

AB Calculus 3.2 Solutions

Derivatives and physics

1. Acceleration is the derivative of _____, which is the derivative of _____.
2. _____ is the *second* derivative of position.

#3-7: fill in all blanks with the correct word from the following: positive, negative, increasing, decreasing, speeding up, slowing down. You may use any term more than once, or not at all.

3. A headline reads, "*Birth rates declining in United States*," then points out the population of the United States is increasing at a decreasing rate. If $p(t)$ represents the population of the United States,
 - a. $p''(t)$ is _____.
 - b. $p'(t)$ is _____ and _____.
 - c. $p(t)$ is _____, _____, and _____.
4. A bungee jumper's height, velocity, and acceleration are modeled by $h(t)$, $v(t)$, and $a(t)$, respectively.
 - a. When $v(t)$ is positive and $a(t)$ is negative, the jumper's height is _____ and speed is _____.
 - b. When $v(t)$ and $a(t)$ are both negative, the jumper's height is _____ and speed is _____.
 - c. When $v(t)$ is negative and $a(t)$ is positive, the jumper's height is _____ and speed is _____.
5. A headline reads, "*Crime rampant in Gotham*," and the ensuing article states that the city's crime rate is increasing at an unprecedented rate. If $c(t)$ represents the amount of crime in Gotham,
 - a. $c''(t)$ is _____.
 - b. $c'(t)$ is _____ and _____.
 - c. $c(t)$ is _____, _____, and _____.

6. A headline reads, “*College tuition recently becoming less expensive,*” and the article describes how the rate at which college tuition is increasing has slowed down. If $p(t)$ represents the price of college tuition,

- a. $p''(t)$ is _____.
- b. $p'(t)$ is _____ and _____.
- c. $p(t)$ is _____, _____, and _____.

7. A headline reads, “*Local schools improving,*” followed by an article stating the rate at which the school district’s test scores are falling is decreasing. If $s(t)$ represents the test scores,

- a. $s''(t)$ is _____.
- b. $s'(t)$ is _____ and _____.
- c. $s(t)$ is _____, _____, and _____.

8. For $t \geq 0$ hours, H is a differentiable function of t that gives the temperature, in degrees Celsius, at an Arctic weather station. Which of the following is the best interpretation of $H'(12)$?

- (A) The change in temperature during the day
- (B) The change in temperature during the 12th hour
- (C) The rate at which the temperature is changing at the end of the 12th hour
- (D) The rate at which the temperature is changing during the first 12 hours
- (E) The average rate at which the temperature changed during the 12th hour

9. The function $P(t)$ models the population of the world, in billions of people, where t is the number of years since January 1, 2010. Which of the following is the best interpretation of the statement $P'(1) = 0.076$?

- (A) On February 1, 2010, the population of the world was increasing at a rate of 0.076 billion people per year.
- (B) On January 1, 2011, the population of the world was increasing at a rate of 0.076 billion people per year.
- (C) On January 1, 2011, the population of the world was 0.076 billion people.
- (D) From January 1, 2010 to January 1, 2011, the population of the world was increasing at an average rate of 0.076 billion people per year.
- (E) When the population of the world was 1 billion people, the population of the world was increasing at a rate of 0.076 billion people per year.

10. People are entering a building at a rate modeled by $f(t)$ people per hour and exiting the building at a rate modeled by $g(t)$ people per hour, where t is measured in hours. The functions f and g are nonnegative and differentiable for all times t . Which of the following inequalities indicates that the rate of change of the number of people in the building is decreasing at time t ?

- (A) $f(t) < 0$
- (B) $f'(t) < 0$
- (C) $f(t) - g(t) < 0$
- (D) $f'(t) - g'(t) < 0$

10. A hot air balloon that is leaking air has an initial internal volume of 4,000 liters. The function $t = f(v)$ models the amount of time t , in hours, it takes for the volume of the balloon to reach v liters. What are the units for $f'(v)$?

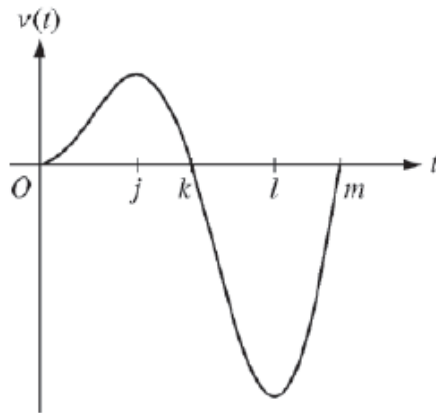
- (A) hours
- (B) liters
- (C) liters per hour
- (D) hours per liter

11. The velocity v , in meters per second, of a certain type of wave is given by $v(h) = 5\sqrt{h}$, where h is the depth, in meters, of the water through which the wave moves. What is the rate of change, in meters per second per meter, of the velocity of the wave with respect to the depth of the water, when the depth is 3 meters?

12. A particle moves along the x -axis so that its position at time t is given by $x(t) = t^2 - 8t + 9$. For what value of t is the velocity of the particle zero?

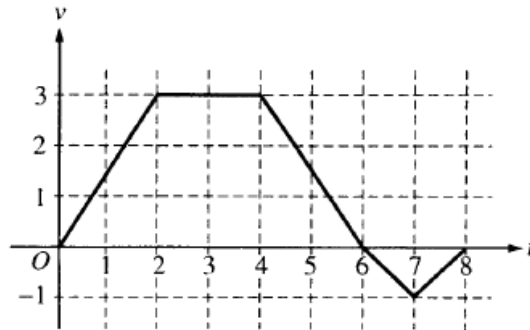
13. A particle moves along the x -axis so that at time $t \geq 0$ its position is given by $x(t) = 2t^3 - 18t^2 + 48t - 57$. At what time(s) is the particle at rest?

14. A particle moves along the x -axis so that its position at time $t > 0$ is given by $x(t)$ and $\frac{dx}{dt} = -8t^4 + 12t^2 + 9t$. The acceleration of the particle is zero when $t =$



15. A particle moves along a straight line. The graph of the particle's velocity $v(t)$ at time t is shown above for $0 \leq t \leq m$, where j , k , l , and m are constants. The graph intersects the horizontal axis at $t = 0$, $t = k$, and $t = m$ and has horizontal tangents at $t = j$ and $t = l$. For what values of t is the speed of the particle increasing?

16. The maximum acceleration attained on the interval $0 \leq t \leq 3$ by the particle whose velocity is given by $v(t) = t^3 - 4t^2 + 4t - 11$ is



17. A bug begins to crawl up a vertical wire at time $t = 0$. The velocity v of the bug at time t , $0 \leq t \leq 8$, is given by the function whose graph is shown above. At what value of t does the bug change direction?