

Review of Motion Along a Line

Multiple-Choice Items:

1. 2003 AP Calculus AB Exam, Item 25 (no calculator):

A particle moves along the x -axis so that at time $t \geq 0$ its position is given by

$x(t) = 2t^3 - 21t^2 + 72t - 53$. At what time t is the particle at rest?

(A) $t = 1$ only

(B) $t = 3$ only

(C) $t = \frac{7}{2}$ only

(D) $t = 3$ and $t = \frac{7}{2}$

(E) $t = 3$ and $t = 4$

2. 1998 AP Calculus AB Exam, Item 24 (no calculator):

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

3. AP Calculus AB, sample multiple-choice Item 9 (no calculator):

The position of a particle moving along a line is given by

$s(t) = 2t^3 - 24t^2 + 90t + 7$ for $t \geq 0$.

For what values of t is the speed of the particle increasing?

(A) $3 < t < 4$ only

(B) $t > 4$ only

(C) $t > 5$ only

(D) $0 < t < 3$ and $t > 5$

(E) $3 < t < 4$ and $t > 5$

4. 2003 AP Calculus AB Exam, Item 76 (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) 2.97

5. 2003 AP Calculus AB Exam, Item 91 (calculator):

A particle moves along the x -axis so that at any time $t > 0$, its acceleration is given by $a(t) = \ln(1 + 2^t)$. If the velocity of the particle is 2 at time $t = 1$, then the velocity of the particle at time $t = 2$ is

- (A) 0.462
- (B) 1.609
- (C) 2.555
- (D) 2.886
- (E) 3.346

6. AP Calculus AB, sample multiple-choice Item 19 (calculator):

Two particles start at the origin and move along the x -axis. For $0 \leq t \leq 10$, their respective position functions are given by $x_1 = \sin t$ and $x_2 = e^{-2t} - 1$. For how many values of t do the particles have the same velocity?

- (A) None
- (B) One
- (C) Two
- (D) Three
- (E) Four

7. AP Calculus AB, sample multiple-choice Item 15 (calculator):

A particle travels along a straight line with a velocity of $v(t) = 3e^{(-t/2)} \sin(2t)$ meters per second. What is the total distance traveled by the particle during the time interval $0 \leq t \leq 2$ seconds?

- (A) 0.835
- (B) 1.850
- (C) 2.055
- (D) 2.261
- (E) 7.025

Free-Response Questions:

8. 2004 AP Calculus AB Exam, FRQ 3 (calculator):

A particle moves along the y -axis so that its velocity at time $t \geq 0$ is given by

$v(t) = 1 - \tan^{-1}(e^t)$. At time $t = 0$, the particle is at $y = -1$. (Note: $\tan^{-1} x = \arctan x$.)

- (a) Find the acceleration of the particle at time $t = 2$.
- (b) Is the speed of the particle increasing or decreasing at time $t = 2$? Give a reason for your answer.
- (c) Find the time $t \geq 0$ at which the particle reaches its highest point. Justify your answer.
- (d) Find the position of the particle at time $t = 2$. Is the particle moving toward the origin or away from the origin at time $t = 2$? Justify your answer.

9. 2006 AP Calculus AB/BC Exams, Item 4 (no calculator):

| | | | | | | | | | |
|--------------------------|---|----|----|----|----|----|----|----|----|
| t (seconds) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 |
| $v(t)$ (feet per second) | 5 | 14 | 22 | 29 | 35 | 40 | 44 | 47 | 49 |

Rocket A has positive velocity $v(t)$ after being launched upward from an initial height of 0 feet at time $t = 0$ seconds. The velocity of the rocket is recorded for selected values of t over the interval $0 \leq t \leq 80$ seconds, as shown in the table above.

- (a) Find the average acceleration of rocket A over the time interval $0 \leq t \leq 80$ seconds. Indicate units of measure.
- (b) Using correct units, explain the meaning of $\int_{10}^{70} v(t) dt$ in terms of the rocket's flight. Use a midpoint Riemann sum with 3 subintervals of equal length to approximate $\int_{10}^{70} v(t) dt$.
- (c) Rocket B is launched upward with an acceleration of $a(t) = \frac{3}{\sqrt{t+1}}$ feet per second. At time $t = 0$ seconds, the initial height of the rocket is 0 feet, and the initial velocity is 2 feet per second. Which of the two rockets is traveling faster at time $t = 80$ seconds? Explain your answer.