Ch. 11 Introduction to Calculus

11.1 Finding Limits Using Tables and Graphs

1 Understand Limit Notation

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Choose the table which contains the best values of x for finding the requested limit of the given function.

1) $\lim_{x \to 2} (x^2 + 8x - 2)$

A)

x	1.9	1.99	1.999	2.001	2.01	2.1
f(x)						

B)

x	0.9	0.99	0.999	1.001	1.01	1.1
f(x)						

C)

x	−1.9	−1.99	−1.999	2.001	2.01	2.1
f(x)						

D)

x	−0.9	−0.99	−0.999	1.001	1.01	1.1
f(x)						

2) $\lim_{x \to 1} \frac{x^4 - 1}{x - 1}$

A)

x	0.9	0.99	0.999	1.001	1.01	1.1
f(x)						

B)

x	1.9	1.99	1.999	1.001	1.01	1.1
f(x)						

C)

x	−0.9	−0.99	−0.999	−1.001	−1.01	−1.1
f(x)						

D)

x	0.1	0.19	0.119	1.99	1.09	1.9
f(x)						

3) $\lim_{x \to 0} \frac{\sin 2x}{x}$

A)

x	−0.03	−0.02	−0.01	0.01	0.02	0.03
f(x)						

B)

x	−0.01	−0.02	−0.03	0.03	0.02	0.01
f(x)						

C)

x	−0.3	−0.2	−0.1	0.1	0.2	0.3
f(x)						

D)

x	0.03	0.02	0.01	0.001	0.002	0.003
f(x)						

Translate the given limit notation into a sentence.

4) $\lim_{x \to 4} (\sqrt{x} - 2) = 0$

A) The limit of $\sqrt{x} - 2$ as x approaches 4 equals the number 0.
B) The limit of $\sqrt{x} - 2$ as x approaches 0 equals the number 4.
C) The limit of $\sqrt{x} - 4$ as x approaches 2 equals the number 0.
D) The limit of $\sqrt{x} - 4$ as x approaches 0 equals the number 2.

5) $\lim_{x \to 0} \frac{\sin 2x}{x} = 2$

A) The limit of $\frac{\sin 2x}{x}$ as x approaches 0 equals the number 2.

B) The limit of $\frac{\sin 2x}{x}$ as x approaches 2 equals the number 0.

C) The limit of $\frac{\sin 2x}{x}$ as x approaches 0 from the left equals the number 2.

D) The limit of $\frac{\sin 2x}{x}$ as x approaches 0 from the right equals the number 2.

2 Find Limits Using Tables

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Complete the table for the function and find the indicated limit.

1) $\lim_{x \to 2} (x^2 + 8x - 2)$

x	1.9	1.99	1.999	2.001	2.01	2.1
f(x)						

A) 16.810; 17.880; 17.988; 18.012; 18.120; 19.210
limit = 18.0

B) 5.043; 5.364; 5.396; 5.404; 5.436; 5.763
limit = 5.40

C) 16.692; 17.592; 17.689; 17.710; 17.808; 18.789
limit = 17.70

D) 6.810; 7.880; 7.988; 8.012; 8.120; 9.210
limit = 8.0

2) $\lim_{x \to 1} \frac{x^4 - 1}{x - 1}$

x	0.9	0.99	0.999	1.001	1.01	1.1
f(x)						

A) 3.439; 3.940; 3.994; 4.006; 4.060; 4.641
limit = 4.0

B) 1.032; 1.182; 1.198; 1.201; 1.218; 1.392
limit = 1.210

C) 4.595; 5.046; 5.095; 5.105; 5.154; 5.677
limit = 5.10

D) 7.439; 7.940; 7.994; 8.006; 8.060; 8.641
limit = 8.0

3) $\lim_{x \to 0} \frac{x^3 - 6x + 8}{x - 2}$

x	−0.1	−0.01	−0.001	0.001	0.01	0.1
f(x)						

A) −4.09476; −4.00995; −4.00100; −3.99900; −3.98995; −3.89526
limit = −4.0

B) −1.22843; −1.20298; −1.20030; −1.19970; −1.19699; −1.16858
limit = −1.20

C) −2.18529; −2.10895; −2.10090; −2.09910; −2.09096; −2.00574
limit = −2.10

D) 4.09476; 4.00995; 4.00100; 3.99900; 3.98995; 3.89526
limit = 4.0

4) $\lim_{x \to 0} (x^2 - 5)$

x	−0.1	−0.01	−0.001	0.001	0.01	0.1
f(x)						

A) −4.9900; −4.9999; −5.0000; −5.0000; −4.9999; −4.9900
limit = −5.0

B) −1.4970; −1.4999; −1.5000; −1.5000; −1.4999; −1.4970
limit = −1.50

C) −2.9910; −2.9999; −3.0000; −3.0000; −2.9999; −2.9910
limit = −3.0

D) 1.4970; 1.4999; 1.5000; 1.5000; 1.4999; 1.4970
limit = 1.50

5) $\lim_{x \to 0} \frac{\sin 2x}{x}$

x	−0.03	−0.02	−0.01	0.01	0.02	0.03
f(x)						

A) 1.9988, 1.9995, 1.9999, 1.9999, 1.9995, 1.9988
limit = 2

B) 1.9988, 1.9995, 1.9999, 1.9999, 1.9995, 1.9988
limit = 0

C) 1.9988, 1.9995, 1.9999, 1.9999, 1.9995, 1.9988
limit = 1

D) 1.9988, 1.9995, 1.9999, 1.9999, 1.9995, 1.9988
limit = −2

6) $\lim_{x \to 0} \frac{x^2}{\sin x}$

x	−0.03	−0.02	−0.01	0.01	0.02	0.03
f(x)						

A) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = 0

B) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = 1

C) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = 0.1

D) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = −1

7) $\lim\limits_{x \to -7} \dfrac{x^2 - 49}{x + 7}$

x	−7.1	−7.01	−7.001	−6.999	−6.99	−6.9
f(x)						

A) −14.1, −14.01, −14.001, −13.999, −13.99, −13.9
limit = −14

B) 7.1, 7.01, 7.001, 6.999, 6.99, 6.9
limit = 7

C) −14.1, −14.01, −14.001, −13.999, −13.99, −13.9
limit = −14

D) −7.1, −7.01, −7.001, −6.999, −6.99, −6.9
limit = −7

8) $\lim\limits_{x \to 0} \dfrac{1 - \cos x}{\sin x}$

x	−0.03	−0.02	−0.01	0.01	0.02	0.03
f(x)						

A) −0.0150, −0.0100, −0.0050, 0.0050, 0.0100, 0.0150
limit = 0

B) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = 1

C) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = 0.1

D) −0.0300, −0.0200, −0.0100, 0.0100, 0.0200, 0.0300
limit = −1

9) $\lim\limits_{x \to 0} f(x)$, where $f(x) = \begin{cases} x + 5 & \text{if } x < 0 \\ 3x + 5 & \text{if } x \geq 0 \end{cases}$

x	−0.1	−0.01	−0.001	0.001	0.01	0.1
f(x)						

A) 4.9, 4.99, 4.999, 5.003, 5.03, 5.3
limit = 5

B) 2.9, 2.99, 2.999, 3.003, 3.03, 3.3
limit = 3

C) 0.9, 0.99, 0.999, 1.003, 1.03, 1.3
limit = 1

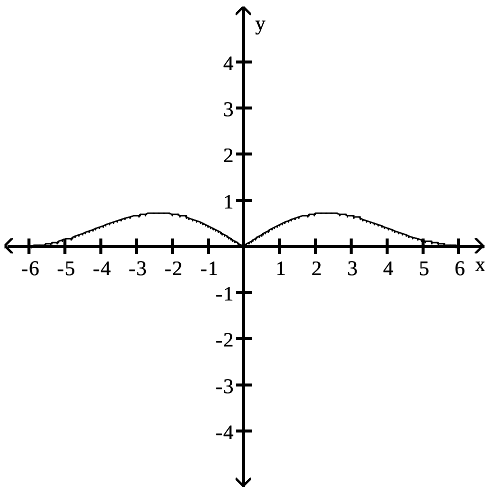
D) 1.9, 1.99, 1.999, 2.003, 2.03, 2.3
limit = 2

3 Find Limits Using Graphs

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

The graph of a function is given. Use the graph to find the indicated limit and function value, or state that the limit or function value does not exist.

