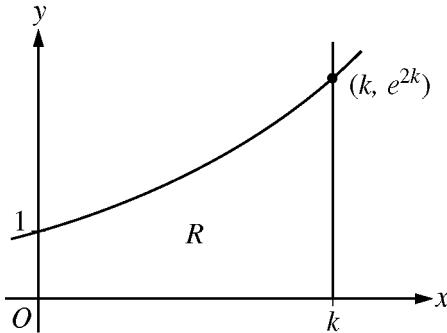


2011 AP[®] CALCULUS BC FREE-RESPONSE QUESTIONS

**CALCULUS BC
SECTION II, Part B
Time—60 minutes
Number of problems—4**

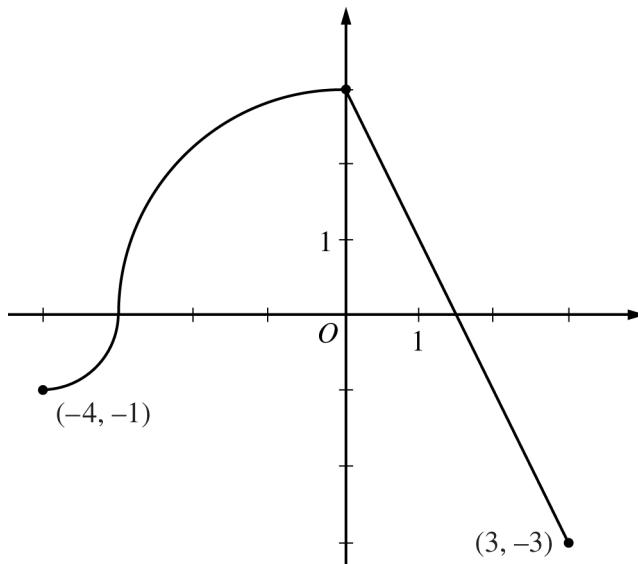
No calculator is allowed for these problems.



3. Let $f(x) = e^{2x}$. Let R be the region in the first quadrant bounded by the graph of f , the coordinate axes, and the vertical line $x = k$, where $k > 0$. The region R is shown in the figure above.
- Write, but do not evaluate, an expression involving an integral that gives the perimeter of R in terms of k .
 - The region R is rotated about the x -axis to form a solid. Find the volume, V , of the solid in terms of k .
 - The volume V , found in part (b), changes as k changes. If $\frac{dk}{dt} = \frac{1}{3}$, determine $\frac{dV}{dt}$ when $k = \frac{1}{2}$.

WRITE ALL WORK IN THE EXAM BOOKLET.

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Graph of f

4. The continuous function f is defined on the interval $-4 \leq x \leq 3$. The graph of f consists of two quarter circles and one line segment, as shown in the figure above. Let $g(x) = 2x + \int_0^x f(t) dt$.
- Find $g(-3)$. Find $g'(x)$ and evaluate $g'(-3)$.
 - Determine the x -coordinate of the point at which g has an absolute maximum on the interval $-4 \leq x \leq 3$. Justify your answer.
 - Find all values of x on the interval $-4 < x < 3$ for which the graph of g has a point of inflection. Give a reason for your answer.
 - Find the average rate of change of f on the interval $-4 \leq x \leq 3$. There is no point c , $-4 < c < 3$, for which $f'(c)$ is equal to that average rate of change. Explain why this statement does not contradict the Mean Value Theorem.

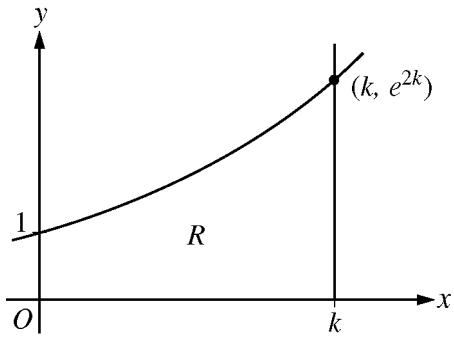
WRITE ALL WORK IN THE EXAM BOOKLET.

**AP[®] CALCULUS BC
2011 SCORING GUIDELINES**

Question 3

Let $f(x) = e^{2x}$. Let R be the region in the first quadrant bounded by the graph of f , the coordinate axes, and the vertical line $x = k$, where $k > 0$. The region R is shown in the figure above.

- (a) Write, but do not evaluate, an expression involving an integral that gives the perimeter of R in terms of k .
- (b) The region R is rotated about the x -axis to form a solid. Find the volume, V , of the solid in terms of k .
- (c) The volume V , found in part (b), changes as k changes. If $\frac{dk}{dt} = \frac{1}{3}$, determine $\frac{dV}{dt}$ when $k = \frac{1}{2}$.



(a) $f'(x) = 2e^{2x}$

$$\text{Perimeter} = 1 + k + e^{2k} + \int_0^k \sqrt{1 + (2e^{2x})^2} dx$$

3 : $\begin{cases} 1 : f'(x) \\ 1 : \text{integral} \\ 1 : \text{answer} \end{cases}$

(b) Volume = $\pi \int_0^k (e^{2x})^2 dx = \pi \int_0^k e^{4x} dx = \frac{\pi}{4} e^{4x} \Big|_{x=0}^{x=k} = \frac{\pi}{4} e^{4k} - \frac{\pi}{4}$

4 : $\begin{cases} 1 : \text{integrand} \\ 1 : \text{limits} \\ 1 : \text{antiderivative} \\ 1 : \text{answer} \end{cases}$

(c) $\frac{dV}{dt} = \pi e^{4k} \frac{dk}{dt}$

$$\text{When } k = \frac{1}{2}, \frac{dV}{dt} = \pi e^2 \cdot \frac{1}{3}.$$

2 : $\begin{cases} 1 : \text{applies chain rule} \\ 1 : \text{answer} \end{cases}$