

## Instantaneous Velocity and the Power Rule

Name \_\_\_\_\_

Show all your work on this sheet. Use your calculator only to check answers

Audrey and Laura decide that the dive would be more “interesting” if Mr. Murphy was really able to get some height on his next attempt so they can take pictures and AirDrop them to everyone. They install an even stronger spring under the diving board but lower it to 180 feet high so that the equation for Mr. Murphy’s height in feet and seconds can be given by

$$h(t) = 180 + 32t - 16t^2 \quad v(t) = 32 - 32t$$

- 1) How long Mr. Murphy was in the air?

$$t = 2.5 \text{ sec}$$

- 2) What was Mr. Murphy’s initial velocity?

$$v(0) = 32 - 32(0) = 32 \text{ ft/sec}$$

- 3) What was Mr. Murphy’s maximum height and at what time.

$$h(t) = 180 + 32t - 16t^2$$

$$h(1) = 196 \text{ ft}$$

$$v(t) = 32 - 32t = 0$$

$$t = 1$$

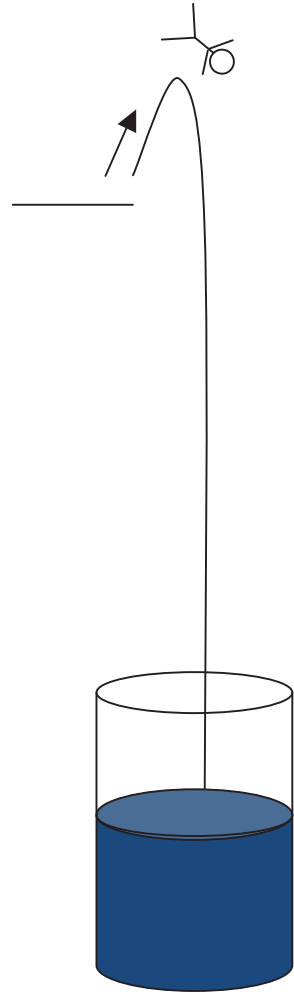
- 4) What was Mr. Murphy’s average velocity over the period of time that he was in the air?

$$\text{Avg vel} = \frac{h(\text{end}) - h(\text{initial})}{\text{end} - \text{initial}} = \frac{h(4.5) - h(0)}{4.5 - 0} \frac{\text{feet}}{\text{sec}} = \frac{-180}{4.5} = -40 \text{ ft/sec}$$

- 5) What was Mr. Murphy’s average velocity from the time he started falling to the time he hit the water?

$$h(4.5) = 0 \quad h(1) = 196$$

$$\frac{h(4.5) - h(1)}{4.5 - 1} \frac{\text{feet}}{\text{sec}} = \frac{0 - 196}{3.5} = -56 \text{ ft/sec}$$



6) Find Mr. Murphy's instantaneous velocity at 1, 2, 3, and 4 seconds.

$$\begin{aligned}\lim_{t \rightarrow 1} \frac{h(t) - h(1)}{t - 1} &= \frac{\overbrace{180 + 32t - 16t^2}^{h(t)} - \overbrace{196}^{h(1)}}{t - 1} = \lim_{t \rightarrow 1} \frac{-16 + 32t - 16t^2}{t - 1} = \lim_{t \rightarrow 1} \frac{-16(t^2 - 2t + 1)}{t - 1} = \lim_{t \rightarrow 1} \frac{-16(t-1)^2}{\cancel{t-1}} \\ &= \lim_{t \rightarrow 1} -16(t-1) = 0 \text{ ft/sec}\end{aligned}$$

$$v(t) = 32 - 32t$$

$$v(1) = 32 - 32(1) = 0 \text{ ft/sec}$$

7) Find Mr. Murphy's instantaneous velocity when he hit the water.

$$\begin{aligned}\lim_{t \rightarrow 4.5} \frac{h(t) - h(4.5)}{t - 4.5} &= \frac{\overbrace{180 + 32t - 16t^2}^{h(t)} - \overbrace{0}^{h(4.5)}}{t - 4.5} = \lim_{t \rightarrow 4.5} \frac{180 + 32t - 16t^2}{t - 4.5} = \lim_{t \rightarrow 4.5} \frac{-16(t^2 - 2t - 11.25)}{t - 4.5} = \lim_{t \rightarrow 4.5} \frac{-16(t+2.5)(\cancel{t-4.5})}{\cancel{t-4.5}} \\ &= \lim_{t \rightarrow 4.5} -16(t+2.5) = -112 \text{ ft/sec}\end{aligned}$$