1. (NC) A particle moves according to $s = t^4 - 4t^3$, for $t \geq 0$, where s is in meters and t is in seconds.

   a. Find the average velocity during the first second.

   $\frac{\Delta s}{\Delta t} = \frac{s(1)-s(0)}{1-0} = \frac{(1-4)-(0-0)}{1} = \frac{-3}{1} = \boxed{-3}$

   Moving left @ 3 m/sec

   b. Find the instantaneous velocity at time $t = 1s$.

   $V(t) = s'(t) = 4t^3 - 12t^2$

   $V(1) = 4(1)^3 - 12(1)^2 = \boxed{-8 \text{ m/sec}}$

   c. What is the particle's speed at time $t = 2s$?

   Speed $= |V(2)| = |4(2)^3 - 12(2)| = |32 - 48| = |-16| = \boxed{16 \text{ m/sec}}$

   d. Does the particle ever come to a stop? If so, when?

   $V(t) = 0 = 4t^3 - 12t^2$

   $0 = 4t^2(t - 3)$

   At $t=0$ and $t=3$, the particle stopped

   e. When is the particle moving the fastest?

   Find $V(t) = \max$

   $a(t) = V'(t) = 12t^2 - 24t = 0$

   $12t(t-2) = 0$

   $t = 0, 2 \rightarrow$ local extrema

   Since $V(t) = 4t^3 - 12t^2$

   as $t \to \infty$, $V(t) \to \infty$

   so, no global Max V exists

   f. Find the distance traveled by the particle during the first 5 seconds.

   Since the particle stopped at 3 seconds, we must use the intervals $[0,3]$ and $[3,5]$

   $s(0) = 0$

   $s(3) = (3)^4 - 4(3)^3 = 81 - 108 = -27$

   $s(5) = (5)^4 - 4(5)^3 = 5(5)^3 - 4(5)^3 = 5^3 = 125$

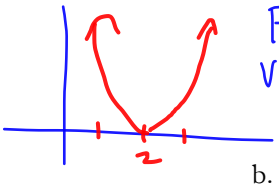
   on $[0,3]$ $d_1 = |s(3) - s(0)| = |-27 - 0| = 27$

   $d_2 = |s(5) - s(3)| = |125 - (-27)| = 152$

   Total $= 27 + 152 = \boxed{179 \text{ m}}$

2. (NC) The position of an object moving along a straight line is given by $s = t^3 - 6t^2 + 12t - 8$, for $t \geq 0$ where s is in feet and t is in seconds.

a. Find the interval during which the ~~displacement~~ position is increasing.



Find $V(t) > 0$

$V(t) = s'(t) = 3t^2 - 12t + 12 = 0$

$3(t^2 - 4t + 4) = 0$

$(t-2)^2 = 0 \quad t = 2$

Velocity is positive on $\boxed{(-\infty, 2) \cup (2, \infty)}$

b. Find the interval during which the velocity is decreasing.

On $(-\infty, 2)$

c. What is the minimum value of the speed of the particle?

at $t = 2$, $|V| = 0$. This gives us a minimum speed of 0 mph.

3. (C) A particle moves along a line according to $s = 2t^3 - 9t^2 + 12t - 4$, $t \geq 0$ where s is in meters and t is in seconds.

a. At what values of t is the ~~displacement~~ position increasing?

$V(t) = s'(t) = 6t^2 - 18t + 12 = 0$

$6(t^2 - 3t + 2) = 0$

$6(t-2)(t-1) = 0$

at $t = 2$ and $t = 1$ $V(t) = 0$

So, $V(t) > 0$ and position is increasing on $(0, 1)$ and $(2, \infty)$

b. At what values of t is the velocity increasing?

Vertex of $V(t)$ at $t = \frac{3}{2}$

So, $V(t)$ is increasing on $\left(\frac{3}{2}, \infty\right)$

c. What is the particle's speed when t=1.5s?

$|V(1.5)| = \left|6\left(\frac{3}{2}\right)^2 - 18\left(\frac{3}{2}\right) + 12\right| = |-1.5| = \boxed{1.5 \text{ m/sec}}$

d. What is the total distance traveled between t=0 and t=4?

Since $V(t) = 0$ at $t = 1$ & $t = 2$, find distance traveled on intervals $(0,1)$ $(1,2)$ $(2,4)$

$d_1 = |s(1) - s(0)| = |1 - (-4)| = 5$

$d_2 = |s(2) - s(1)| = |0 - 1| = |-1| = 1$

$d_3 = |s(4) - s(2)| = |28 - 0| = 28$

Total Distance $= 5 + 1 + 28 = \boxed{34 \text{ m}}$

$s(0) = -4$

$s(1) = 1$

$s(2) = 0$

$s(4) = 28$