**Derivatives and Rates of Change**

1. Suppose s(t) = 2t 3 represents the position of a race car along a straight track, measured in feet from the starting line at time t seconds.
2. What is the average rate of change of s(t) from t = 2 to t = 3 ?
3. What is the instantaneous rate of change of the same race car at time t = 2 ?

\*Remember the derivative is the slope (rate of change) of the tangent line at a point on a curve.

\*The instantaneous rate of change measures the rate of change, or slope, of a curve at a certain instant.

Thus, the instantaneous rate of change is given by the derivative.

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1. At time t = 0, a diver jumps from a diving board that is 32 feet above the water. The position of the diver is given by

s(t) = -16t2 + 16t + 32 where s is measured in feet and t is measured in seconds.

1. When does the diver hit the water?
2. What is the diver’s velocity at impact?

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“Derivatives as Rates of Change” Exercises

1. Assume that a falling body will fall 16t2 feet in t seconds.
2. What is its average velocity on the interval [3, 4]?
3. Find its instantaneous velocity at t = 3.
4. An object travels along a line so that its position s is s = 2t2 + 2 meters after t seconds.
5. What is its average velocity on the interval [2, 3]?
6. Find its instantaneous velocity at t = 2.
7. If a particle moves along a coordinate line so that its directed distance from the origin after t seconds is (-t2 + 4t) feet, when did the particle come to a momentary stop (that is, when did its instantaneous velocity become zero)?
8. A certain bacterial culture is growing so that it has a mass of $\left(\frac{1}{2}t^{2} + 1 \right)$ grams after t hours. What was its rate of growth at 2 hours? (Hint: growth rate is a rate of change, so…)
9. The weight in grams of a malignant tumor at time t is W(t) = 0.2t2 – 0.09t, where t is measured in weeks. Find the growth rate of the tumor when at 10 weeks.

In exercises 6 – 7, use the position functions s(t) = -16t2 + v0t + s0 for free falling objects, where v0 is initial velocity and s0 is initial height.

1. A silver dollar is dropped from the top of the World Trade Center, which is 1362 feet tall.
2. Determine the position and velocity functions for the coin.
3. Determine the average velocity on the interval [1, 2].
4. Find the instantaneous velocities when t =1 and t = 2.
5. Find the time required for the coin to reach ground level.
6. Find the velocity of the dollar as it hits the ground.
7. A ball is thrown straight down from the top of a 220-foot building with an initial velocity of -22 feet per second.
8. Determine the position and velocity functions of the ball.
9. What is its velocity after 3 seconds?
10. What is its velocity after falling 108 feet?
11. Find an equation of the tangent line to the graph of $f\left(x\right)=x+\frac{1}{x}$ at the point (1, 2).

1. Find all points on the graph of y = x3 – x2 where the tangent line is horizontal.
2. What is the rate of change of the area of a circle with respect to the radius when the radius is r = 3 in?