

# 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

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

(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  $t = 4$

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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

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

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  $t > 5$

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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
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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                      (C) 2.555  
(B) 1.609                      (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                      (D) Three  
(B) One                      (E) Four  
(C) Two
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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

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

- (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.