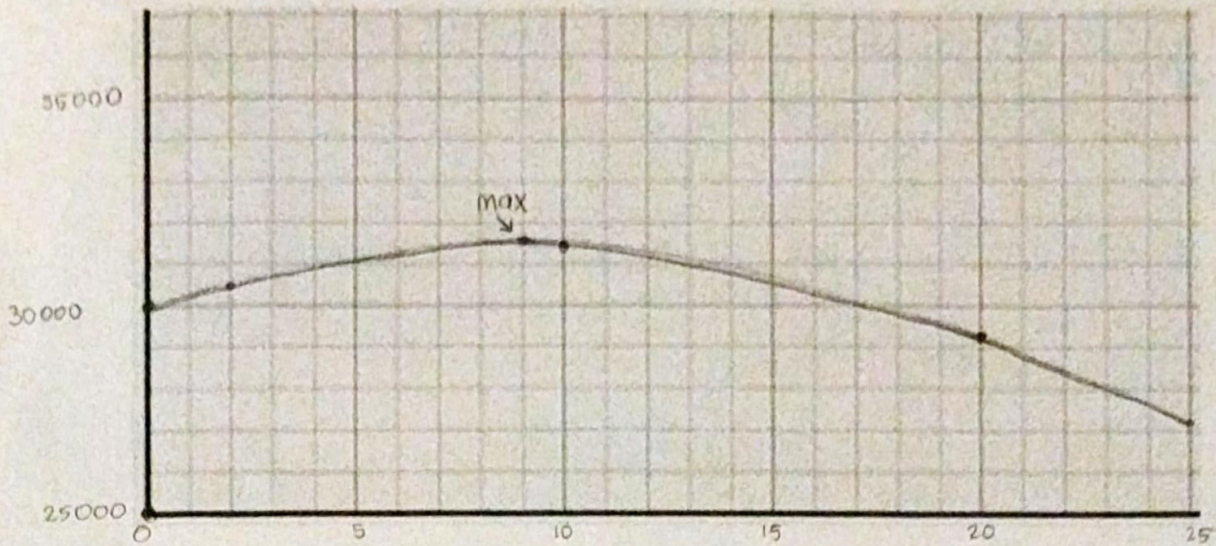Vertex: $\left( \frac{-b}{2a}, f\left(\frac{-b}{2a}\right) \right) \longrightarrow (8.9, 31269.1)$

$$t: \quad \frac{-(285)}{2(-16)} \to \frac{285}{32} \quad \text{or} \approx 8.9$$

$$h: \quad -16\left(\frac{285}{32}\right)^2 + 285\left(\frac{285}{32}\right) + 30000 \to \approx 31269.1$$

$$\boxed{max \approx 31269.1}$$

Part 5: Sketch the parabola. Label the given data plus the maximum point. A good way to start labeling your axes is to have the lower left point be (0, 25000)



Part 6: Reflective Writing.

Did this project change the way you think about how math can be applied to the real world? Write one paragraph stating what ideas changed and why. If this project did not change the way you think, write how this project gave further evidence to support your existing opinion about applying math. Be specific.

This problem is similar to many from the homework. This problem, then, only served as further evidence, or practice, for one way to apply quadratic formulas. I enjoy word problems like this, if they can be relevant.