

**2011 AP<sup>®</sup> CALCULUS AB FREE-RESPONSE QUESTIONS (Form B)**

**CALCULUS AB  
SECTION II, Part A**

**Time—30 minutes**

**Number of problems—2**

**A graphing calculator is required for these problems.**

1. A cylindrical can of radius 10 millimeters is used to measure rainfall in Stormville. The can is initially empty, and rain enters the can during a 60-day period. The height of water in the can is modeled by the function  $S$ , where  $S(t)$  is measured in millimeters and  $t$  is measured in days for  $0 \leq t \leq 60$ . The rate at which the height of the water is rising in the can is given by  $S'(t) = 2\sin(0.03t) + 1.5$ .
- (a) According to the model, what is the height of the water in the can at the end of the 60-day period?
- (b) According to the model, what is the average rate of change in the height of water in the can over the 60-day period? Show the computations that lead to your answer. Indicate units of measure.
- (c) Assuming no evaporation occurs, at what rate is the volume of water in the can changing at time  $t = 7$ ? Indicate units of measure.
- (d) During the same 60-day period, rain on Monsoon Mountain accumulates in a can identical to the one in Stormville. The height of the water in the can on Monsoon Mountain is modeled by the function  $M$ , where  $M(t) = \frac{1}{400}(3t^3 - 30t^2 + 330t)$ . The height  $M(t)$  is measured in millimeters, and  $t$  is measured in days for  $0 \leq t \leq 60$ . Let  $D(t) = M'(t) - S'(t)$ . Apply the Intermediate Value Theorem to the function  $D$  on the interval  $0 \leq t \leq 60$  to justify that there exists a time  $t$ ,  $0 < t < 60$ , at which the heights of water in the two cans are changing at the same rate.
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2. A 12,000-liter tank of water is filled to capacity. At time  $t = 0$ , water begins to drain out of the tank at a rate modeled by  $r(t)$ , measured in liters per hour, where  $r$  is given by the piecewise-defined function

$$r(t) = \begin{cases} \frac{600t}{t+3} & \text{for } 0 \leq t \leq 5 \\ 1000e^{-0.2t} & \text{for } t > 5 \end{cases}$$

- (a) Is  $r$  continuous at  $t = 5$ ? Show the work that leads to your answer.
- (b) Find the average rate at which water is draining from the tank between time  $t = 0$  and time  $t = 8$  hours.
- (c) Find  $r'(3)$ . Using correct units, explain the meaning of that value in the context of this problem.
- (d) Write, but do not solve, an equation involving an integral to find the time  $A$  when the amount of water in the tank is 9000 liters.
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**WRITE ALL WORK IN THE EXAM BOOKLET.**

**END OF PART A OF SECTION II**

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