MATH 2250 - Royal Section 3.4

New Formulas.

$s = f(t)$	position function
$v = f'(t)$	velocity function
$a = f''(t)$	acceleration function
$j = f'''(t)$	jerk
$\|v\| = \|f'(t)\|$	speed

1. The volume of a sphere is $V = \frac{4}{3}\pi r^3$.
   (a) Determine the average rate of change of the volume from $r = 1$ to $r = 3$.

   (b) Determine the (instantaneous) rate of change of the volume when $r = 5$.

2. The position of a particle moving along a straight line is given by $s = t^3 - 6t^2 + 9t$, $t \geq 0$ where t is in seconds and s is in feet.
   (a) Determine the position, velocity, and speed of the particle when $t = 2$.

   (b) Determine the position of the particle when it is stationary. (At an instant when the velocity is zero, we say the particle is *stationary*.)

   (c) Make a rough sketch of the graph of $s = f(t)$.

3. The position of a particle after t seconds is $s = 36t - \frac{4}{3}t^3$ meters for $t \geq 0$.
   (a) Determine the average velocity of the particle over the interval $0 \leq t \leq 6$.

(b) Determine the value(s) of t for which the velocity is zero.

4. The Doctor uses a slingshot to launch an orange straight up in the air to see what will happen. (He is on the planet Gallifrey.) The distance in feet between the orange and the ground after t seconds is given by the equation $s(t) = -24t^2 + 70t + 6$. Use this equation to answer the following questions.

   (a) What is the initial height of the orange?

   (b) What is the maximum height of the orange? (Try to do this one two ways, with and without using calculus.)

   (c) When will the orange hit the ground?

   (d) What is the velocity of the orange at the instant it hits the ground?

5. Suppose the velocity of a particle at time t is given by $v = \dfrac{t^2 - 64}{t + 1}$, $t > 0$.

   (a) Determine when the particle is stationary.

   (b) When is the particle moving in the positive direction? In the negative direction?

   (c) Determine the acceleration at the instant when the velocity is zero.

   (d) Determine all values of t for which the acceleration is zero.