Height of a Zero Gravity Parabolic Flight

Ashley Cavender 6th

PROMPT:

Have you ever wondered what is 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 $5,000.

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 parabolic to come up with a quadratic model for the flight. Then you will work to find the maximum value of the model.

PART ONE:

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

$h(t)=at^2+bt+c$

1. $a(2)^2+b(2)+c = 30{,}506$ $4a+2b+c=30{,}506$
2. $a(10)^2+b(10)+c = 31{,}250$ $100a+10b+c=31{,}250$
3. $a(20)^2+b(20)+c = 29{,}300$ $400a+20b+c=29{,}300$

PART TWO:

Solve this system (a,b,c). Make sure to show your work.

$4a+2b+c=30{,}506$

$100a+10b+c=31{,}250$

$400a+20b+c=29{,}300$

(4 2 1 : 30506)
(100 10 1 : 31250)
(400 20 1 : 29300)

-25R1+R2 R2
-100 -50 -25 : -762650
(^ Row 1 multiplied by -25)

(4 2 1 : 30506)
(0 -40 -24 : -731400)
(400 20 1 : 29300)

-100R1+R3 R3
-400 -200 -100 : -3050600
(^ Row 1 multiplied by -100)

(4 2 1 : 30506)
(0 -40 -24 : -731400)
(0 -180 -99 : -3021300)

-18R2 R2
4R3 R3

(Continued on next slide)

PART TWO: CONTINUED

$$\left(\begin{array}{ccc|c} 4 & 2 & 1 & 30506 \\ 0 & 720 & 432 & 13165200 \\ 0 & -720 & -396 & -12085200 \end{array}\right) \quad R2+R3 \quad R3$$

$$\left(\begin{array}{ccc|c} 4 & 2 & 1 & 30506 \\ 0 & 720 & 432 & 13165200 \\ 0 & 0 & 36 & 1080000 \end{array}\right)$$

$1080000/36 = 30000$

$c = 30000$

$-40b+(-24*30000)= -731400$

$\qquad +720000 \qquad +720000$

$$\frac{-40b}{-40} = \frac{-11400}{-40}$$

$b = 285$

$4a+2(285)+(30000) = 30506$

$4a+570+30000 = 30506$

$\qquad -30570 \quad -30570$

$$\frac{4a}{4} = \frac{-64}{4}$$

$a = -16$

$$\boxed{\begin{array}{l} a = -16 \\ b = 285 \\ c = 30000 \end{array}}$$

PART THREE:

Using your solution to the system from PART TWO to form your quadratic model of the data.

$h(t)=at^2+bt+c$

$a=-16$

$b=285$

$c=30,000$

(Plug in a, b, and c into the equation)

$h(t)=-16t^2+285t+30,000$

PART FOUR:

Find the maximum value (vertex) of the quadratic function.

Y-Vertex = $\frac{-b}{2a}$ =Time

$\frac{-285}{2(-16)} = \frac{-285}{-32}$

8.91 Seconds

-16(8.91)^ 2+285(8.91)+30,000

-16(79.39)+285(8.91)+30,000

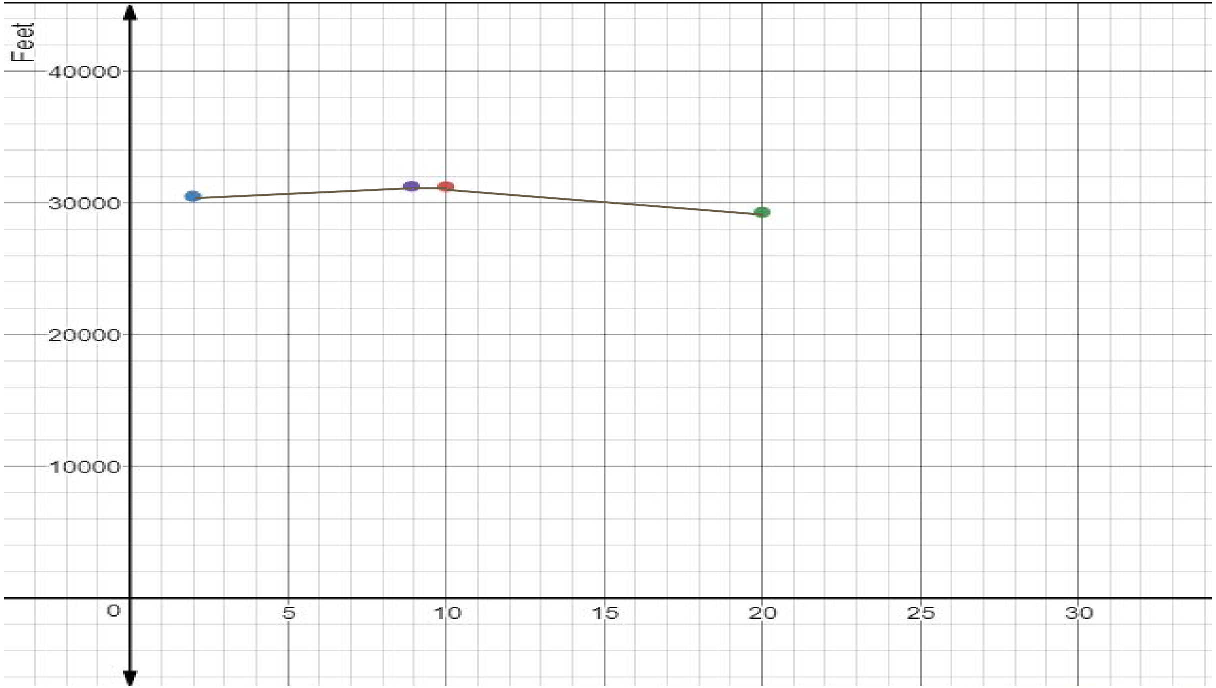
-1,270.21+2,539.35+30,000

-1,270.21+32,539.35

31,269.14 Feet

PAR FIVE:

Sketch the parabola. Label the given data plus the maximum point.



PART SIX:

This project did not change the way I think about how math can be applied to the real world. However, it has further supported my existing opinion. I had already come to believe that math has a lot of value in the real world. This math project has shown step by step how math is used to solve a real world problems in this particular situation. Not only that, It also has the equations, the numbers, and the graphs to all support each other to make a true, solid answer.