AP[®] CALCULUS BC 2010 SCORING GUIDELINES

Question 1

There is no snow on Janet's driveway when snow begins to fall at midnight. From midnight to 9 A.M., snow accumulates on the driveway at a rate modeled by $f(t) = 7te^{\cos t}$ cubic feet per hour, where t is measured in hours since midnight. Janet starts removing snow at 6 A.M. (t = 6). The rate g(t), in cubic feet per hour, at which Janet removes snow from the driveway at time t hours after midnight is modeled by

$$g(t) = \begin{cases} 0 & \text{for } 0 \le t < 6\\ 125 & \text{for } 6 \le t < 7\\ 108 & \text{for } 7 \le t \le 9 \,. \end{cases}$$

- (a) How many cubic feet of snow have accumulated on the driveway by 6 A.M.?
- (b) Find the rate of change of the volume of snow on the driveway at 8 A.M.
- (c) Let h(t) represent the total amount of snow, in cubic feet, that Janet has removed from the driveway at time *t* hours after midnight. Express *h* as a piecewise-defined function with domain $0 \le t \le 9$.
- (d) How many cubic feet of snow are on the driveway at 9 A.M.?

(a)	$\int_{0}^{6} f(t) dt = 142.274 \text{ or } 142.275 \text{ cubic feet}$	$2: \begin{cases} 1: integral \\ 1: answer \end{cases}$
(b)	Rate of change is $f(8) - g(8) = -59.582$ or -59.583 cubic feet per hour.	1 : answer
(c)	h(0) = 0 For $0 < t \le 6$, $h(t) = h(0) + \int_0^t g(s) ds = 0 + \int_0^t 0 ds = 0$. For $6 < t \le 7$, $h(t) = h(6) + \int_6^t g(s) ds = 0 + \int_6^t 125 ds = 125(t-6)$. For $7 < t \le 9$, $h(t) = h(7) + \int_7^t g(s) ds = 125 + \int_7^t 108 ds = 125 + 108(t-7)$. Thus, $h(t) = \begin{cases} 0 & \text{for } 0 \le t \le 6\\ 125(t-6) & \text{for } 6 < t \le 7\\ 125 + 108(t-7) & \text{for } 7 < t \le 9 \end{cases}$	$3: \begin{cases} 1: h(t) \text{ for } 0 \le t \le 6\\ 1: h(t) \text{ for } 6 < t \le 7\\ 1: h(t) \text{ for } 7 < t \le 9 \end{cases}$
(d)	Amount of snow is $\int_{0}^{9} f(t) dt - h(9) = 26.334$ or 26.335 cubic feet.	$3: \begin{cases} 1: \text{ integral} \\ 1: h(9) \\ 1: \text{ answer} \end{cases}$

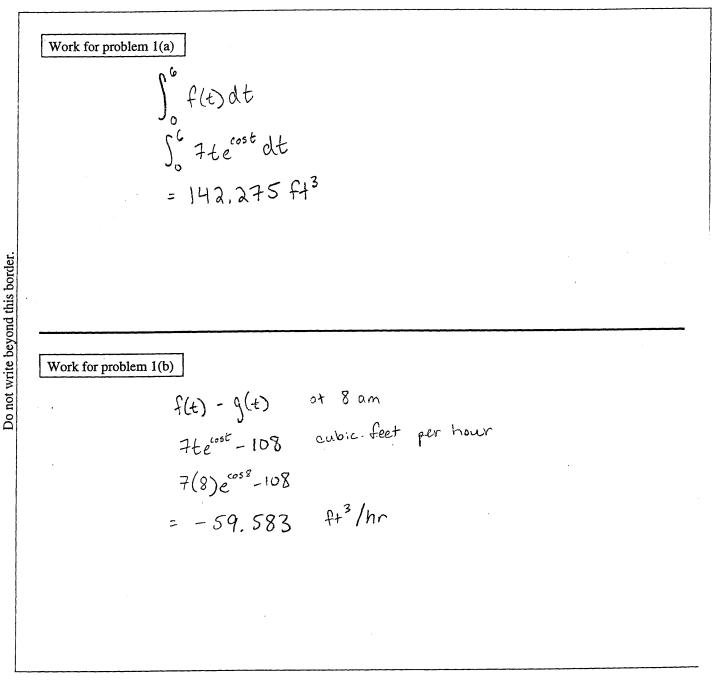


CALCULUS AB SECTION II, Part A

Time—45 minutes

Number of problems-3

A graphing calculator is required for some problems or parts of problems.



Continue problem 1 on page

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CALCULUS BC

SECTION II, Part A

Time—45 minutes

Number of problems—3

A graphing calculator is required for some problems or parts of problems.

