NAME James Ding

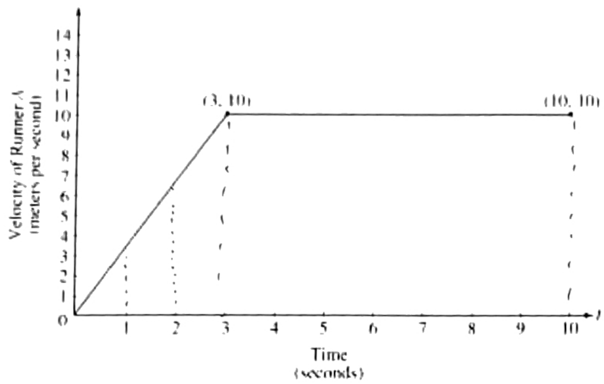
AP Calculus

DATE ____________

FRQ #20

Graph

Two runners, A and B, run on a straight racetrack for $0 \leq t \leq 10$ seconds. The graph shows the velocity, in meters per second, of Runner A. The velocity, in meters per second, of Runner B is given by $v(t) = \frac{24t}{2t+3}$.



a) Find the velocity of Runner A and the velocity of Runner B at time t = 2 seconds. Indicate units of measure.

Runner A: 6 m/s

Runner B: 6.85 m/s $= \frac{48}{7}$

b) Find the acceleration of Runner A and the acceleration of Runner B at time t = 2 seconds. Indicate units of measure.

Runner A: $3 m/s^2$

Runner B: $\frac{d}{dx}\left[\frac{24x}{2x+3}\right] = \frac{72}{(2x+3)^2} = 1.467 \ m/s^2$

c) Find the total distance run by Runner A and the total distance run by Runner B over the time interval [0,10]. Indicate units of measure.

$\int_0^{10} \left(\frac{24t}{2t+3}\right) dt = 83.336$

Runner A: $\frac{1}{2}(3)(10) + (7)(10) = 85$

Runner B: 83.336

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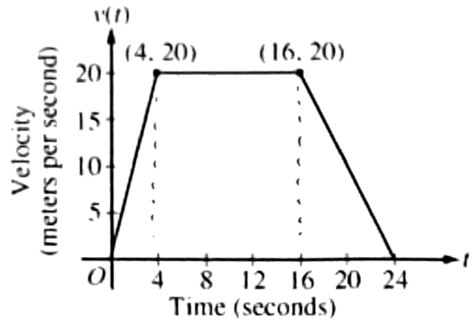
FRQ #21

Graph

A car is traveling on a straight road. For $0 \le t \le 24$ seconds, the car's velocity v(t), in meters/sec, is modeled by the piecewise-linear function defined by the given graph.



a) Find $\int_0^{24} v(t)dt$. Using correct units, explain the meaning of this integral.

$\frac{1}{2}(4)(20) + (12)(20) + \frac{1}{2}(8)(20)$

$= 40 + 240 + 80$

$= 360$ meters. Displacement.

b) For each of v′(4) and v′(20), find the value or explain why it does not exist. Indicate units of measure.

v′(4) DNE. Derivative of a function cannot be created from a function with sharp points. It must be curved throughout the interval you are trying to use, in this case $x \in (0, 24)$

$v'(20) = -\frac{5}{2}$

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).

$$a(t) = \begin{cases} 5x, & x \in (0,4) \\ 0, & x \in (4,16) \\ -\frac{5}{2}x, & x \in (16,24) \end{cases}$$

d) Find the average rate of change of *v* over the interval $8 \le t \le 20$. 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?

Avg rate of change: $-\frac{20}{16} = -\frac{5}{4}$.

MVT would not apply, as the function is not differentiable throughout the interval $x \in (8, 20)$