

Height of a Zero Gravity Parabolic Flight

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.



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:

| | | | |
|---------------------|-------|-------|-------|
| Time t in seconds | 4 | 22 | 43 |
| Height h in feet | 23845 | 33017 | 34004 |

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 .

Plug in the values from the chart:

$$\begin{aligned} a(4)^2 + b(4) + c &\rightarrow 16a + 4b + c = 23845 & (1) \\ a(22)^2 + b(22) + c &\rightarrow 484a + 22b + c = 33017 & (2) \\ a(43)^2 + b(43) + c &\rightarrow 1849a + 43b + c = 34004 & (3) \end{aligned}$$

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

$$\begin{array}{r} 484a+22b+c=33017 \\ -16a \quad -4b \quad -c=-23845 \\ \hline 468a+18b=9172 \end{array} \quad \begin{array}{l} \text{*Subtract (1) from (2)} \\ \rightarrow (4) \end{array}$$

$$\begin{array}{r} 1849a+43b+c=34004 \\ -484a \quad -22b \quad -c=-33017 \\ \hline 1365a+21b=987 \end{array} \quad \begin{array}{l} \text{*Subtract (2) from (3)} \\ \rightarrow (5) \end{array}$$

$$7(468a)+7(18b)=7(9172) \rightarrow 3276a +126b=64204 \quad \text{*Multiply (4) by 7}$$

$$6(1365a)+6(21b)=6(987) \rightarrow 8190a - 126b =-5922 \quad \text{*Multiply (5) by 6}$$

$$\begin{array}{r} 3276a +126b=64204 \\ -8190a - 126b =-5922 \\ \hline -4914a=58282 \\ a= -11.86 \end{array} \quad \begin{array}{l} \text{*Subtract (5) from (4)} \\ \text{*Simplify} \end{array}$$

$$\begin{array}{l} 1365(-11.86)+21b=987 \\ -16188.9+21b=987 \\ 21b=17175.9 \\ b= 817.9 \end{array} \quad \text{*Substitute a into (5) and Simplify}$$

$$\begin{array}{l} 16(-11.86)+4(817.9)+c=23845 \\ -189.76+3271.6+c=23845 \\ c= 20763.16 \end{array} \quad \text{*Substitute a and b into (1) and Simplify}$$

$$\begin{array}{l} a= -11.86 \\ b= 817.9 \\ c= 20763.16 \end{array}$$

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

Quadratic Function: $h = at^2 + bt + c$

Plug in the values:

$$a = -11.86$$

$$b = 817.9$$

$$c = 20763.16$$

$$h = -11.86t^2 + 817.9t + 20763.16$$

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

Formula: $t = -b / 2a$

Plug in the values:

