

1. [10 points] Laquita decides to visit an amusement park during Fall Break and rides several roller coasters, including the Classic Amazing Looping Coaster and the Ultra Mountain. Let  $R(t)$  be the distance, in feet, that the CAL Coaster has moved along the track  $t$  seconds after the ride begins. The ride lasts a total of 60 seconds. Several values of  $R(t)$  are shown in the following table.

$t$	0	10	25	30	40	45	55	60
$R(t)$	0	496	1103	1327	1817	2136	2718	3141

For parts a.– c., remember to show your work and reasoning clearly.

- a. [2 points] Find the average velocity of the CAL Coaster during the last 15 seconds of the ride, i.e. for  $45 \leq t \leq 60$ . *Include units.*

$$\text{Solution: } \frac{R(60) - R(45)}{60 - 45} = \frac{3141 - 2136}{60 - 45} = \frac{1005}{15} = 67.$$

**Answer:** 67 ft/sec

- b. [2 points] Estimate the instantaneous velocity of the CAL Coaster 30 seconds after the ride begins. *Include units.*

*Solution:* We estimate using average velocity based on nearby measurements.  
 Average velocity for  $25 \leq t \leq 30$ :  $\frac{R(30) - R(25)}{30 - 25} = \frac{1327 - 1103}{5} = \frac{224}{5} = 44.8$   
 (Note that other answers, such as those incorporating (40, 1817), were accepted if work and appropriate units were shown.)

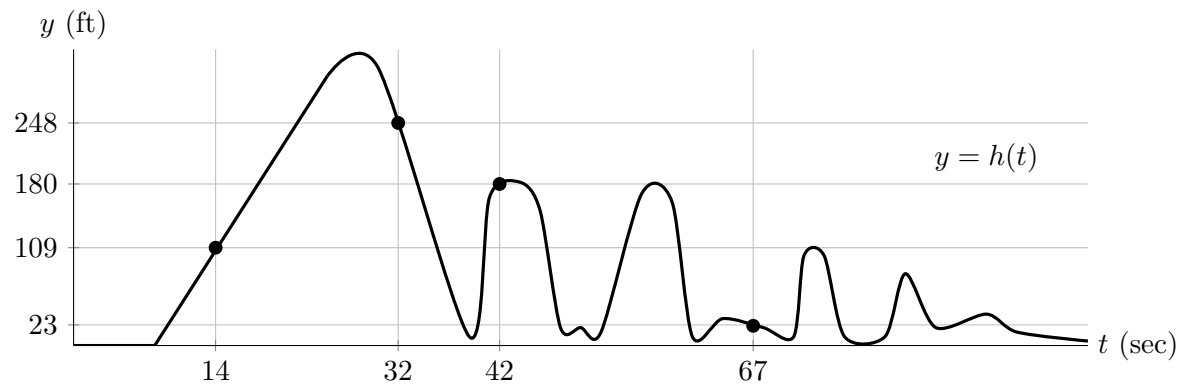
**Answer:** About 44.8 ft/sec

- c. [2 points] Estimate  $R'(55)$ .

*Solution:* We estimate the derivative using the average rate of change of  $R(t)$  for  $55 \leq t \leq 60$ :  $\frac{R(60) - R(55)}{60 - 55} = \frac{3141 - 2718}{5} = 84.6$   
 (Again, answers incorporating (45, 2136) were accepted with appropriate work.)

**Answer:**  $R'(55) \approx$  84.6

- d. [4 points] Let  $h(t)$  be Laquita's height, in feet, above the ground,  $t$  seconds after her ride on the Ultra Mountain begins. A graph of  $h(t)$  is shown below.



Let the quantities I–V be defined as follows:

- I. The number 0.
- II. Laquita's instantaneous vertical velocity, in ft/sec, at  $t = 14$ .
- III.  $h'(32)$
- IV. Laquita's average vertical velocity, in ft/sec, between  $t = 14$  and  $t = 42$ .
- V. Laquita's instantaneous vertical velocity, in ft/sec, at  $t = 67$ .

Rank the quantities in order from least to greatest by filling in the blanks below with the options I–V. You do not need to show your work.

$$\underline{\text{III}} < \underline{\text{V}} < \underline{\text{I (0)}} < \underline{\text{IV}} < \underline{\text{II}}$$