

9. What is the average value of the function  $y = x + \sin x$  on the interval  $[0, 3\pi/2]$ ?

(A) 2.144 (B) 2.356  
(C) 2.568 (D) 2.781

**Section 2, Part A, Free Response, Technology Permitted**

10. As a pot of coffee cools down, the temperature of the coffee is modeled by a differentiable function  $C$ , for  $0 \leq t \leq 12$ , where time  $t$  is measured in minutes and the temperature  $C(t)$  is measured in degrees Celsius. Selected values of  $t$  are shown in the table.

$t$ (minutes)	0	3	5	7	8	12
$C(t)$ (degrees Celsius)	65	57	50	46	44	40

- (a) Evaluate  $\int_0^{12} C'(t) dt$ . Explain the meaning of your answer in the context of the problem. Indicate units of measure.
- (b) Use the data in the table to approximate the rate at which the temperature is changing at time  $t = 4$ . Show the work that leads to your answer.
- (c) For  $12 \leq t \leq 15$ , the rate of cooling is modeled by  $C'(t) = -2 \cos(0.5t)$ .

Based on the model, what is the temperature of the coffee when  $t = 15$ ? Assume  $C(t)$  is continuous at  $t = 12$ .

11. On a typical day, the snow on a mountain melts at a rate modeled by the function

$$M(t) = \frac{\pi}{6} \sin \frac{\pi t}{12}$$

A snow maker adds snow at a rate modeled by the function

$$S(t) = 0.006t^2 - 0.12t + 0.87$$

Both  $M$  and  $S$  have units in inches per hour and  $t$  is measured in hours for  $0 \leq t \leq 6$ . At  $t = 0$ , the mountain has 40 inches of snow.

- (a) How much snow will melt during the 6-hour period? Indicate units of measure.
- (b) Write an expression for  $I(t)$ , the total number of inches of snow at any time  $t$ .
- (c) Find the rate of change of the total amount of snow when  $t = 3$ .
- (d) For  $0 \leq t \leq 6$ , at what time  $t$  is the amount of snow a maximum? What is the maximum value? Justify your answers.

**Section 2, Part B, Free Response, No Technology**

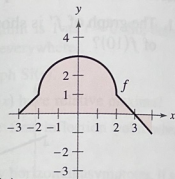
12. For  $0 \leq t \leq 9$ , a particle moves along the  $x$ -axis. The velocity of the particle is given by  $v(t) = \sin(\pi t/4)$ . The particle is at position  $x = -4$  when  $t = 0$ .

- (a) For  $0 \leq t \leq 9$ , when is the particle moving to the right? Justify your answer.
- (b) Write, but do not evaluate, an integral expression that gives the total distance traveled by the particle from time  $t = 0$  to  $t = 9$ .
- (c) Find the acceleration of the particle at time  $t = 3$ . Is the particle speeding up, slowing down, or neither at  $t = 3$ ? Justify your answer.
- (d) Find the position of the particle at time  $t = 3$ .

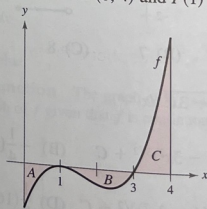
13. Let

$$F(x) = \int_3^x f(t) dt$$

The graph of  $f$  on the interval  $[-3, 4]$  consists of two line segments and a semicircle (see figure).



- (a) Find  $F(0)$ ,  $F'(0)$ , and  $F(4)$ .
- (b) Find all relative minimum values of  $F(x)$  on the interval  $[-3, 4]$ . Justify your answer.
- (c) Find the  $x$ -coordinate of each inflection point of the graph of  $F$  on the interval  $[-3, 4]$ . Justify your answer.
- (d) Write an equation of the line tangent to the graph of  $F$  at  $x = 2$ .
14. The graph of a continuous function  $f$  is shown. The three regions between the graph of  $f$  and the  $x$ -axis are marked A, B, and C, and have unsigned areas 5.5, 6, and 15.5, respectively. Let  $F(x)$  be an antiderivative of  $f$  that is differentiable on  $(0, 4)$  and  $F(1) = 9$ .



- (a) Find  $F(0)$  and  $F(4)$ .
- (b) What is the minimum number of times  $F$  equals 5 on the interval  $[0, 4]$ ? Show the work that leads to your answer.
- (c) Find all intervals where  $F$  is increasing. Justify your answer.