1) a. $\lim_{x \to 0} f(x)$ b. $f(0)$



A) a. $\lim_{x \to 0} f(x) = 0$

b. $f(0) = 0$

B) a. $\lim_{x \to 0} f(x) = 0$

b. $f(0) = 1$

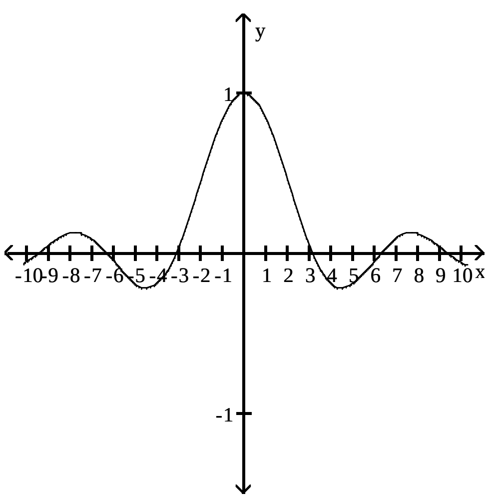
C) a. $\lim_{x \to 0} f(x) = -1$

b. $f(0) = -1$

D) a. $\lim_{x \to 0} f(x)$ does not exist

b. $f(0)$ does not exist

2) a. $\lim_{x \to 0} f(x)$ b. $f(0)$



A) a. $\lim_{x \to 0} f(x) = 1$

b. $f(0) = 1$

B) a. $\lim_{x \to 0} f(x) = 0$

b. $f(0) = 0$

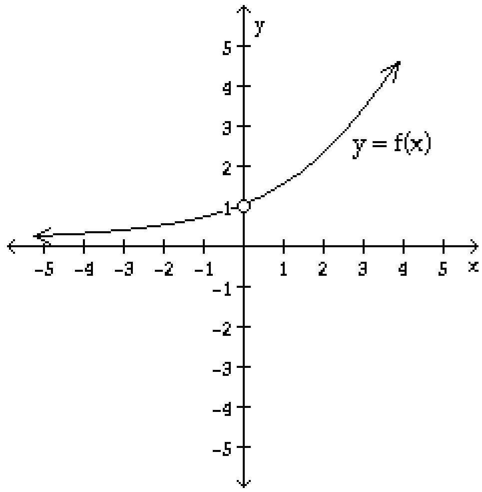
C) a. $\lim_{x \to 0} f(x) = -1$

b. $f(0) = -1$

D) a. $\lim_{x \to 0} f(x)$ does not exist

b. $f(0)$ does not exist

3) a. $\lim_{x \to 0} f(x)$ b. $f(0)$



A) a. $\lim_{x \to 0} f(x) = 1$

b. f(0) does not exist

B) a. $\lim_{x \to 0} f(x) = -1$

b. f(0) does not exist

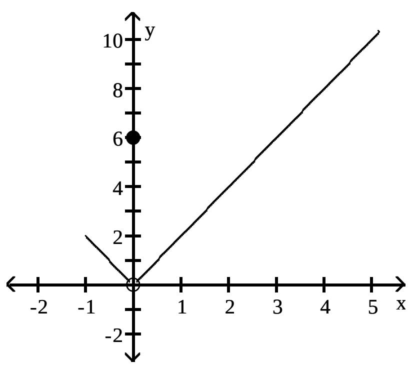
C) a. $\lim_{x \to 0} f(x) = 0$

b. $f(0) = 0$

D) a. $\lim_{x \to 0} f(x)$ does not exist

b. f(0) does not exist

4) a. $\lim_{x \to 0} f(x)$ b. $f(0)$



A) a. $\lim_{x \to 0} f(x) = 0$

b. $f(0) = 6$

B) a. $\lim_{x \to 0} f(x) = 6$

b. $f(0) = 6$

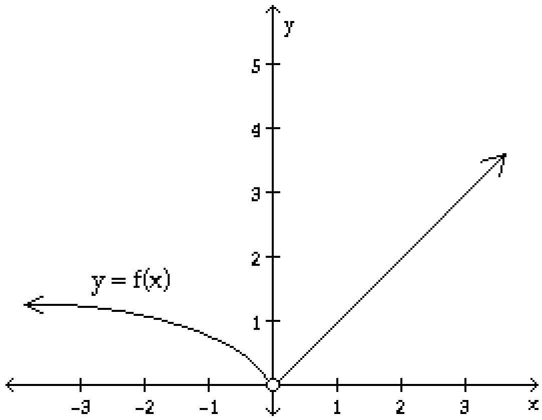
C) a. $\lim_{x \to 0} f(x) = 6$

b. $f(0) = 0$

D) a. $\lim_{x \to 0} f(x)$ does not exist

b. $f(0) = 6$

5) a. $\lim_{x \to 0} f(x)$ b. $f(0)$



A) a. $\lim_{x \to 0} f(x) = 0$

b. $f(0)$ does not exist

B) a. $\lim_{x \to 0} f(x) = 1$

b. $f(0) = 1$

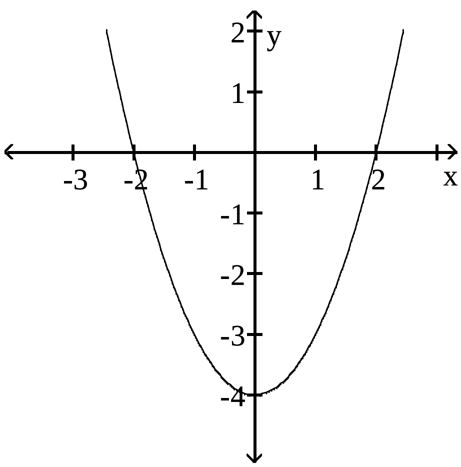
C) a. $\lim_{x \to 0} f(x) = -1$

b. $f(0)$ does not exist

D) a. $\lim_{x \to 0} f(x)$ does not exist

b. $f(0)$ does not exist

6) a. $\lim_{x \to 1} f(x)$ b. $f(1)$



A) a. $\lim_{x \to 1} f(x) = -3$

b. $f(1) = -3$

B) a. $\lim_{x \to 1} f(x) = 3$

b. $f(1) = 3$

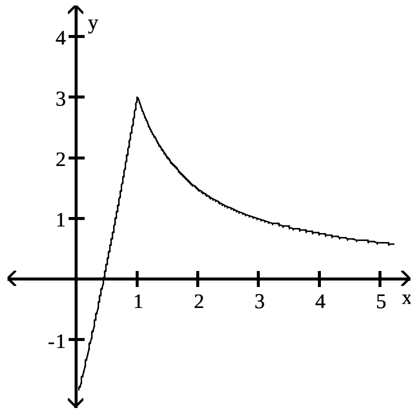
C) a. $\lim_{x \to 1} f(x) = 1$

b. $f(1) = 1$

D) a. $\lim_{x \to 1} f(x)$ does not exist

b. $f(1) = -3$

7) a. $\lim_{x \to 1} f(x)$ b. $f(1)$



A) a. $\lim_{x \to 1} f(x) = 3$

b. $f(1) = 3$

B) a. $\lim_{x \to 1} f(x) = 1$

b. $f(1) = 3$

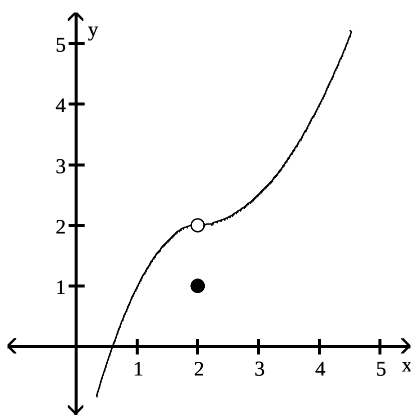
C) a. $\lim_{x \to 1} f(x) = 0$

b. $f(1) = 0$

D) a. $\lim_{x \to 1} f(x)$ does not exist

b. $f(1)$ does not exist

8) a. $\lim_{x \to 2} f(x)$ b. $f(2)$



A) a. $\lim_{x \to 2} f(x) = 2$

b. $f(2) = 1$

B) a. $\lim_{x \to 2} f(x) = 1$

b. $f(2) = 1$

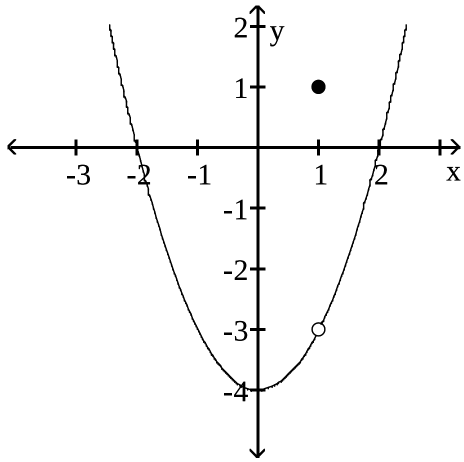
C) a. $\lim_{x \to 2} f(x) = 1$

b. $f(2) = 2$

D) a. $\lim_{x \to 2} f(x)$ does not exist

b. $f(2) = 1$

9) a. $\lim\limits_{x \to 1} f(x)$ b. $f(1)$



A) a. $\lim\limits_{x \to 1} f(x) = -3$

b. $f(1) = 1$

B) a. $\lim\limits_{x \to 1} f(x) = -3$

b. $(1) = -3$

C) a. $\lim\limits_{x \to 1} f(x) = 1$

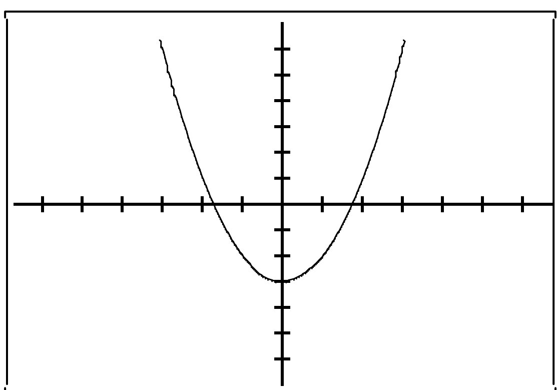
b. $f(1) = -3$

D) a. $\lim\limits_{x \to 1} f(x) = -3$

b. $f(1)$ does not exist

Use the graph and the viewing rectangle shown below the graph to find the indicated limit.

