

2004 AP[®] CALCULUS AB Problem #1

Traffic flow is defined as the rate at which cars pass through an intersection, measured in cars per minute. The traffic flow at a particular intersection is modeled by the function F defined by

$$F(t) = 82 + 4 \sin\left(\frac{t}{2}\right) \text{ for } 0 \leq t \leq 30,$$

where $F(t)$ is measured in cars per minute and t is measured in minutes.

(a) To the nearest whole number, how many cars pass through the intersection over the 30-minute period?

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

(b) Is the traffic flow increasing or decreasing at $t = 7$? Give a reason for your answer.

$$F(t) = 82 + 4 \sin\left(\frac{t}{2}\right) \text{ for } 0 \leq t \leq 30,$$

$$F'(7) = -1.873$$

$$F'(x) < 0 \text{ at } x = 7$$

\therefore traffic flow is decreasing at $x = 7$

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(c) What is the average value of the traffic flow over the time interval $10 \leq t \leq 15$? Indicate units of measure.

$$\frac{1}{15-10} \int_{10}^{15} F(t) dt = 81.899 \text{ cars/minute}$$

Handwritten notes: Red wavy lines under the denominator and the integral, and under the result. Blue circles with '+1' are placed above the upper limit and below the denominator and result.

(d) What is the average rate of change of the traffic flow over the time interval $10 \leq t \leq 15$? Indicate units of measure.

$$ARC = \frac{F(10) - F(15)}{10 - 15} = 1.518 \text{ car/min}^2$$

Handwritten note: A blue circle with '+1' is placed below the result.

+1 proper units in (c) and (d)