

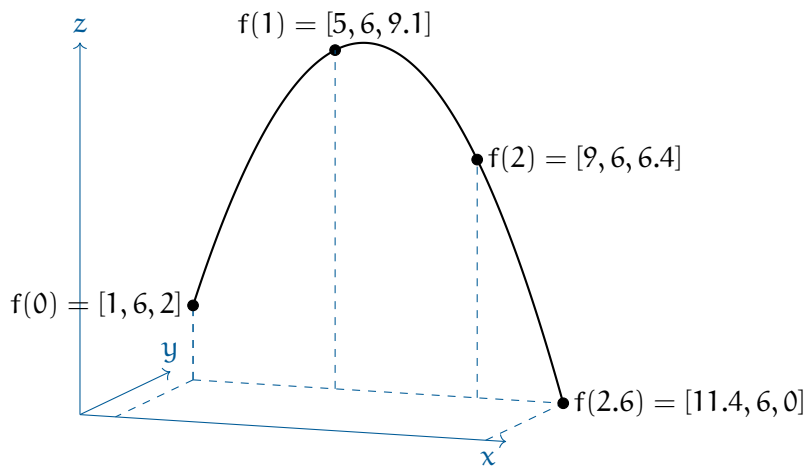
# Vector-valued Functions

In the last chapter, you calculated the flight of the shell. For any time  $t$ , you could find a vector [distance, height]. This can be thought of as a function  $f$  that takes a number and returns a 2-dimensional vector. We call this a *vector-valued* function from  $\mathbb{R} \rightarrow \mathbb{R}^2$ .

We often make a vector-valued function by defining several real-valued functions. For example, if you threw a hammer with an initial upward speed of 12 m/s and a horizontal speed of 4 m/s along the  $x$  axis from the point  $(1, 6, 2)$ , its position at time  $t$  (during its flight) would be given by:

$$f(t) = [4t + 1, 6, -4.8t^2 + 12t + 2]$$

In other words,  $x$  is increasing with  $t$ ,  $y$  is constant, and  $z$  is a parabola.

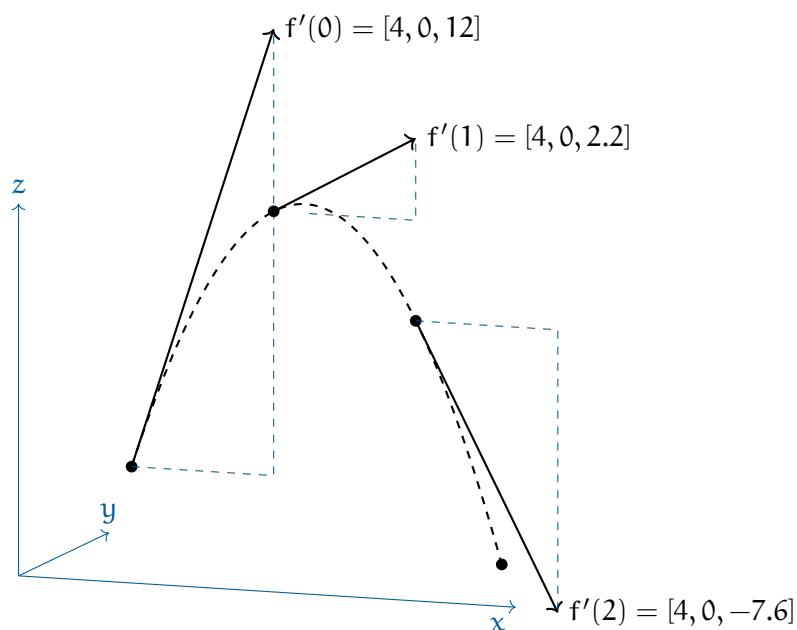


## 1.1 Finding the velocity vector

Now that we have its position vector, we can differentiate each component separately to get its velocity as a vector-valued function:

$$f'(t) = [4, 0, -9.8t + 12]$$

In other words, the velocity is constant along the  $x$ -axis, zero along the  $y$ -axis, and decreasing with time along the  $z$  axis.

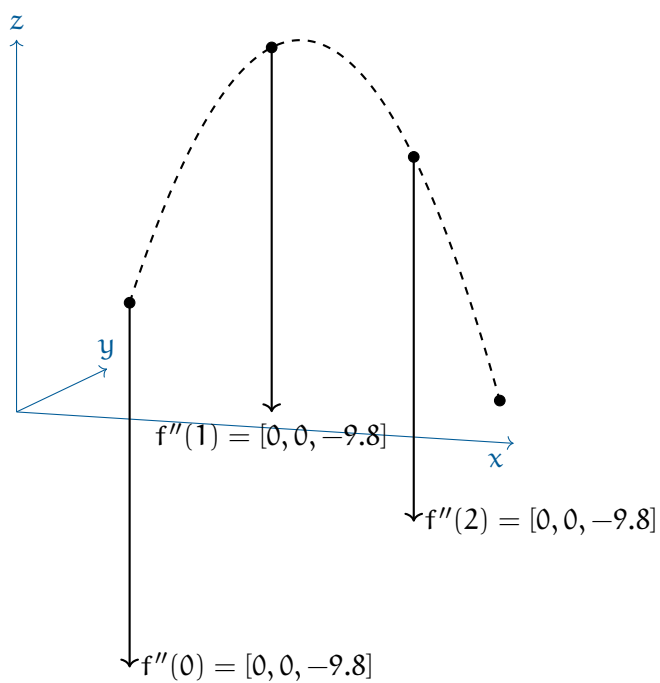


## 1.2 Finding the acceleration vector

Now that we have its velocity, we can get its acceleration as a vector-valued function:

$$f''(t) = [0, 0, -9.8]$$

There is no acceleration along the  $x$  or  $y$  axes. It is accelerating down at a constant  $9.8\text{m/s}^2$ .



This is a draft chapter from the Kontinua Project. Please see our website (<https://kontinua.org/>) for more details.



# Answers to Exercises