10) $\lim\limits_{x \to -2} (x^2 - 3)$



[−6, 6, 1] by [−6, 6, 1]

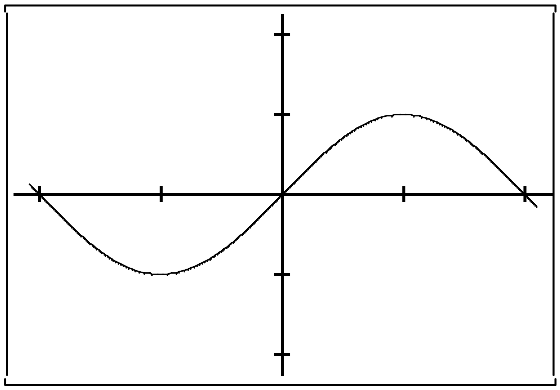
A) $\lim\limits_{x \to -2} (x^2 - 3) = 1$

B) $\lim\limits_{x \to -2} (x^2 - 3) = -7$

C) $\lim\limits_{x \to -2} (x^2 - 3) = 7$

D) $\lim\limits_{x \to -2} (x^2 - 3) = -1$

11) $\lim_{x \to -\pi/2} \sin x$



$\left[-\pi, \pi, \frac{\pi}{2}\right]$ by $[-2, 2, 1]$

A) $\lim_{x \to -\pi/2} \sin x = -1$

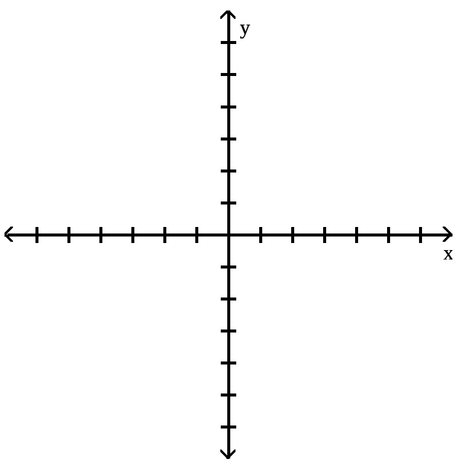
B) $\lim_{x \to -\pi/2} \sin x = 1$

C) $\lim_{x \to -\pi/2} \sin x = 0$

D) $\lim_{x \to -\pi/2} \sin x = -2$

Graph the function. Then use your graph to find the indicated limit.

