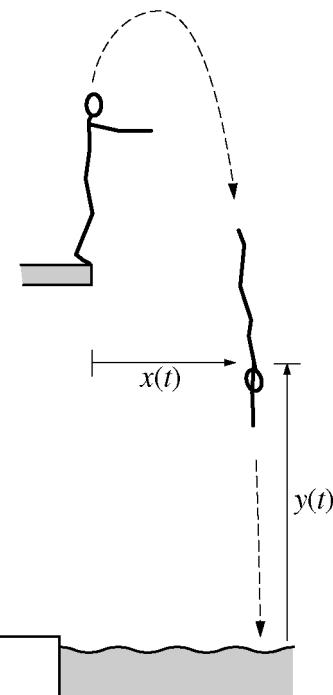


2009 AP[®] CALCULUS BC FREE-RESPONSE QUESTIONS

2. The rate at which people enter an auditorium for a rock concert is modeled by the function R given by $R(t) = 1380t^2 - 675t^3$ for $0 \leq t \leq 2$ hours; $R(t)$ is measured in people per hour. No one is in the auditorium at time $t = 0$, when the doors open. The doors close and the concert begins at time $t = 2$.
- (a) How many people are in the auditorium when the concert begins?
- (b) Find the time when the rate at which people enter the auditorium is a maximum. Justify your answer.
- (c) The total wait time for all the people in the auditorium is found by adding the time each person waits, starting at the time the person enters the auditorium and ending when the concert begins. The function w models the total wait time for all the people who enter the auditorium before time t . The derivative of w is given by $w'(t) = (2 - t)R(t)$. Find $w(2) - w(1)$, the total wait time for those who enter the auditorium after time $t = 1$.
- (d) On average, how long does a person wait in the auditorium for the concert to begin? Consider all people who enter the auditorium after the doors open, and use the model for total wait time from part (c).
-

WRITE ALL WORK IN THE PINK EXAM BOOKLET.

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Note: Figure not drawn to scale.

3. A diver leaps from the edge of a diving platform into a pool below. The figure above shows the initial position of the diver and her position at a later time. At time t seconds after she leaps, the horizontal distance from the front edge of the platform to the diver's shoulders is given by $x(t)$, and the vertical distance from the water surface to her shoulders is given by $y(t)$, where $x(t)$ and $y(t)$ are measured in meters. Suppose that the diver's shoulders are 11.4 meters above the water when she makes her leap and that

$$\frac{dx}{dt} = 0.8 \text{ and } \frac{dy}{dt} = 3.6 - 9.8t,$$

for $0 \leq t \leq A$, where A is the time that the diver's shoulders enter the water.

- (a) Find the maximum vertical distance from the water surface to the diver's shoulders.
- (b) Find A , the time that the diver's shoulders enter the water.
- (c) Find the total distance traveled by the diver's shoulders from the time she leaps from the platform until the time her shoulders enter the water.
- (d) Find the angle θ , $0 < \theta < \frac{\pi}{2}$, between the path of the diver and the water at the instant the diver's shoulders enter the water.

WRITE ALL WORK IN THE PINK EXAM BOOKLET.

END OF PART A OF SECTION II

**AP[®] CALCULUS BC
2009 SCORING GUIDELINES**

Question 2

The rate at which people enter an auditorium for a rock concert is modeled by the function R given by $R(t) = 1380t^2 - 675t^3$ for $0 \leq t \leq 2$ hours; $R(t)$ is measured in people per hour. No one is in the auditorium at time $t = 0$, when the doors open. The doors close and the concert begins at time $t = 2$.

- (a) How many people are in the auditorium when the concert begins?
- (b) Find the time when the rate at which people enter the auditorium is a maximum. Justify your answer.
- (c) The total wait time for all the people in the auditorium is found by adding the time each person waits, starting at the time the person enters the auditorium and ending when the concert begins. The function w models the total wait time for all the people who enter the auditorium before time t . The derivative of w is given by $w'(t) = (2 - t)R(t)$. Find $w(2) - w(1)$, the total wait time for those who enter the auditorium after time $t = 1$.
- (d) On average, how long does a person wait in the auditorium for the concert to begin? Consider all people who enter the auditorium after the doors open, and use the model for total wait time from part (c).

(a) $\int_0^2 R(t) dt = 980$ people

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

(b) $R'(t) = 0$ when $t = 0$ and $t = 1.36296$
The maximum rate may occur at 0, $a = 1.36296$, or 2.

3 : $\begin{cases} 1 : \text{considers } R'(t) = 0 \\ 1 : \text{interior critical point} \\ 1 : \text{answer and justification} \end{cases}$

$R(0) = 0$
 $R(a) = 854.527$
 $R(2) = 120$

The maximum rate occurs when $t = 1.362$ or 1.363.

(c) $w(2) - w(1) = \int_1^2 w'(t) dt = \int_1^2 (2 - t)R(t) dt = 387.5$

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

The total wait time for those who enter the auditorium after time $t = 1$ is 387.5 hours.

(d) $\frac{1}{980}w(2) = \frac{1}{980} \int_0^2 (2 - t)R(t) dt = 0.77551$
On average, a person waits 0.775 or 0.776 hour.

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