t (minutes)	0	2	5	9	10
$H(t)$ (degrees Celsius)	66	60	52	44	43

2. As a pot of tea cools, the temperature of the tea is modeled by a differentiable function H for $0 \le t \le 10$, where time t is measured in minutes and temperature $H(t)$ is measured in degrees Celsius. Values of $H(t)$ at selected values of time t are shown in the table above.

(a) Use the data in the table to approximate the rate at which the temperature of the tea is changing at time $t = 3.5$. Show the computations that lead to your answer.

(b) Using correct units, explain the meaning of $\dfrac{1}{10}\displaystyle\int_0^{10} H(t)\, dt$ in the context of this problem. Use a trapezoidal sum with the four subintervals indicated by the table to estimate $\dfrac{1}{10}\displaystyle\int_0^{10} H(t)\, dt$.

(c) Evaluate $\displaystyle\int_0^{10} H'(t)\, dt$. Using correct units, explain the meaning of the expression in the context of this problem.

(d) At time $t = 0$, biscuits with temperature 100°C were removed from an oven. The temperature of the biscuits at time t is modeled by a differentiable function B for which it is known that $B'(t) = -13.84e^{-0.173t}$. Using the given models, at time $t = 10$, how much cooler are the biscuits than the tea?

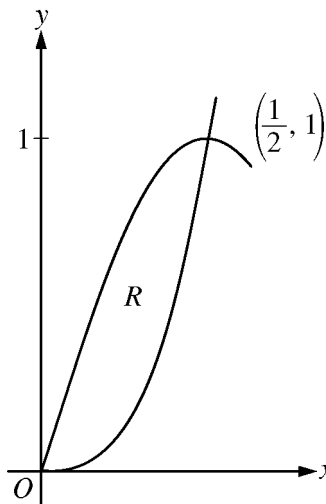**WRITE ALL WORK IN THE EXAM BOOKLET.**

END OF PART A OF SECTION II

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

No calculator is allowed for these problems.

3. Let R be the region in the first quadrant enclosed by the graphs of $f(x) = 8x^3$ and $g(x) = \sin(\pi x)$, as shown in the figure above.

(a) Write an equation for the line tangent to the graph of f at $x = \dfrac{1}{2}$.

(b) Find the area of R.

(c) Write, but do not evaluate, an integral expression for the volume of the solid generated when R is rotated about the horizontal line $y = 1$.

WRITE ALL WORK IN THE EXAM BOOKLET.

Question 2

t (minutes)	0	2	5	9	10
$H(t)$ (degrees Celsius)	66	60	52	44	43

As a pot of tea cools, the temperature of the tea is modeled by a differentiable function H for $0 \leq t \leq 10,$ where time t is measured in minutes and temperature $H(t)$ is measured in degrees Celsius. Values of $H(t)$ at selected values of time t are shown in the table above.

(a) Use the data in the table to approximate the rate at which the temperature of the tea is changing at time $t = 3.5.$ Show the computations that lead to your answer.

(b) Using correct units, explain the meaning of $\frac{1}{10}\int_0^{10} H(t)\, dt$ in the context of this problem. Use a trapezoidal sum with the four subintervals indicated by the table to estimate $\frac{1}{10}\int_0^{10} H(t)\, dt.$

(c) Evaluate $\int_0^{10} H'(t)\, dt.$ Using correct units, explain the meaning of the expression in the context of this problem.

(d) At time $t = 0,$ biscuits with temperature $100°C$ were removed from an oven. The temperature of the biscuits at time t is modeled by a differentiable function B for which it is known that $B'(t) = -13.84e^{-0.173t}.$ Using the given models, at time $t = 10,$ how much cooler are the biscuits than the tea?

(a) $H'(3.5) \approx \dfrac{H(5) - H(2)}{5 - 2}$

$\qquad = \dfrac{52 - 60}{3} = -2.666$ or -2.667 degrees Celsius per minute

$1:$ answer

(b) $\dfrac{1}{10}\int_0^{10} H(t)\, dt$ is the average temperature of the tea, in degrees Celsius, over the 10 minutes.

$\dfrac{1}{10}\int_0^{10} H(t)\, dt \approx \dfrac{1}{10}\left(2 \cdot \dfrac{66 + 60}{2} + 3 \cdot \dfrac{60 + 52}{2} + 4 \cdot \dfrac{52 + 44}{2} + 1 \cdot \dfrac{44 + 43}{2}\right)$

$\qquad = 52.95$

$3: \begin{cases} 1: \text{meaning of expression} \\ 1: \text{trapezoidal sum} \\ 1: \text{estimate} \end{cases}$

(c) $\int_0^{10} H'(t)\, dt = H(10) - H(0) = 43 - 66 = -23$

The temperature of the tea drops 23 degrees Celsius from time $t = 0$ to time $t = 10$ minutes.

$2: \begin{cases} 1: \text{value of integral} \\ 1: \text{meaning of expression} \end{cases}$

(d) $B(10) = 100 + \int_0^{10} B'(t)\, dt = 34.18275; \quad H(10) - B(10) = 8.817$

The biscuits are 8.817 degrees Celsius cooler than the tea.

$3: \begin{cases} 1: \text{integrand} \\ 1: \text{uses } B(0) = 100 \\ 1: \text{answer} \end{cases}$