

1. From 5 A.M. to 10 A.M., the rate at which vehicles arrive at a certain toll plaza is given by  $A(t) = 450\sqrt{\sin(0.62t)}$ , where  $t$  is the number of hours after 5 A.M. and  $A(t)$  is measured in vehicles per hour. Traffic is flowing smoothly at 5 A.M. with no vehicles waiting in line.
- (a) Write, but do not evaluate, an integral expression that gives the total number of vehicles that arrive at the toll plaza from 6 A.M. ( $t = 1$ ) to 10 A.M. ( $t = 5$ ).
- (b) Find the average value of the rate, in vehicles per hour, at which vehicles arrive at the toll plaza from 6 A.M. ( $t = 1$ ) to 10 A.M. ( $t = 5$ ).
- (c) Is the rate at which vehicles arrive at the toll plaza at 6 A.M. ( $t = 1$ ) increasing or decreasing? Give a reason for your answer.
- (d) A line forms whenever  $A(t) \geq 400$ . The number of vehicles in line at time  $t$ , for  $a \leq t \leq 4$ , is given by  $N(t) = \int_a^t (A(x) - 400) dx$ , where  $a$  is the time when a line first begins to form. To the nearest whole number, find the greatest number of vehicles in line at the toll plaza in the time interval  $a \leq t \leq 4$ . Justify your answer.

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**Write your responses to this question only on the designated pages in the separate Free Response booklet. Write your solution to each part in the space provided for that part.**

**CALCULUS BC**  
**SECTION II, Part A**  
**Time—30 minutes**  
**Number of questions—2**

**A GRAPHING CALCULATOR IS REQUIRED FOR THESE QUESTIONS.**

1. People enter a line for an escalator at a rate modeled by the function  $r$  given by

$$r(t) = \begin{cases} 44\left(\frac{t}{100}\right)^3\left(1 - \frac{t}{300}\right)^7 & \text{for } 0 \leq t \leq 300 \\ 0 & \text{for } t > 300, \end{cases}$$

where  $r(t)$  is measured in people per second and  $t$  is measured in seconds. As people get on the escalator, they exit the line at a constant rate of 0.7 person per second. There are 20 people in line at time  $t = 0$ .

- (a) How many people enter the line for the escalator during the time interval  $0 \leq t \leq 300$  ?
- (b) During the time interval  $0 \leq t \leq 300$ , there are always people in line for the escalator. How many people are in line at time  $t = 300$  ?
- (c) For  $t > 300$ , what is the first time  $t$  that there are no people in line for the escalator?
- (d) For  $0 \leq t \leq 300$ , at what time  $t$  is the number of people in line a minimum? To the nearest whole number, find the number of people in line at this time. Justify your answer.