CALCULUS BC
WORKSHEET 1 ON PARTICLE MOTION

Work these on **notebook paper**. Use your calculator on problems 1(f), 2, and 4, and give decimal answers correct to three decimal places. Do not use your calculator on the other problems. Write your justifications in a sentence.

1. A particle moves along a horizontal line so that its position at any time is given by
$s(t) = t^3 - 12t^2 + 36t, \ t \geq 0$, where s is measured in meters and t in seconds. Do not use your calculator except on part (f).
(a) Find the instantaneous velocity at time t and at $t = 3$ seconds.
(b) When is the particle at rest? Moving to the right? Moving to the left? Justify your answers.
(c) Find the displacement of the particle after the first 8 seconds.
(d) Find the total distance traveled by the particle during the first 8 seconds.
(e) Find the acceleration of the particle at time t and at $t = 3$ seconds.
(f) Graph the position, velocity, and acceleration functions for $0 \leq t \leq 8$.
(g) When is the particle speeding up? Slowing down? Justify your answers.

2. A particle moves along the x-axis with its position at time t given by
$$x(t) = \frac{t}{1+t^2}, \ t \geq 0$$
where t is measured in seconds and x in meters. Use your calculator.
(a) Find the velocity at time t and at $t = 2$ seconds.
(b) When is the particle at rest? When is moving to the right? To the left? Justify your answers.
(c) Find the displacement of the particle during the time interval $0 \leq t \leq 4$.
(d) Find the total distance traveled by the particle during the time interval $0 \leq t \leq 4$.
(e) Find the acceleration of the particle at time t and at $t = 3$ seconds.
(f) When is the particle speeding up? Slowing down? Justify your answers.

3. (Noncalculator)The maximum acceleration attained on the interval $0 \leq t \leq 3$ by the particle whose velocity is given by $v(t) = t^3 - 3t^2 + 12t + 4$ is
(A) 9   (B) 12   (C) 14   (D) 21   (E) 40

4. (Calculator) A particle moves along the x-axis so that at any time $t \geq 0$, its velocity is given by $v(t) = 3 + 4.1\cos(0.9t)$. What is the acceleration of the particle at time $t = 4$?
(A) − 2.016   (B) − 0.677   (C) 1.633   (D) 1.814   (E) 2.978

5. The figure on the right shows the position s of a particle moving along a horizontal line.
(a) When is the particle moving to the left? moving to the right? standing still? Justify your answer.
(b) For each of $v(1.5)$, $v(2.5)$, $v(4)$, and $v(5)$, find the value or explain why it does not exist.
(c) Graph the particle's velocity.
(d) Graph the particle's speed.
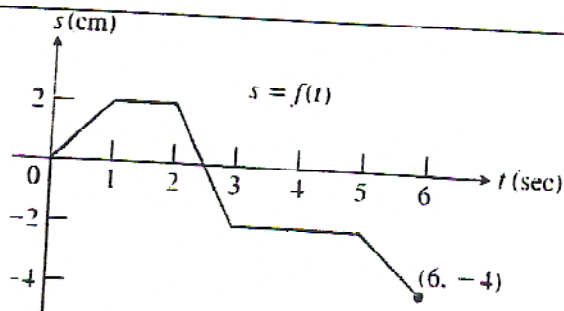
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6. The figure on the right shows the velocity v of a
   particle moving along a horizontal line.
(a) When does the particle move to the right? to the
    left? stand still? Justify your answer.
(b) When is the particle's acceleration positive?
    negative? zero? Justify your answer.
(c) Graph the particle's acceleration.
(d) When does the particle move at its greatest
    speed? Justify your answer.
(e) When is the particle speeding up? slowing
    down? Justify your answer.

$v = f(t)$