NAME:_____
Period:_____ Date:_____

Calculus

PHYSICAL APPLICATIONS OF DERIVATIVES

Circle the correct answer.

1. What information does the **ORIGINAL FUNCTION** tell you?

   Acceleration Position Velocity

2. What information does the **FIRST DERIVATIVE** tell you?

   Acceleration Position Velocity

3. What information does the **SECOND DERIVATIVE** tell you?

   Acceleration Position Velocity

4. Which function would answer the question “When does the object reach its highest point?”

   Original Function 1st Derivative 2nd Derivative

5. Which function would answer the question “How fast is the object moving after 9 seconds?”

   Original Function 1st Derivative 2nd Derivative

6. Which function would answer the question “When does the object return to the ground?”

   Original Function 1st Derivative 2nd Derivative

7. Which function would answer the question “When is the object moving at –75 feet/second?”

   Original Function 1st Derivative 2nd Derivative

8. Which function would answer the question “When does the object 30 feet above the surface of the earth?”

   Original Function 1st Derivative 2nd Derivative

9. Which function would answer the question “How high is the object after 2.75 seconds?”

   Original Function 1st Derivative 2nd Derivative

10. **THINK CAREFULLY:** Which function would answer the question “When is the velocity greatest (or least)?”

    Original Function 1st Derivative 2nd Derivative

Physical Applications of Derivatives – Page 2

Now answer these questions.
(In the process you will learn about Mr. Burrow's high school classmates.)

11. Rusty is standing on a cliff 100 feet above the surface of the ocean. He throws a seashell into the air with an initial velocity of 50 feet/second. Because he is very intelligent, Rusty knows the position of the seashell is given by the function $s(t) = 100 + 50t - 16t^2$.

    a. When is the seashell at its highest point?

    b. How high is the seashell at its highest point?

    c. When does the seashell land on the beach below?

    d. How fast is the seashell travelling when it lands on the beach?

12. Bounyenne is golfing. When her club hits the ball, it propels her ball through the air with so much upward force that the vertical position of her ball is given by the function $s(t) = 300t - 16t^2$. Unfortunately, there is so much wind that her ball doesn't move forward at all. It just goes up and then comes right back down.

    a. The instantaneous acceleration is constant for this problem. What is it?

    b. What is the velocity after 1 second?

    c. When does the ball stop rising and start falling?

    d. What is the highest point the ball reaches? (Yes, it's a stupid answer.)

    e. When will the ball return to the ground?

    f. What is the velocity when the ball hits the ground?

13. Ed's mouth is 1.5 meters off the ground. When he spits his gum out, it travels with an initial downward velocity of 1 meter/second. Thinking quick, Ed calculates that the position of his gum at any given time is given by the function $s(t) = 1.5 - t - 4.9t^2$.

    a. What is the instantaneous velocity at the second Ed spits the gum out of his mouth?

    b. What is the instantaneous acceleration at the second Ed spits the gum out of his mouth?

    c. Using the quadratic formula, you can figure out that the gum hits the pavement at approximately .459183673 seconds. Find the velocity at this time.

    d. Suppose instead of landing on the ground, the gum falls into a gutter and keeps on falling. After how long will the velocity be –25 meters/second?

    e. How far below ground level will the gum be when the velocity is –25 meters/second?

14. Kaila is roller-skating down a hill in Charleston, South Carolina. The function describing her position is $s(t) = t - t^2$.

    a. What formula will tell Kaila's velocity?

    b. After travelling one mile (5280 feet), Kaila reaches the bottom of the hill and plunges into Charleston Harbor. (Her position is then –5280 feet.) How long has she been skating?

    c. How fast is she moving when she plunges into the harbor?

    d. What is her rate of acceleration?

15. Bryan was standing under a 60-foot oak tree. Suddenly an acorn fell downward and hit him on the head. Its position function was $s(t) = 60 - 16t^2$.

    a. If Bryan was 5 feet tall, how long did it take the acorn to land on his head?

    b. How fast was the acorn travelling when it hit Bryan on the head?

    c. What was the acorn's acceleration?

    The acorn causes Bryan to pass out. He falls down, and the position function for his body is $s(t) = 5 - 16t^2$.

    d. How long does it take Bryan to hit the ground?

    e. How fast is Bryan travelling when he hits the ground?

    f. What is Bryan's acceleration?

For the following problems, use these rules:

As a general rule, the position function of an object dropped from a height of "h" feet with an initial velocity of "v" feet/second is given by the function $s(t) = h - vt - 16t^2$.

The position of an object thrown upward with an initial velocity of "v" feet/second is given by the function $s(t) = vt - 16t^2$.

16. Allison throws her baton in the air with an initial velocity of 48 feet/second. Unfortunately, she doesn't catch the baton, and it falls on the ground.

    a. Use one of the rules above to write a position function for this problem.

    b. When is the baton at its highest point?

    c. How high is the baton's highest point?

    d. When does the baton hit the ground?

    e. What is the velocity when the baton hits the ground?

17. Jeff slam-dunks a basketball from 11 feet above the court. The initial downward force is 2 feet/second.

    a. Write a position function.

    b. What is the instantaneous velocity after ¼ second?

    c. What is the instantaneous velocity after ½ second?

18. Patty is flying in an airplane 13,200 feet in the air. Suddenly a bolt drops off her plane and drops to the earth. The initial downward velocity is zero.

    a. Write a position function.

    b. How long does it take the bolt to hit the ground?

    c. What is the velocity when the bolt hits the ground?

Now do these problems.

19. When the Viking spacecraft landed on Mars, it threw a rock into the Martian atmosphere. The height of the rock (in feet) at "t" seconds after being thrown is described by the function $s(t) = 112t - 5.6t^2$ (… a true formula!)

    a. After how many seconds does the rock reach its maximum height?

    b. How many feet above the surface of Mars is the rock when it is at its highest point?

    c. When will the rock hit the surface of Mars?

    d. What is the instantaneous velocity (in feet/second) at the time it hits the surface of Mars?

    e. What is the instantaneous acceleration (in feet/second^2) of the rock at the time it hits the surface of Mars?

20. Annabel rolls a ball up a ramp. The position of the ball at any second is given by the function $s(t) = 5 + 32t - t^2$.

    a. What formula would give you the velocity of the ball?

    b. After how many seconds does the ball start rolling backwards (stops rolling up the ramp, and starts rolling back down)?

    c. What is the furthest distance up the ramp the ball will go?

21. A bomb is dropped from a height of 256 feet. The function for its position is therefore $s(t) = 256 - 16t^2$.

    a. When will the bomb hit the ground?

    b. How fast will the bomb be falling when it hits the ground?