AP® CALCULUS BC
2018 SCORING GUIDELINES

Question 1

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

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

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 $0 \le t \le 300$?

(b) During the time interval $0 \le t \le 300$, 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 $0 \le t \le 300$, 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.

(a) $\int_0^{300} r(\mathrm{t})\, dt = 270$ people

$2 : \begin{cases} 1 : \text{integral} \\ 1 : \text{answer} \end{cases}$

(b) $f(\mathrm{t}) = 20 - 0.7\mathrm{t} + \int_0^t r(\mathrm{t})\, dt$

$f(300) = 20 - 0.7\,(300) + \int_0^{300} r(\mathrm{t})\, dt$

$= 80$ people

$2 : \begin{cases} 1 : \text{expression for } f(\mathrm{t}) \\ 1 : \text{answer} \end{cases}$

(c) 0 people $= f(300) - 0.7\mathrm{t}$

t = 415 seconds

$2 : \begin{cases} 1 : \text{linear equation equal to zero} \\ 1 : \text{answer} \end{cases}$

(d) $f(\mathrm{t}) = 20 - 0.7\mathrm{t} + \int_0^{300} r(\mathrm{t})\, dt$

$f(t)$ achieves a minimum at t = 33.013 seconds

Candidates: t = 0, t = 300, t=33.013

$f(33.013) = 4$ people in line

$3 : \begin{cases} 1 : t \text{ when number of people is minimal} \\ 1 : \text{identifies all candidates} \\ 1 : \text{minimum number of people} \end{cases}$

Created by Josh Calianos and Xavier Thibault for the Williston Northampton School