12) $f(x) = 2x - 3$, $\lim_{x \to 6} f(x)$



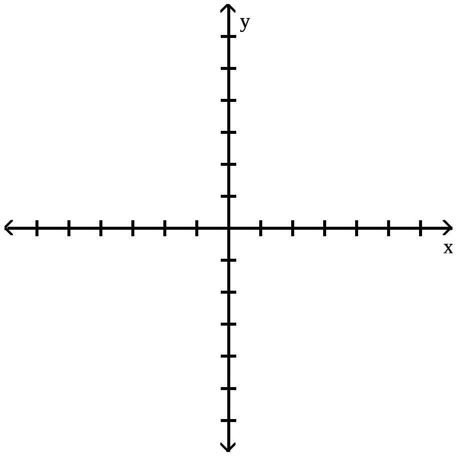
A) 9

B) 6

C) 12

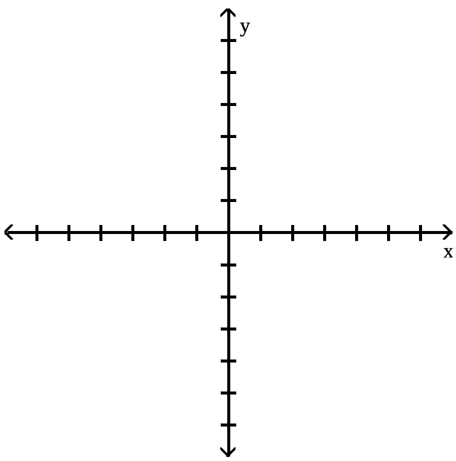
D) 3

13) $f(x) = 3x - 1, \quad \lim_{x \to -3} f(x)$



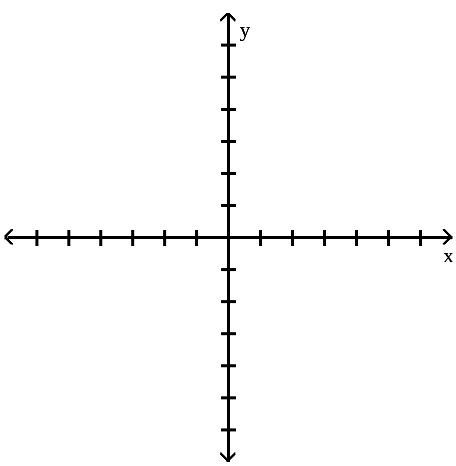
A) -10 B) -3 C) -9 D) -4

14) $f(x) = -3 - x^2, \quad \lim_{x \to 2} f(x)$



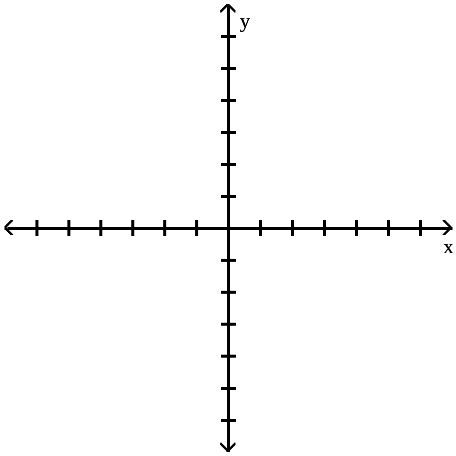
A) -7 B) -3 C) -5 D) 4

15) $f(x) = |4x|, \quad \lim_{x \to -3} f(x)$



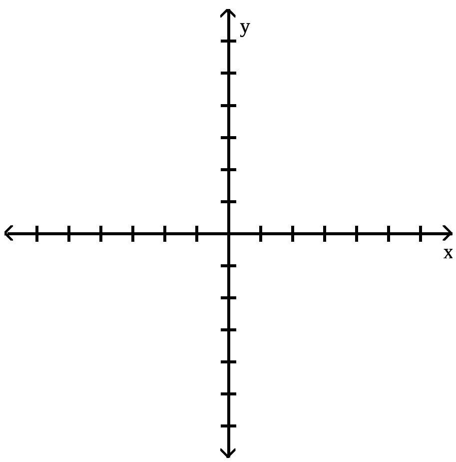
A) 12 B) 3 C) -12 D) -3

16) $f(x) = \sin x - 1$, $\lim\limits_{x \to \pi/2} f(x)$



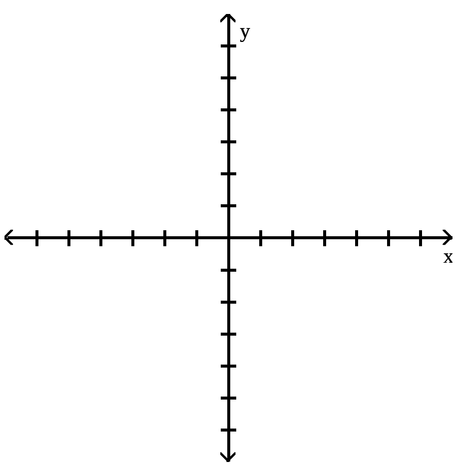
A) 0 B) -1 C) 2 D) 1

17) $f(x) = \dfrac{x^2 - 25}{x - 5}$, $\lim\limits_{x \to 5} f(x)$



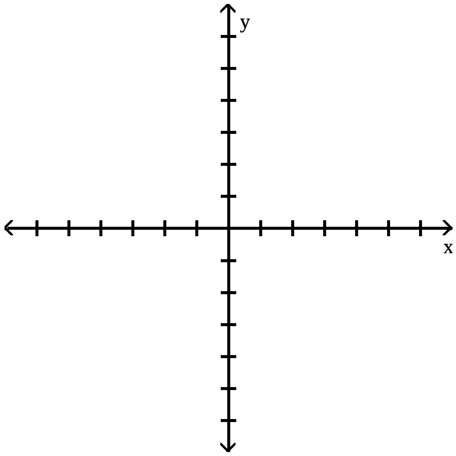
A) 10 B) does not exist C) 5 D) 1

18) $f(x) = \dfrac{x^2 - 100}{x + 10}$, $\lim\limits_{x \to -10} f(x)$



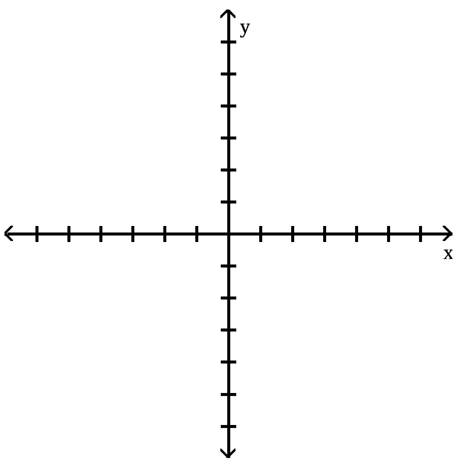
A) -20 B) does not exist C) -10 D) 1

19) $f(x) = 2e^x$, $\lim\limits_{x \to 0} f(x)$



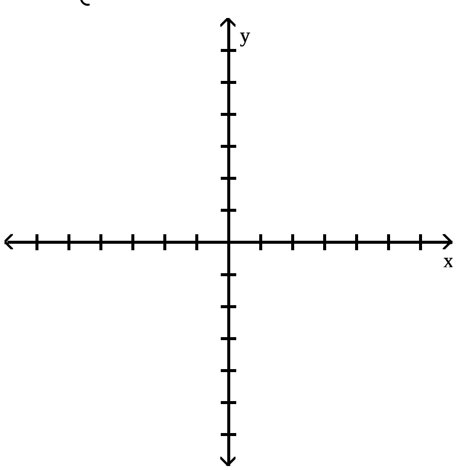
A) 2 B) -2 C) 1 D) 0

20) $f(x) = \begin{cases} x + 3 & \text{if } x < 0 \\ 5x + 3 & \text{if } x \geq 0 \end{cases}$, $\lim\limits_{x \to 0} f(x)$



A) 3 B) does not exist C) 8 D) 0

21) $f(x) = \begin{cases} x + 5 & x < 8 \\ 5 - x & x \geq 8 \end{cases}$, $\lim\limits_{x \to 8} f(x)$



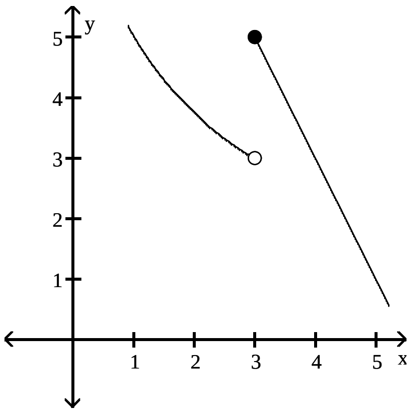
A) does not exist B) 13 C) -3 D) 8

4 Find One–Sided Limits and Use Them to Determine If a Limit Exists

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

The graph of a function is given. Use the graph to find the indicated limit and function value, or state that the limit or function value does not exist.

1) a. $\lim_{x \to 3} f(x)$ b. $f(3)$



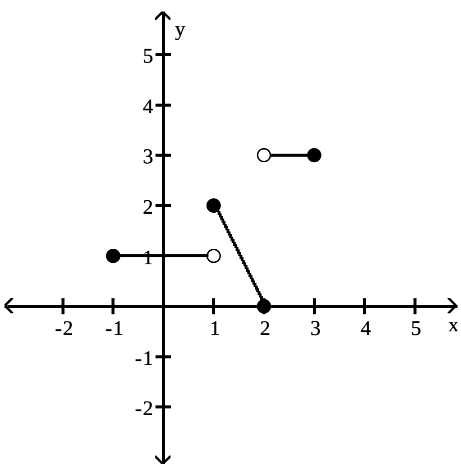
A) a. $\lim_{x \to 3} f(x)$ does not exist
b. $f(3) = 5$

B) a. $\lim_{x \to 3} f(x) = 5$
b. $f(3) = 5$

C) a. $\lim_{x \to 3} f(x) = 3$
b. $f(3) = 5$

D) a. $\lim_{x \to 3} f(x) = 4$
b. $f(3)$ does not exist

2) a. $\lim_{x \to 1} f(x)$ b. $f(1)$



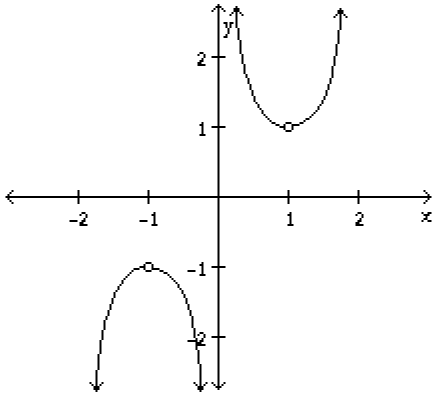
A) a. $\lim_{x \to 1} f(x)$ does not exist
b. $f(1) = 2$

B) a. $\lim_{x \to 1} f(x) = 1$
b. $f(1) = 2$

C) a. $\lim_{x \to 1} f(x) = 2$
b. $f(1) = 2$

D) a. $\lim_{x \to 1} f(x) = 1$
b. $f(1) = 0$

3) a. $\lim_{x \to 1} f(x)$ b. $f(1)$



A) a. $\lim_{x \to 1} f(x) = 1$

b. $f(1)$ does not exist

B) a. $\lim_{x \to 1} f(x) = 0$

b. $f(1) = 1$

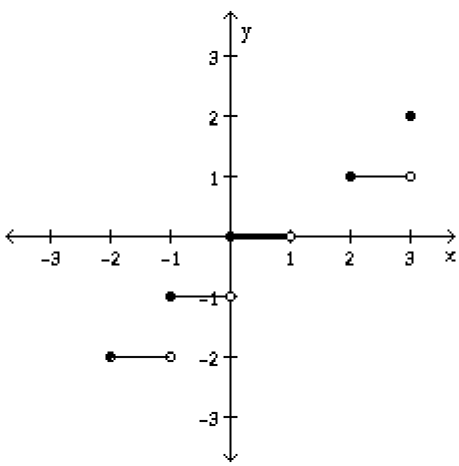
C) a. $\lim_{x \to 1} f(x) = -1$

b. $f(1) = 1$

D) a. $\lim_{x \to 1} f(x)$ does not exist

b. $f(1)$ does not exist

4) a. $\lim_{x \to -1} f(x)$ b. $f(-1)$



A) a. $\lim_{x \to -1} f(x)$ does not exist

b. $f(-1) = -1$

B) a. $\lim_{x \to -1} f(x) = 0$

b. $f(-1) = -1$

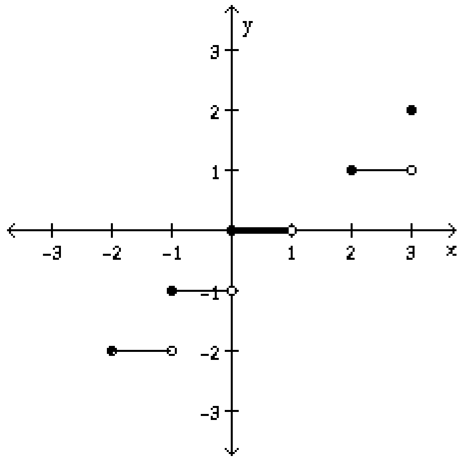
C) a. $\lim_{x \to -1} f(x) = -1$

b. $f(-1)$ does not exist

D) a. $\lim_{x \to -1} f(x) = -2$

b. $f(-1) = -1$

5) a. $\lim_{x \to -1/2} f(x)$ b. $f(-1/2)$



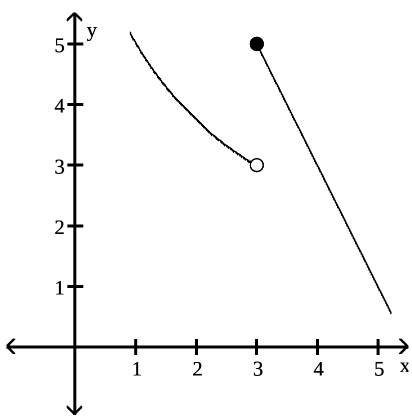
A) a. $\lim_{x \to -1/2} f(x) = -1$
b. $f(-1/2) = -1$

