

## 2003 AP<sup>®</sup> CALCULUS AB FREE-RESPONSE QUESTIONS

2. A particle moves along the  $x$ -axis so that its velocity at time  $t$  is given by

$$v(t) = -(t + 1) \sin\left(\frac{t^2}{2}\right).$$

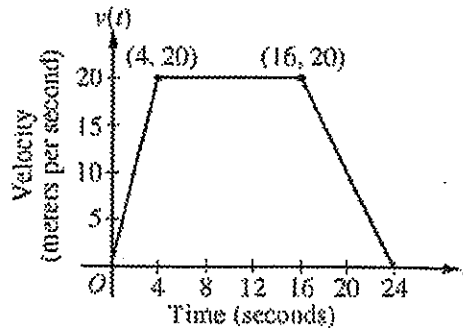
At time  $t = 0$ , the particle is at position  $x = 1$ .

- (a) Find the acceleration of the particle at time  $t = 2$ . Is the speed of the particle increasing at  $t = 2$ ? Why or why not?
  - (b) Find all times  $t$  in the open interval  $0 < t < 3$  when the particle changes direction. Justify your answer.
  - (c) Find the total distance traveled by the particle from time  $t = 0$  until time  $t = 3$ .
  - (d) During the time interval  $0 \leq t \leq 3$ , what is the greatest distance between the particle and the origin? Show the work that leads to your answer.
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## 2004 AP<sup>®</sup> CALCULUS AB FREE-RESPONSE QUESTIONS

3. A particle moves along the  $y$ -axis so that its velocity  $v$  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.
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**2005 AP<sup>®</sup> CALCULUS AB FREE-RESPONSE QUESTIONS**



5. A car is traveling on a straight road. For  $0 \leq t \leq 24$  seconds, the car's velocity  $v(t)$ , in meters per second, is modeled by the piecewise-linear function defined by the graph above.
- (a) Find  $\int_0^{24} v(t) dt$ . Using correct units, explain the meaning of  $\int_0^{24} v(t) dt$ .
- (b) For each of  $v'(4)$  and  $v'(20)$ , find the value or explain why it does not exist. Indicate units of measure.
- (c) Let  $a(t)$  be the car's acceleration at time  $t$ , in meters per second per second. For  $0 < t < 24$ , write a piecewise-defined function for  $a(t)$ .
- (d) Find the average rate of change of  $v$  over the interval  $8 \leq t \leq 20$ . Does the Mean Value Theorem guarantee a value of  $c$ , for  $8 < c < 20$ , such that  $v'(c)$  is equal to this average rate of change? Why or why not?
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**2005 AP<sup>®</sup> CALCULUS AB FREE-RESPONSE QUESTIONS (Form B)**

3. A particle moves along the  $x$ -axis so that its velocity  $v$  at time  $t$ , for  $0 \leq t \leq 5$ , is given by  $v(t) = \ln(t^2 - 3t + 3)$ . The particle is at position  $x = 8$  at time  $t = 0$ .
- (a) Find the acceleration of the particle at time  $t = 4$ .
- (b) Find all times  $t$  in the open interval  $0 < t < 5$  at which the particle changes direction. During which time intervals, for  $0 \leq t \leq 5$ , does the particle travel to the left?
- (c) Find the position of the particle at time  $t = 2$ .
- (d) Find the average speed of the particle over the interval  $0 \leq t \leq 2$ .
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