$$a = -11.86$$

$$b = 817.9$$

$$c = 20763.16$$

$$\begin{aligned} t &= -817.9 / 2(-11.86) \\ &= 34.48 \end{aligned}$$

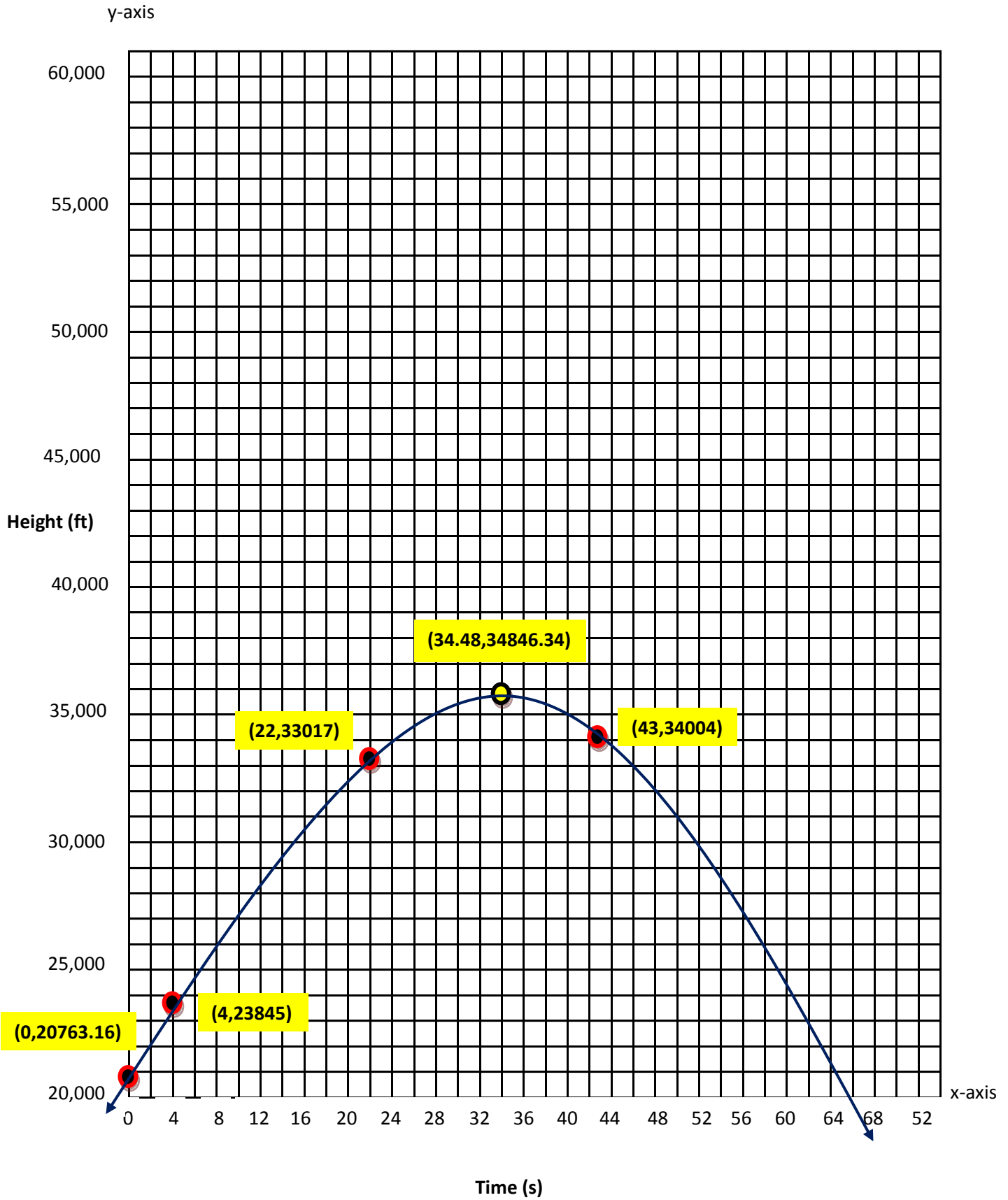
$$\begin{aligned} h &= -11.86t^2 + 817.9t + 20763.16 && \text{*Substitute t into quadratic function and Simplify} \\ &= -11.86(34.48)^2 + 817.9(34.48) + 20763.16 \\ &= -14100 + 28201.19 + 20763.16 \\ &= 34864.35 \end{aligned}$$

Maximum Value/Vertex **(34.48, 34864.35)**

Part 5: Sketch the parabola. Label the given data plus the maximum point. A good way to start labeling your axis is to have the lower left point be (0, 20000)

| Time (x) | Height (y) |
|----------|--------------------------|
| 0 | 20763.16 |
| 4 | 23845 |
| 22 | 33017 |
| 34.48 | 34864.35 (Maximum Point) |
| 43 | 34004 |

Height of a Zero-G Flight



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 project taught Jerry two things; he hates math and that math really is used in everyday stuff. What some see as simple math, he sees as a head ache. However, Jerry feels that simple math produces some pretty cool results. He looks forward to seeing how he can apply the math he learns, in the next 3 math classes he takes, to jerry-world examples. I agree that at times simple Math is not so simple. However, I also think that we can 'over think' simple Math and make it harder than it really is. This project made more sense to me for finding the vertex and graphing a parabola than finding the maximum value for a baseball being hit as a fly ball. I wish that in high school, they would have used more examples that would have applied to everyday life or at least have some cool examples like a Zero Gravity Flight.