B) a. $\lim_{x \to -1/2} f(x) = -2$
b. $f(-1/2) = -1$

C) a. $\lim_{x \to -1/2} f(x) = 0$
b. $f(-1/2)$ does not exist

D) a. $\lim_{x \to -1/2} f(x)$ does not exist
b. $f(-1/2) = -1$

6) a. $\lim_{x \to 3^-} f(x)$ b. $f(3)$



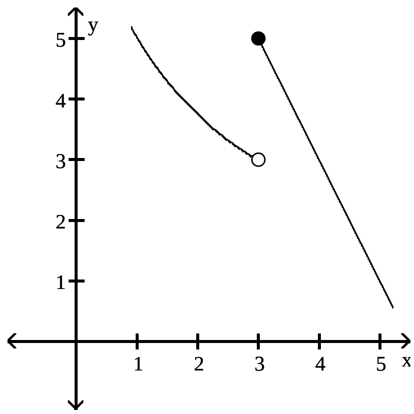
A) a. $\lim_{x \to 3^-} f(x) = 3$
b. $f(3) = 5$

B) a. $\lim_{x \to 3^-} f(x) = 3$
b. $f(3) = 3$

C) a. $\lim_{x \to 3^-} f(x) = 3$
b. $f(3)$ does not exist

D) a. $\lim_{x \to 3^-} f(x)$ does not exist
b. $f(3) = 5$

7) a. $\lim_{x \to 3^+} f(x)$ b. $f(3)$



A) a. $\lim_{x \to 3^+} f(x) = 5$

b. $f(3) = 5$

B) a. $\lim_{x \to 3^+} f(x) = 3$

b. $f(3) = 3$

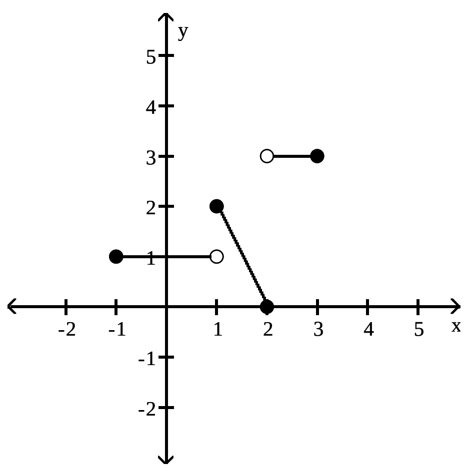
C) a. $\lim_{x \to 3^+} f(x) = 3$

b. $f(3)$ does not exist

D) a. $\lim_{x \to 3^+} f(x)$ does not exist

b. $f(3) = 5$

8) a. $\lim_{x \to 1^+} f(x)$ b. $f(1)$



A) a. $\lim_{x \to 1^+} f(x) = 2$

b. $f(1) = 2$

B) a. $\lim_{x \to 1^+} f(x) = 2$

b. $f(1) = 1$

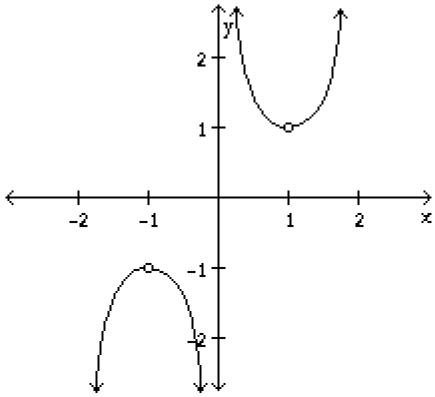
C) a. $\lim_{x \to 1^+} f(x) = 1$

b. $f(1) = 0$

D) a. $\lim_{x \to 1^+} f(x)$ does not exist

b. $f(1) = 2$

9) a. $\lim_{x \to -1^-} f(x)$ b. $f(-1)$



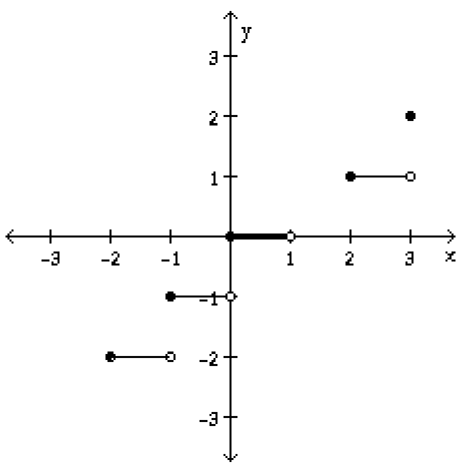
A) a. $\lim_{x \to -1^-} f(x) = -1$
b. $f(-1)$ does not exist

B) a. $\lim_{x \to -1^-} f(x) = 0$
b. $f(-1) = 1$

C) a. $\lim_{x \to -1^-} f(x) = -1$
b. $f(-1) = 1$

D) a. $\lim_{x \to -1^-} f(x)$ does not exist
b. $f(-1)$ does not exist

10) a. $\lim_{x \to -2^+} f(x)$ b. $f(-2)$



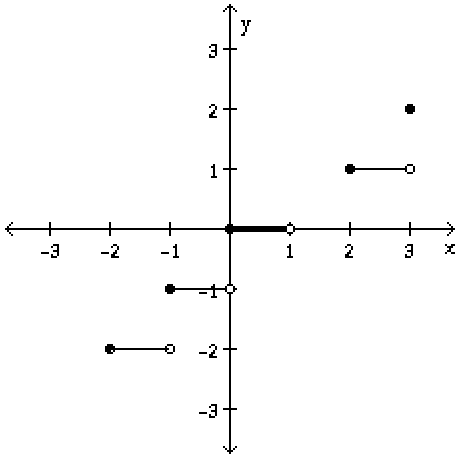
A) a. $\lim_{x \to -2^+} f(x) = -2$
b. $f(-2) = -2$

B) a. $\lim_{x \to -2^+} f(x) = -1$
b. $f(-2)$ does not exist

C) a. $\lim_{x \to -2^+} f(x) = -2$
b. $f(-2) = -1$

D) a. $\lim_{x \to -2^+} f(x)$ does not exist
b. $f(-2) = -1$

11) a. $\lim_{x \to 2.5^-} f(x)$ b. f(2.5)



A) a. $\lim_{x \to 2.5^-} f(x) = 1$

b. f(2.5) = 1

B) a. $\lim_{x \to 2.5^-} f(x) = 2$

b. f(2.5) = 1

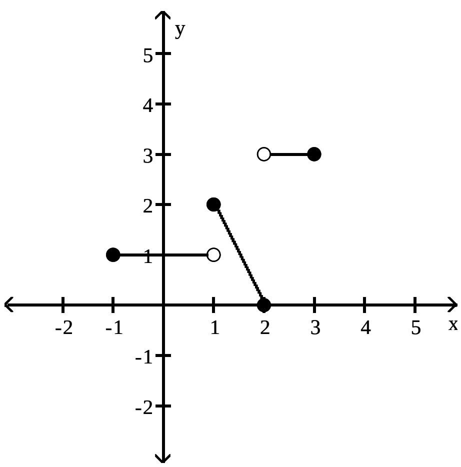
C) a. $\lim_{x \to 2.5^-} f(x) = 0$

b. f(2.5) = 2

D) a. $\lim_{x \to 2.5^-} f(x)$ does not exist

b. f(2.5) = 2

12) a. $\lim_{x \to 1^-} f(x)$ b. f(1)



A) a. $\lim_{x \to 1^-} f(x) = 1$

b. f(1) = 2

B) a. $\lim_{x \to 1^-} f(x) = 2$

b. f(1) = 2

C) a. $\lim_{x \to 1^-} f(x) = 1$

b. f(1) = 1

D) a. $\lim_{x \to 1^-} f(x)$ does not exist

b. f(1) = 2

5 Solve Apps: Use Limits

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Solve the problem.

1) You are riding your motorcycle along a freeway traveling x miles per hour. The function $f(x) = 0.0014x^2 + x + 9$ describes the recommended safe distance, f(x), in feet, between your motorcycle and the other motorcycles on the freeway. Use the values in the table below to solve this exercise.

x	49.9	49.99	49.999 →	← 50.001	50.01	50.1
f(x)	93.76	93.976	93.998 →	← 94.002	94.024	94.24

Find $\lim_{x \to 50} f(x)$. Describe what this means in terms of your motorcycle's speed and the recommended safe distance.

