Practice Problems

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TI Technology in AP® Calculus

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FRQ

For $t \geq 0$, a particle moves along the x-axis. The velocity of the particle at time t is given by $v(t) = 1 - 2\cos\left(\frac{t^2}{2}\right)$. The particle is at position $x = 2$ at time $t = 4$.

a. At time $t = 4$, is the particle speeding up or slowing down? Justify your answer.

$v(4) = 1.291$

$a(4) = v'(4) = 7.914$

Speeding up because $v(4)$ and $v'(4)$ have the same sign

b. Find the time(s), t, in the interval $0 < t < 3$ when the particle changes directions. Justify your answer.

$v(t) = 0$ @ $t = 1.447$

Changes direction at $t = 1.447$ because $v(t)$ changes signs there

c. Find the position of the particle at time $t = 0$.

$$x(0) = x(4) + \int_4^0 v(t)\,dt = 2 + \int_4^0 v(t)\,dt = .266$$

d. Find the total distance the particle travels from time $t = 0$ to time $t = 3$.

$$\int_0^3 |v(t)|\,dt = 4.138$$

MCQ

1. The first derivative of the function f is given by $f'(x) = 10\sin(4x) + 5x - 7$. How many inflection points does the graph of the function f have on the open interval $(0, \pi)$?
   A. Three
   B. Four
   C. Five
   D. Six

POI when f' changes from inc to dec or dec to inc

f' has relative extrema

2. A particle moves along the x-axis with a velocity given by $v(t) = \ln(4\sin(t) + 5) - 1$ for $t \geq 0$. What is the first positive time t at which the particle changes direction?
   A. 1.571
   B. 3.748
   C. 4.069
   D. 5.676

changes directions when v(t) changes signs

3. The number of bacteria in a petri dish is modeled by the equation $P(t) = 3600e^{0.2t}$ where t is measured in days. At what rate is the number of bacteria growing in bacteria per day at time $t = 7$?
   A. 2,919.744
   B. 10,998.720
   C. 14,598.719
   D. 54,993.599

P'(7)

4. Water is pumped into a cylinder at a rate given by $r(t) = 5\cos\left(\frac{\sqrt{t}}{2}\right)$ gallons per minute where t is measured in minutes. If there are 4 gallons of water in the cylinder when it begins pumping at time $t = 0$, how many gallons are in the cylinder at the end of 5 minutes?
   A. 2.187
   B. 6.187
   C. 17.713
   D. 21.713

$4 + \int_0^5 r(t)\,dt$

gal $\frac{\text{gal}}{\text{min}} \cdot \text{min}$

5. Let f be the function with derivative given by $f'(x) = \cos\left(\frac{3x^3 - 4x}{9}\right)$. At what values of x in the interval $-3 < x < 3$ does f have a relative maximum?
   A. -1.940 and 2.601
   B. -2.601 and 1.940
   C. -2.828, 0, and 2.828
   D. -2.601, -1.940, 1.940, and 2.601

f' changes from pos. to neg.

6. Let f be a differentiable function such that $f(1) = \pi$ and $f'(x) = \sqrt{25 - x^2}$. What is the value of $f(4)$?

A. 3
B. 6.142
C. 12.625
D. 15.766

$f(4) = f(1) + \int_1^4 f'(x)\,dx$

$= \pi + \int_1^4 \sqrt{25 - x^2}\,dx$

7. Let f be the function defined by $f(x) = \begin{cases} e^{kx}, & x < 2 \\ x^2 - k, & x \geq 2 \end{cases}$, where k is a constant. For what value of k is f continuous?

A. -1.434
B. 0
C. 0.610
D. 1.333

$\lim_{x \to 2^-} e^{kx} = \lim_{x \to 2^+} x^2 - k$

$e^{2k} = 2^2 - k$

8. A particle moving along the x-axis is given by $v(t) = 2\sin(\ln(t+1)) - t^2$ for $t \geq 0$. Which of the following statements describes the motion of the particle at time $t = 2$?

A. Moving right with positive acceleration
B. Moving left with positive acceleration
C. Moving right with negative acceleration
D. Moving left with negative acceleration

$v(2) = -2.219 < 0 \Rightarrow$ left

$a(2) = v'(2) = -3.696 < 0$

9. The temperature F, in degrees Fahrenheit (°F), of a gooey chocolate chip cookie t minutes after it has been removed from the oven is given by $F(t) = 68 + 282e^{-0.1t}$. To the nearest degree, what is the average temperature of the cookie between $0 \leq t \leq 12$ minutes?

A. 99 °F
B. 153 °F
C. 197 °F
D. 232 °F

$\frac{1}{12 - 0} \int_0^{12} F(t)\,dt = 232.219$

$\frac{1}{\text{min}} \cdot {}^\circ\text{F} \cdot \text{min}$

10. What is the area of the region enclosed by the graphs of $y = \sqrt{9 - x^2}$ and $y = \frac{1}{3}x + 1$?

A. 2.973
B. 4.454
C. 8.541
D. 38.201

$\sqrt{9 - x^2} = \frac{1}{3}x + 1$ @ $x = -3, 2.4$

$\int_{-3}^{2.4} \sqrt{9 - x^2} - \left(\frac{1}{3}x + 1\right) dx$