Work for problem 1(a) Rate of accumalation of show = 7 te cost Accumulation at GAIM = (Ttecost) dE # 142.275 ft³ Do not write beyond this border. Work for problem 1(b) Volume of snow at $8 \text{ A} \cdot \text{M} = 7 \text{te}^{\cos t} - 108$ $dV = (7t) (e^{\cos t} - \sin t) + (7) (e^{\cos t})$ $dt = (7t) (e^{\cos t} - \sin t) + (7) (e^{\cos t})$ $\frac{dV}{dt} = 7t(-e^{cost}sint) + 7e^{cost}$ dV = -7te cost at At t=8, dV ~ -41,8496 ft3/hr

Continue problem 1 on page 5

1 1 1 1 1 1 1 1 1 1 B
Work for problem 10

$$h(E) = \begin{cases} 0 & \text{for } 0 \notin C & \text{for } 0 \notin C & \text{for } 0 \end{pmatrix}$$

$$Work for problem 10
$$h(E) = \begin{cases} 0 & \text{for } 0 \notin C & \text{for } 1 \notin E & \text{for } 1 \# E & \text{$$$$

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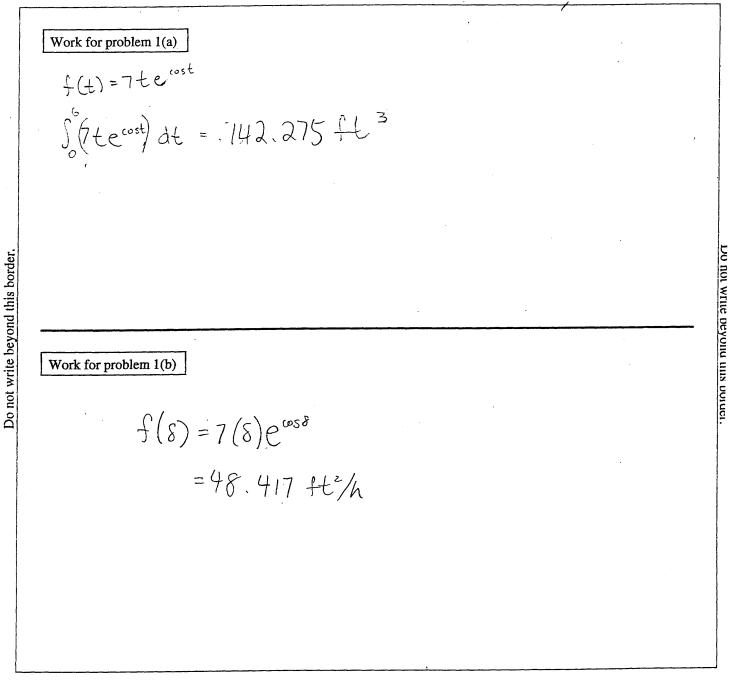
CALCULUS AB

SECTION II, Part A

Time—45 minutes

Number of problems—3

A graphing calculator is required for some problems or parts of problems.



Continue problem 1 on page 5.

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1 1 Work for problem 1(c) $S_{125} dt = 125$ $S_{108} dt = 216$ $h(t) \begin{cases} 0, 0' \le t < 6' \\ 125, 6 \le t < 7' \\ 216, 7 \le t \le 9 \end{cases}$ Do not write beyond this border. Do not write beyond this border. Work for problem 1(d) $\int (7te^{\cos t}) dt = 367.335 ft^{2}$

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AP[®] CALCULUS BC 2010 SCORING COMMENTARY

Question 1

Overview

This problem supplied two rate functions related to the amount of snow on Janet's driveway during a nine-hour period. One function f, given by $f(t) = 7te^{\cos t}$, measured in cubic feet per hour, models the rate of accumulation on the driveway for t between 0 and 9 hours after midnight. A second function, g, is a step function that gives the rate at which Janet removes snow from the driveway during this period. For part (a)

students needed to use the definite integral $\int_{0}^{6} f(t) dt$ to calculate the accumulation of snow on the driveway by

6 A.M. — integrating the rate of accumulation of snow over a time interval gives the net accumulation of snow during that time period. Part (b) asked for the rate of change of the volume of snow on the driveway at 8 A.M.; students needed to recognize this as the difference f(8) - g(8) between the rate of accumulation and the rate of removal at time t = 8. Part (c) asked the students to recover a function h measuring the total amount of snow removed from the driveway for t between 0 and 9 hours after midnight. Students needed to integrate to obtain a piecewise-linear expression for h from the step function g. Part (d) asked for the amount of snow on the

driveway at 9 A.M., which required students to compute the difference of two integrals, $\int_0^9 f(t) dt - \int_0^9 g(t) dt$.

Sample: 1A Score: 9

The student earned all 9 points.

Sample: 1B Score: 6

The student earned 6 points: 2 points in part (a), no points in part (b), 1 point in part (c), and 3 points in part (d). In part (a) the student's work is correct. In part (b) the student works with f', rather than f and g. The student's numeric answer is incorrect. In part (c) the student earned the first point for correctly identifying h(t) = 0 on the interval from 0 to 6. The second point was not earned since the student reports that the linear expression is 125t. The student does not use the initial condition that h(7) = 125 and does not horizontally translate the linear expression, so the third point was not earned. In part (d) the student's work is correct.

Sample: 1C Score: 4

The student earned 4 points: 2 points in part (a), no points in part (b), 1 point in part (c), and 1 point in part (d). In part (a) the student's work is correct. In part (b) the student does not subtract g(8) from the evaluation of f(8). In part (c) the student earned the first point for correctly identifying h(t) = 0 on the interval from 0 to 6. The student presents constant functions for the other intervals and did not earn the other two points. In part (d) the student earned the point for the correct integral expression.