CollegeBoard
Advanced Placement Program

AP® Calculus BC (Operational)
2004 Sample Student Responses

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CALCULUS BC

SECTION II, Part A

Time—45 minutes

Number of problems—3

A graphing calculator is required for some problems or parts of problems.

Work for problem 1(a)

$$\int_0^{30} \left[82 + 4\sin\left(\frac{t}{2}\right) \right] dt \approx 2474 \text{ cars}$$

2474 cars pass through over the 30-minute period.

Work for problem 1(b)

$$F(t) = 82 + 4\sin\left(\frac{t}{2}\right)$$

$$F'(t) = 4 \cdot \frac{1}{2} \cdot \cos\left(\frac{t}{2}\right)$$

$$= 2\cos\left(\frac{t}{2}\right)$$

$$F'(7) = 2\cos\left(\frac{7}{2}\right) = -1.8729$$

Since the derivative of $F(t)$ is negative, the traffic flow is decreasing.

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Work for problem 1(c)

Average value theo:
$$\frac{\int_a^b f(x)\,dx}{b-a}$$

$$\frac{\int_{10}^{15} \left[82+4\sin\left(\frac{t}{2}\right)\right]dt}{15-10} = \frac{409.4962}{5} = 81.8992 \approx 82 \text{ cars/} \text{min}$$

Work for problem 1(d)

$$\frac{\int_{10}^{15} F'(t)\,dt}{15-10}$$

$$= \frac{\int_{10}^{15} \left[2\cos\left(\frac{t}{2}\right)\right]dt}{5}$$

$$= \frac{7.587697}{5}$$

$$= 1.5175$$

$$\approx 2 \text{ cars/min}^2$$

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CALCULUS AB

SECTION II, Part A

Time—45 minutes

Number of problems—3

A graphing calculator is required for some problems or parts of problems.

Work for problem 1(a)

$$\int_0^{30} \left[82 + 4\sin\left(\frac{t}{2}\right) \right] dt$$

2474 cars

Work for problem 1(b)

$$F'(7) = 82 + 4\sin\left(\frac{7}{2}\right)$$

$$F'(7) = 83.403$$

Traffic flow is increasing because $F'(7)$ is positive.

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Work for problem 1(c)

$$\frac{1}{5} \int_{10}^{15} \left[82 + 4\sin\left(\frac{t}{3}\right) \right] dt =$$

$$\boxed{81.899 \text{ cars}}$$

Work for problem 1(d)

$$\frac{F(15) - F(10)}{15 - 10} = \frac{85.752 - 78.164}{5}$$

$$\boxed{1.518 \text{ cars per minute}}$$

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