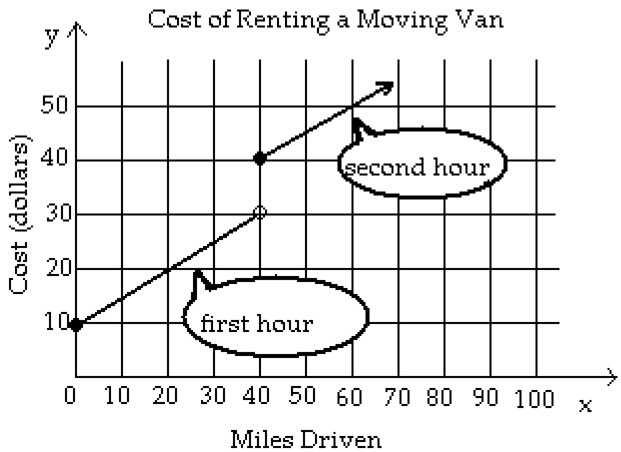
A) 94; This means that the recommended safe distance between motorcycles traveling at 50 miles per hour is 94 feet.

B) 50; This means that the recommended safe distance between motorcycles traveling at 50 miles per hour is 50 feet.

C) 93.999; This means that the recommended safe distance between motorcycles traveling at 50 miles per hour is 93.999 feet.

D) $\lim_{x \to 50} f(x)$ does not exist.

2) You rent a moving van from a company that charges \$10 per hour plus \$0.50 per mile. The van is driven 40 miles in the first hour. The figure below shows the graph of the cost, f(x), in dollars, as a function of the miles, x, that you drive the van.



(i) Find $\lim_{x \to 20} f(x)$. Interpret the limit, referring to miles driven and cost.

(ii) For the first hour hour only, what is the rental cost approaching as the mileage gets closer to 40?
(iii) What is the cost to rent the van at the start of the second hour?

A) (i) 20; the cost to rent the van for one hour and drive it 20 miles is \$20.
(ii) \$30
(iii) \$40

B) (i) 30; the cost to rent the van for one hour and drive it 20 miles is \$30.
(ii) \$40
(iii) \$40

C) (i) 40; the cost to rent the van for one hour and drive it 20 miles is \$40.
(ii) \$30
(iii) \$40

D) (i) 20; the cost to rent the van for one hour and drive it 20 miles is \$20.
(ii) \$30
(iii) \$30

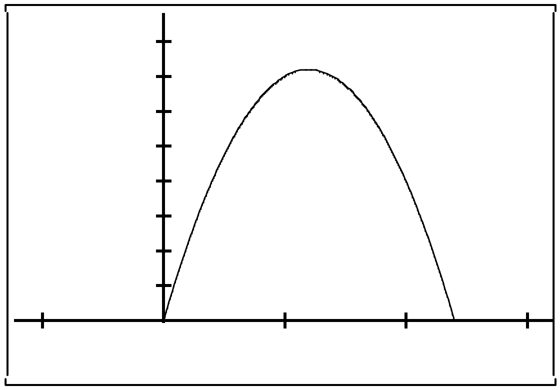
3) You are building a screened–in porch attached to your house. Because the house will be used for one side of the enclosure, only three sides will need to be enclosed. You have 24 yards of material to enclose the three walls. The function f(x) = x(24 – 2x) describes the area of the screened–in porch that you can enclose, f(x), in square yards, if the width of the screened–in porch is x yards

X	Y_1	
5.7	71.82	
5.8	71.92	
5.9	71.98	
6		
6.1	71.98	
6.2	71.92	
6.3	71.82	
Y_1 = X * (24 – 2X)		

(i) Use the table shown to find $\lim_{x \to 6} f(x)$.

(ii) Use the graph of f(x) = x(24– 2x) shown to find $\lim_{x \to 6} f(x)$. Do you get the same limit as you did in part (i)?

What information about the limit is shown by the graph that might not be obvious from the table?



[−5, 15, 5] by [0, 80, 10]

A) (i) 72
(ii) 72; Yes, the same limit is obtained. The graph shows that the limit is the maximum area.

B) (i) 80
(ii) 80; Yes, the same limit is obtained. The graph shows that the limit is the maximum area.

C) (i) 72
(ii) 80; No, the same limit is not obtained. The graph shows that the limit is the maximum amount of material that can be used.

D) (i) 80
(ii) 72; No, the same limit is not obtained. The graph shows that the limit is the maximum amount of material that can be used.

11.2 Finding Limits Using Properties of Limits

1 Find Limits of Constant Functions and the Identity Function

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Use properties of limits to find the indicated limit. It may be necessary to rewrite an expression before limit properties can be applied.

1) $\lim_{x \to 9} 1$

A) 1 B) 9 C) −1 D) 0

2) $\lim_{x \to \sqrt{5}} x$

A) $\sqrt{5}$ B) $-\sqrt{5}$ C) 0 D) 1

2 Find Limits Using Properties of Limits

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Use properties of limits to find the indicated limit. It may be necessary to rewrite an expression before limit properties can be applied.

1) $\lim_{x \to -9} -2x^2$

A) −162 B) −9 C) 81 D) −2

2) $\lim_{x \to 0} (x^2 - 5)$

A) −5 B) 5 C) 0 D) does not exist

3) $\lim_{x \to 2} (x^2 + 8x - 2)$

A) 18 B) −18 C) 0 D) does not exist

4) $\lim_{x \to 2} (x^3 + 5x^2 - 7x + 1)$

A) 15 B) 29 C) 0 D) does not exist

5) $\lim_{x \to 0} (\sqrt{x} - 2)$

A) −2 B) 0 C) 2 D) does not exist

6) $\lim_{x \to 1} (3x^2 - 19)^2$

A) 256 B) −352 C) 144 D) 100

7) $\lim_{x \to 4} (x - 4)(\sqrt{x} - 2)$

A) 0 B) 2 C) 4 D) does not exist

8) $\lim_{x \to 1} (x^2 - 2)^3$

A) −1 B) 1 C) 3 D) −3

9) $\lim_{x \to 3} (3x^2 - 2x + 3)^2$

A) 576 B) −576 C) 100 D) does not exist

10) $\lim_{x \to 1} \sqrt{3x - 2}$

A) 1 B) $\sqrt{2}$ C) −1 D) does not exist

11) $\lim_{x \to 1} \frac{2x - 7}{4x + 5}$

A) $-\frac{5}{9}$ B) $-\frac{1}{2}$ C) $-\frac{7}{5}$ D) does not exist

12) $\lim_{x \to 1} \frac{2x - 7}{4x + 5}$

A) $-\frac{5}{9}$ B) $-\frac{1}{2}$ C) $-\frac{7}{5}$ D) does not exist

13) $\lim_{x \to 5} \frac{x^2 - 2x - 15}{x + 3}$

A) 0 B) −8 C) 5 D) does not exist

14) $\lim_{x \to 0} \frac{x^3 - 6x + 8}{x - 2}$

A) −4 B) 0 C) 4 D) does not exist

15) $\lim_{x \to 1} \dfrac{3x^2 + 7x - 2}{3x^2 - 4x + 2}$

A) 8 B) $-\dfrac{7}{4}$ C) 0 D) does not exist

16) $\lim_{x \to 3} [(x - 2)^3(3x + 1)^2]$

A) 100 B) -100 C) -16 D) does not exist

17) $\lim_{x \to 7} \dfrac{\sqrt{x} - 7}{x - 49}$

A) $\dfrac{1}{6} - \dfrac{\sqrt{7}}{42}$ B) 0 C) $\dfrac{\sqrt{7}}{42} - \dfrac{1}{6}$ D) does not exist

3 Find One-Sided Limits Using Properties of Limits

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

A piecewise function is given. Use the properties of limits to find the indicated limits, or state that the limit does not exist.

1) $f(x) = \begin{cases} -7x + 2 & \text{if } x < 1 \\ 2x - 7 & \text{if } x > 1 \end{cases}$

a. $\lim_{x \to 1^-} f(x)$ b. $\lim_{x \to 1^+} f(x)$ c. $\lim_{x \to 1} f(x)$

A) a. -5 b. -5 c. -5

B) a. -5 b. -5 c. does not exist

C) a. 2 b. -7 c. does not exist

D) a. -7 b. 2 c. does not exist

2) $f(x) = \begin{cases} x^2 + 3 & \text{if } x < 0 \\ 1 & \text{if } x \ge 0 \end{cases}$

a. $\lim_{x \to -1^-} f(x)$ b. $\lim_{x \to -1^+} f(x)$ c. $\lim_{x \to -1} f(x)$

A) a. 4 b. 4 c. 4

B) a. 3 b. 1 c. does not exist

C) a. 1 b. 3 c. does not exist

D) a. 3 b. 1 c. 1

3) $f(x) = \begin{cases} \dfrac{1}{x - 4} & \text{if } x > 4 \\ x^2 - 2x & \text{if } x \le 4 \end{cases}$

a. $\lim_{x \to 4^-} f(x)$ b. $\lim_{x \to 4^+} f(x)$ c. $\lim_{x \to 4} f(x)$

A) a. 8 b. does not exist c. does not exist

B) a. does not exist b. 8 c. does not exist

C) a. 8 b. does not exist c. 8

D) a. does not exist b. 8 c. 8

4) $f(x) = \begin{cases} \dfrac{x^2 - 9}{x - 3} & \text{if } x \neq 3 \\ 5 & \text{if } x = 3 \end{cases}$

a. $\lim\limits_{x \to 3^-} f(x)$ b. $\lim\limits_{x \to 3^+} f(x)$ c. $\lim\limits_{x \to 3} f(x)$

