

3.4 EXERCISES

For the following exercises, the given functions represent the position of a particle traveling along a horizontal line.

- Find the velocity and acceleration functions.
- Determine the time intervals when the object is slowing down or speeding up.

150. $s(t) = 2t^3 - 3t^2 - 12t + 8$

151. $s(t) = 2t^3 - 15t^2 + 36t - 10$

152. $s(t) = \frac{t}{1+t^2}$

153. A rocket is fired vertically upward from the ground. The distance s in feet that the rocket travels from the ground after t seconds is given by $s(t) = -16t^2 + 560t$.

- Find the velocity of the rocket 3 seconds after being fired.
- Find the acceleration of the rocket 3 seconds after being fired.

154. A ball is thrown downward with a speed of 8 ft/s from the top of a 64-foot-tall building. After t seconds, its height above the ground is given by $s(t) = -16t^2 - 8t + 64$.

- Determine how long it takes for the ball to hit the ground.
- Determine the velocity of the ball when it hits the ground.

155. The position function $s(t) = t^2 - 3t - 4$ represents the position of the back of a car backing out of a driveway and then driving in a straight line, where s is in feet and t is in seconds. In this case, $s(t) = 0$ represents the time at which the back of the car is at the garage door, so $s(0) = -4$ is the starting position of the car, 4 feet inside the garage.

- Determine the velocity of the car when $s(t) = 0$.
- Determine the velocity of the car when $s(t) = 14$.

156. The position of a hummingbird flying along a straight line in t seconds is given by $s(t) = 3t^3 - 7t$ meters.

- Determine the velocity of the bird at $t = 1$ sec.
- Determine the acceleration of the bird at $t = 1$ sec.
- Determine the acceleration of the bird when the velocity equals 0.

157. A potato is launched vertically upward with an initial velocity of 100 ft/s from a potato gun at the top of an 85-foot-tall building. The distance in feet that the potato travels from the ground after t seconds is given by

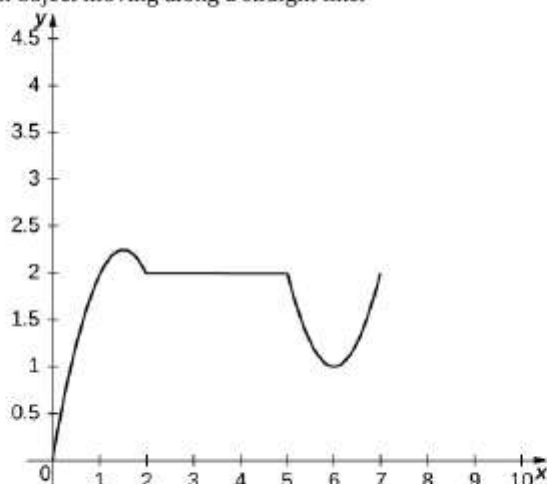
$$s(t) = -16t^2 + 100t + 85.$$

- Find the velocity of the potato after 0.5 s and 5.75 s.
- Find the speed of the potato at 0.5 s and 5.75 s.
- Determine when the potato reaches its maximum height.
- Find the acceleration of the potato at 0.5 s and 1.5 s.
- Determine how long the potato is in the air.
- Determine the velocity of the potato upon hitting the ground.

158. The position function $s(t) = t^3 - 8t$ gives the position in miles of a freight train where east is the positive direction and t is measured in hours.

- Determine the direction the train is traveling when $s(t) = 0$.
- Determine the direction the train is traveling when $a(t) = 0$.
- Determine the time intervals when the train is slowing down or speeding up.

159. The following graph shows the position $y = s(t)$ of an object moving along a straight line.



- Use the graph of the position function to determine the time intervals when the velocity is positive, negative, or zero.
- Sketch the graph of the velocity function.
- Use the graph of the velocity function to determine the time intervals when the acceleration is positive, negative, or zero.
- Determine the time intervals when the object is speeding up or slowing down.