



**AP[®] Calculus BC
2004 Sample Student Responses
Form B**

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3



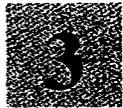
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t (minutes)	0	5	10	15	20	25	30	35	40
$v(t)$ (miles per minute)	7.0	9.2	9.5	7.0	4.5	2.4	2.4	4.3	7.3

Work for problem 3(a)

$$\text{Area} = \cancel{10f} = \cancel{10(9.2) + 10(7.5)}$$

$$\begin{aligned} \text{area} &= 10(f(5) + f(15) + f(25) + f(35)) \\ &= 10(9.2 + 7 + 2.4 + 4.3) \end{aligned}$$

$$\boxed{\text{area} = 229 \text{ miles}}$$

$\int_0^{40} v(t) dt$ is the total distance traveled between $t=0$ and $t=40$ minutes

Work for problem 3(b)

$$a(t) = 0$$

~~between (7, 15)~~

on the intervals $[0, 15]$ and $[25, 30]$

The smallest number of instances the acceleration can equal zero is 2 by MVT and Rolle's Theorem

Continue problem 3 on page 9.

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Work for problem 3(c)

$$f'(t) = \frac{1}{10} \sin t/10 + 3 \cdot \frac{7}{40} \cos 7t/40$$

$$f'(t) = \frac{1}{10} \sin t/10 + \frac{21}{40} \cos 7t/40$$

$$f'(23) = \frac{1}{10} \sin 23/10 + \frac{21}{40} \cos 161/40$$

$$f'(23) = \boxed{-0.408 \text{ miles per minute}^2}$$

Work for problem 3(d)

$$\text{Average } v = \frac{f(40) - f(0)}{40 - 0}$$

$$= \frac{7.317 - 6}{40}$$

$$= 0.033 \text{ miles per minute}$$

$$\frac{1}{40-0} \int_0^{40} (6 + \cos(t/10) + 3 \sin(7t/40)) dt$$

$$\text{Average velocity} = \frac{1}{40} \cdot 236.65079$$

$$= \boxed{5.916 \text{ miles per minute}}$$

END OF PART A OF SECTION II

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON PART A ONLY. DO NOT GO ON TO PART B UNTIL YOU ARE TOLD TO DO SO.

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C₁

t (minutes)	0	5	10	15	20	25	30	35	40
$v(t)$ (miles per minute)	7.0	9.2	9.5	7.0	4.5	2.4	2.4	4.3	7.3

Work for problem 3(a)

$$\int_0^{40} v(t) dt = \frac{40-0}{4} [9.2 + 7 + 2.4 + 4.3]$$

$$= \frac{40}{4} [22.9] = 229 \text{ miles}$$

↓
distance plane flies.

Work for problem 3(b)

Acceleration of the plane equals zero where the graph changes concavity. There are 2 such instances one at $t = 10 \text{ min}$ & the other $t \in (25, 30)$.

Continue problem 3 on page 9.

Work for problem 3(c)

$$a(t) = \frac{df}{dt} = \frac{-1}{10} \sin\left(\frac{t}{10}\right) + \frac{21}{40} \cos\left(\frac{7t}{40}\right)$$

$$a(23) = \frac{-1}{10} \sin(2.3) + \frac{21}{40} \cos\left(\frac{161}{40}\right) \approx -0.408 \text{ miles/min}^2.$$

Work for problem 3(d)

$$\begin{aligned} \text{avg velocity} &= \frac{1}{40-0} \int_0^{40} f(t) dt = \frac{1}{40} \int_0^{40} 6 + \cos\left(\frac{t}{10}\right) + 3\sin\left(\frac{7t}{40}\right) \\ &= \frac{1}{40} \left[6t + 10\sin\left(\frac{t}{10}\right) - 3\cos\left(\frac{7t}{40}\right) \left(\frac{40}{7}\right) \right]_0^{40} \\ &= \frac{1}{40} \left[6t + 10\sin\left(\frac{t}{10}\right) - \frac{120}{7} \cos\left(\frac{7t}{40}\right) \right]_0^{40} \\ &= \frac{1}{40} \left[240 - 7.568 - 12.924 - \left(-\frac{120}{7}\right) \right] \\ &= 5.916 \frac{\text{miles}}{\text{min}} \end{aligned}$$

END OF PART A OF SECTION II

IF YOU FINISH BEFORE TIME IS CALLED, YOU MAY CHECK YOUR WORK ON PART A ONLY. DO NOT GO ON TO PART B UNTIL YOU ARE TOLD TO DO SO.