A) a. 6 b. 6 c. 6
B) a. 6 b. 6 c. 5
C) a. 3 b. 3 c. does not exist
D) a. 3 b. 3 c. 5

5) $f(x) = \begin{cases} -7x + 2 & \text{if } x < 1 \\ 1 & \text{if } x = 1 \\ 6x - 8 & \text{if } x > 1 \end{cases}$

a. $\lim\limits_{x \to 1^-} f(x)$ b. $\lim\limits_{x \to 1^+} f(x)$ c. $\lim\limits_{x \to 1} f(x)$

A) a. –5 b. –2 c. does not exist
B) a. –2 b. –5 c. does not exist
C) a. –5 b. –2 c. –7
D) a. –2 b. –5 c. –7

6) $f(x) = \begin{cases} 7 - x & \text{if } x < 1 \\ 5 & \text{if } x = 1 \\ x^2 + 5 & \text{if } x > 1 \end{cases}$

a. $\lim\limits_{x \to 1^-} f(x)$ b. $\lim\limits_{x \to 1^+} f(x)$ c. $\lim\limits_{x \to 1} f(x)$

A) a. 6 b. 6 c. 6
B) a. 6 b. 5 c. does not exist
C) a. 5 b. 7 c. does not exist
D) a. 6 b. 6 c. 5

4 Find Limits of Fractional Expressions in Which the Limit of the Denominator is Zero

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Use properties of limits to find the indicated limit. It may be necessary to rewrite an expression before limit properties can be applied.

1) $\lim\limits_{x \to 1} \dfrac{x^4 - 1}{x - 1}$

A) 4 B) 2 C) 0 D) does not exist

2) $\lim\limits_{x \to -3} \dfrac{x^2 - 2x - 15}{x + 3}$

A) –8 B) 0 C) 5 D) does not exist

3) $\lim\limits_{x \to 0} \dfrac{x^3 + 12x^2 - 5x}{5x}$

A) –1 B) 0 C) 5 D) does not exist

4) $\lim\limits_{x \to 1} \dfrac{x^3 + 5x^2 + 3x - 9}{x - 1}$

A) 16 B) –16 C) 0 D) does not exist

5) $\lim_{x \to 0} \frac{\sqrt{81 + x} - 9}{x}$

A) $\frac{1}{18}$ B) $\frac{1}{9}$ C) 18 D) 0

6) $\lim_{x \to 9} \frac{\frac{1}{x} - \frac{1}{9}}{x - 9}$

A) $-\frac{1}{81}$ B) $\frac{1}{9}$ C) 0 D) does not exist

7) $\lim_{x \to 4} \frac{x - 4}{\sqrt{x} - 2}$

A) 4 B) 1/4 C) 0 D) does not exist

8) $\lim_{x \to 4} \frac{\sqrt{x} - 2}{x - 4}$

A) 1/4 B) 4 C) 0 D) does not exist

9) $\lim_{x \to 5} \frac{x^2 - 25}{x^3 - 125}$

A) $\frac{2}{15}$ B) $-\frac{2}{15}$ C) $\frac{1}{15}$ D) does not exist

10) $\lim_{h \to 0} \frac{(x + h)^3 - x^3}{h}$

A) $3x^2$ B) 0 C) $3x^2 + 3xh + h^2$ D) does not exist

11.3 Limits and Continuity

1 Determine Whether a Function is Continuous at a Number

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Use the definition of continuity to determine whether f is continuous at a.

1) $f(x) = 3x^4 - 8x^3 + x - 9$
$a = 0$

A) Continuous B) Not continuous

2) $f(x) = 4x^4 - 5x^3 + x - 8$
$a = 8$

A) Continuous B) Not continuous

3) $f(x) = \frac{5}{x - 9}$
$a = 9$

A) Not continuous B) Continuous

4) $f(x) = \frac{5}{x + 5}$

$a = 0$

A) Continuous

B) Not continuous

5) $f(x) = \frac{x + 1}{x + 3}$

$a = -1$

A) Continuous

B) Not continuous

6) $f(x) = \frac{x - 5}{x - 8}$

$a = 0$

A) Continuous

B) Not continuous

7) $f(x) = \frac{x + 5}{x - 6}$

$a = 6$

A) Not continuous

B) Continuous

8) $f(x) = \frac{1}{x^2 + 3x}$

$a = 0$

A) Not continuous

B) Continuous

9) $f(x) = \frac{-4}{x^2 - 6x}$

$a = 6$

A) Not continuous

B) Continuous

10) $f(x) = \frac{2}{x^2 + 6x}$

$a = -2$

A) Continuous

B) Not continuous

11) $f(x) = \frac{x^2 - 81}{x - 9}$

$a = 0$

A) Continuous

B) Not continuous

12) $f(x) = \frac{x^2 - 49}{x - 7}$

$a = 7$

A) Not continuous

B) Continuous

13) $f(x) = \begin{cases} x^2 - 4, & \text{if } x < 0 \\ 2, & \text{if } x \geq 0 \end{cases}$

$a = -2$

A) Continuous

B) Not continuous

14) $f(x) = \begin{cases} -4x - 1, & \text{if } x < 1 \\ 1, & \text{if } x = 1 \\ 3x + 3, & \text{if } x > 1 \end{cases}$

$a = 1$

A) Not continuous

B) Continuous

15) $f(x) = \begin{cases} \dfrac{1}{x + 2}, & \text{if } x > -2 \\ x^2 + 3x, & \text{if } x \le -2 \end{cases}$

$a = -2$

A) Not continuous

B) Continuous

2 Determine For What Numbers a Function is Discontinuous

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Determine for what numbers, if any, the given function is discontinuous.

1) $f(x) = 2x - 1$

A) None B) $-\frac{1}{2}$ C) $\frac{1}{2}$ D) 1

2) $f(x) = -4x^2 + 3x$

A) None B) $-\frac{3}{8}$ C) $\frac{3}{8}$ D) -4

3) $f(x) = -4 \cos x$

A) None B) 0 C) 1 D) -4

4) $f(x) = 4 \tan x$

A) $\frac{n\pi}{2}$ and $-\frac{n\pi}{2}$ B) 0 C) $\frac{n\pi}{4}$ and $-\frac{n\pi}{4}$ D) None

5) $f(x) = \dfrac{3x + 3}{x^2 - 16}$

A) -4 and 4 B) 4 C) -4 and 4 and 1 D) None

6) $f(x) = \begin{cases} x - 5 & \text{if } x \le 5 \\ x^2 - 10 & \text{if } x > 5 \end{cases}$

A) 5 B) None C) -5, 5 D) 0

7) $f(x) = \begin{cases} x - 3 & \text{if } x \le 3 \\ x^2 & \text{if } x > 3 \end{cases}$

A) 3

B) [the set of numbers 1, 2, 3, . . . 8]

C) [the set of numbers 1, 2, 3, . . . 9]

D) None

8) $f(x) = \begin{cases} \dfrac{x^2 - 9}{x - 3} & \text{if } x \ne 3 \\ 6 & \text{if } x = 3 \end{cases}$

A) None B) 3 C) 9 D) 3, 9

9) $f(x) = \begin{cases} 9x & \text{if } x < 8 \\ 71 & \text{if } x = 8 \\ x^2 + 8 & \text{if } x > 8 \end{cases}$

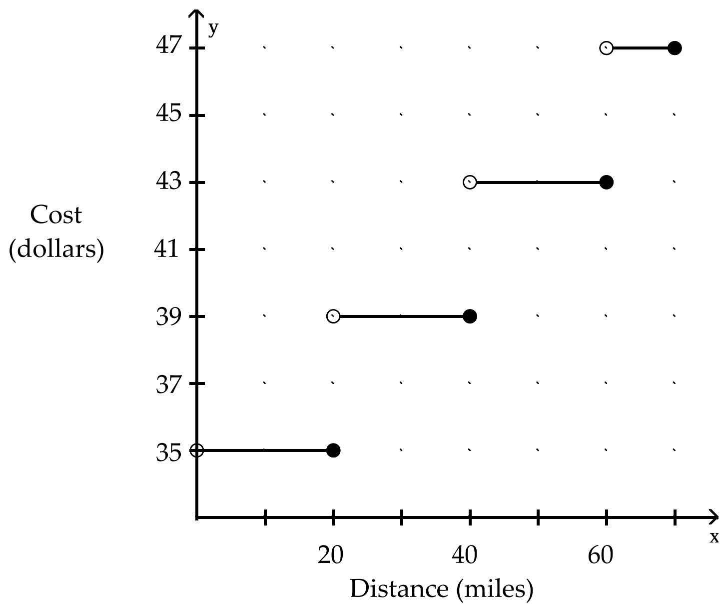
A) 8 B) 0, 8 C) 9, 8 D) None

3 Solve Apps: Limits and Continuity

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

Solve the problem.

