Name_____ Worksheet: Position, Velocity, Acceleration
AP Calculus

A. Using the Product Rule, find the derivative of each of the following.

1. $f(x) = (x^2 - 3x + 4)(2x - 1)$

2. $f(x) = x^3(x^2 - 1)$

3. $f(x) = (3x - 1)(2x + 5)$

4. $f(x) = 4(x^3 - 2x^2 + 5x - 7)$

B. Using the Quotient Rule, find the derivative of each of the following. Simplify the fraction.

5. $f(x) = \dfrac{x-5}{x-1}$

6. $f(x) = \dfrac{x^2 - 2x + 1}{x - 1}$

7. $f(x) = \dfrac{6}{x-4}$

C. Answer each of the following

8. Find the equation of the tangent and normal lines to $f(x) = \dfrac{x}{x-4}$ at $x = 8$.

9. The position of an object at time t is given by $s = (t^2 - 1)(t^2 - 3t + 4)$.
   a. Find the velocity and acceleration functions
   b. What is the velocity for all integral times t when acceleration is 0

D. In each of the following, s is the position of a particle in feet, and t is the time in seconds for a particle moving along a coordinate line.

10. Let $s(t) = t^3 - 6t^2$.
    a. Make a table showing the position, velocity, speed, and acceleration of the particle at times t=1, t=2, t=3, t=4, and $t = 5$.
    b. At each of these times, specify the direction of motion (forward/backward, up/down), if any, and whether the particle is speeding up, slowing down, or neither.

11. Let $s = 5t^2 - 22t$ for $t \geq 0$. Find the maximum speed of the particle and the direction of motion of the particle when it has this speed (hint: Maximum/Minimum velocity is achieved when the acceleration of the particle is 0).

12. Let $s = t^3 - 9t^2 + 24t$.
    a. Find all times in which the particle is at rest (velocity = 0)
    b. At what values of t is the particle moving backward?
    c. At what values of t is the particle moving forward?
    d. Find all times in which the particle's speed is constant (not accelerating).

13. Let $s = 1 + 6t - t^2$.
    a. Find all times in which the particle is at rest (velocity = 0)
    b. At what values of t is the particle moving backward?
    c. At what values of t is the particle moving forward?
    d. Find all times in which the particle's speed is constant (not accelerating).

14. If $s = \dfrac{t}{t^2 + 5}$ is the position function of a moving particle for $t \geq 0$, then at what instant of time will the particle start to reverse its direction of motion and where is it at the instant?

15. If $s = t^3 - 6t^2 + 1$, then
    a. Find s and v when $a = 0$.
    b. Find s and a when $v = 0$.

16. When is a particle at rest if
    a. $s = t^3 - 6t^2 + 9t + 1$?
    b. $s = t + \dfrac{9}{t+1}$

17. Let $s_A = 15t^2 + 10t + 20$ and $s_B = 5t^2 + 40t$ be the position functions for cars A and B that are moving along parallel straight lanes of a highway for time $t \geq 0$.
    a. How far is car A ahead of car B when $t = 0$?
    b. At what instant of time are the cars next to one another?
        i. At this instant, which car is moving faster?
    c. At what instant of time do have the same velocity?
        i. Which car is ahead at this instant?
        ii. What car is accelerating faster at this time?