1) The figure shows the cost of renting a car, f(x), as a function of distance driven, x, in miles, for distances not exceeding 70 miles.



(i) Find $\lim_{x \to 60^-} f(x)$.

(ii) Find $\lim_{x \to 60^+} f(x)$.

(iii) What can you conclude about $\lim_{x \to 60} f(x)$? How is this shown by the graph?

(iv) What aspect of costs of renting a car causes the graph to jump vertically by the same amount at its discontinuities?

2) The following piecewise function gives the tax owed, T(x), by a single taxpayer on a taxable income of x dollars.

$$T(x) = \begin{cases} 0.13x & \text{if } 0 < x \le 6659 \\ 665.90 + 0.18(x - 6659) & \text{if } 6659 < x \le 30{,}687 \\ 4990.94 + 0.26(x - 30{,}687) & \text{if } 30{,}687 < x \le 72{,}784 \\ 15{,}936.16 + 0.29(x - 72{,}784) & \text{if } 72{,}784 < x \le 149{,}897 \\ 38{,}298.93 + 0.32(x - 149{,}897) & \text{if } 149{,}897 < x \le 325{,}127 \\ 94{,}372.53 + 0.36(x - 325{,}127) & \text{if } x > 325{,}127 \end{cases}$$

(i) Determine whether T is continuous at 6659.
(ii) Determine whether T is continuous at 30,687.
(iii) If T had discontinuities, use one of these discontinuities to describe a situation where it might be advantageous to earn less money in taxable income.

11.4 Introduction to Derivatives

1 Find Slopes and Equations of Tangent Lines

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Find the slope of the tangent line to the graph of f at the given point.

1) $f(x) = -4x + 30$ at (6, 6)

A) −4 B) 30 C) −30 D) $-\frac{1}{4}$

2) $f(x) = x^2 + 5x$ at (4, 36)

A) 13 B) 9 C) 3 D) 21

3) $f(x) = 5x^2 + x$ at (−4, 76)

A) −39 B) −41 C) 6 D) −14

4) $f(x) = -4x^2 + 7x$ at (5, −65)

A) −33 B) 33 C) −13 D) 3

5) $f(x) = 2x^2 + x - 3$ at (4, 33)

A) 17 B) 15 C) 5 D) 19

6) $f(x) = x^2 + 11x - 15$ at (1, −3)

A) 13 B) −9 C) 26 D) 11

7) $f(x) = \sqrt{x}$ at (16, 4)

A) $\frac{1}{8}$ B) 2 C) 8 D) $\frac{1}{2}$

8) $f(x) = \frac{7}{x}$ at (1, 7)

A) −7 B) 7 C) 14 D) $\frac{7}{2}$

Find the slope–intercept equation of the tangent line to the graph of f at the given point.

9) $f(x) = x^2 + 5x$ at (4, 36)

A) $y = 13x - 16$ B) $y = 13x - 72$ C) $y = 2x - 5$ D) $y = 2x + 5$

10) $f(x) = 5x^2 + x$ at (−4, 76)

A) $y = -39x - 80$ B) $y = 10x + 1$ C) $y = 10x$ D) $y = -39x - 232$

11) $f(x) = -4x^2 + 7x$ at (5, −65)

A) $y = -33x + 100$ B) $y = -8x + 7$ C) $y = -4x + 7$ D) $y = 2x - 7$

12) $f(x) = 2x^2 + x - 3$ at x = (4, 33)

A) $y = 17x - 35$ B) $y = 4x + 1$ C) $y = 2x - 3$ D) $y = 4x + 3$

13) $f(x) = x^2 + 11x - 15$ at (1, −3)

A) $y = 13x - 16$ B) $y = 2x + 11$ C) $y = 11x + 15$ D) $y = 11x$

14) $f(x) = \sqrt{x}$ at (16, 4)

A) $y = \frac{1}{8}x + 2$ B) $y = 2x + 2$ C) $y = 8x + \frac{1}{2}$ D) $y = \frac{1}{2}x + \frac{1}{2}$

15) $f(x) = \frac{7}{x}$ at (1, 7)

A) $y = -7x + 14$ B) $y = 7x + 14$ C) $y = 14x - 7$ D) $y = \frac{7}{2}x - 7$

2 Find the Derivative of a Function

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Find the derivative of f at x. That is, find f '(x).

1) $f(x) = x^3 + 14;\ x = 7$

A) 147 B) 1029 C) 21 D) 6

2) $f(x) = -9x + 3;\ x = 9$

A) -9 B) 3 C) -81 D) 27

3) $f(x) = x^2 - 8x + 11;\ x = 2$

A) -4 B) 4 C) -8 D) -6

4) $f(x) = \sqrt{x};\ x = 16$

A) $\frac{1}{8}$ B) 8 C) $\frac{1}{4}$ D) 4

5) $f(x) = \frac{7}{x};\ x = 7$

A) $-\frac{1}{7}$ B) -1 C) $\frac{1}{7}$ D) 1

3 Find Average and Instantaneous Rates of Change

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Solve the problem.

1) The function $f(x) = x^2$ describes the area of a square, f(x), in square centimeters, whose sides each measure x centimeters. If x is changing,
(i) Find the average rate of change of the area with respect to x as x changes from 4 centimeters to 4.1 centimeters.
(ii) Find the average rate of change of the area with respect to x as x changes from 4 centimeters to 4.01 centimeters.
(iii) Find the instantaneous rate of change of the area with respect to x at the moment when x = 4 centimeters.

A) (i) 8.1 square centimeters per centimeter;
(ii) 8.01 square centimeters per centimeter;
(iii) 8 square centimeters per centimeter

B) (i) 0.81 square centimeters per centimeter;
(ii) 0.0801 square centimeters per centimeter;
(iii) 8 square centimeters per centimeter

C) (i) 328.1 square centimeters per centimeter;
(ii) 3208.01 square centimeters per centimeter;
(iii) 2 square centimeters per centimeter

D) (i) 8.01 square centimeters per centimeter;
(ii) 8.001 square centimeters per centimeter;
(iii) 2 square centimeters per centimeter

2) The function $f(x) = \pi x^2$ describes the area of a circle, f(x), in square meters, whose radius measures x meters. If x is changing,

(i) Find the average rate of change of the area with respect to the radius as the radius changes from 9 meters to 9.1 meters.

(ii) Find the average rate of change of the area with respect to the radius as the radius changes from 9 meters to 9.01 meters.

(iii) Find the instantaneous rate of change of the area with respect to the radius at the moment when the radius is 9 meters.

Express all answers in terms of π.

A) (i) 18.1π square meters per meter;
(ii) 18.01π square meters per meter;
(iii) 18π square meters per meter

B) (i) 1638.1π square meters per meter;
(ii) $16{,}218.01\pi$ square meters per meter;
(iii) 18π square meters per meter

C) (i) 18.1π square meters per meter;
(ii) 18.01π square meters per meter;
(iii) 36π square meters per meter

D) (i) 1638.1π square meters per meter;
(ii) $16{,}218.01\pi$ square meters per meter;
(iii) 36π square meters per meter

3) The function $f(x) = x^3$ describes the volume of a cube, f(x), in cubic inches, whose length, width, and height each measure x inches. If x is changing, find the average rate of change of the volume with respect to x as x changes from 7 inches to 7.1 inches.

A) 149.11 cubic inches per inch
B) −149.11 cubic inches per inch
C) 7009.11 cubic inches per inch
D) 100.13 cubic inches per inch

4) The function $f(x) = x^3$ describes the volume of a cube, f(x), in cubic inches, whose length, width, and height each measure x inches. If x is changing, find the instantaneous rate of change of the volume with respect to x at the moment when x = 2 inches.

A) 12 cubic inches per inch
B) 24 cubic inches per inch
C) 6 cubic inches per inch
D) 12.61 cubic inches per inch

5) The function $f(x) = 6\pi x^2$ describes the volume, f(x), of a right circular cylinder of height 6 feet and radius x feet. If the radius is changing, find the instantaneous rate of change of the volume with respect to the radius when the radius is 9 feet. Leave answer in terms of π.

A) 108π cubic feet per feet
B) 54π cubic feet per feet
C) 12π cubic feet per feet
D) 18π cubic feet per feet

4 Find Instantaneous Velocity

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

Solve the problem.

1) An explosion causes debris to rise vertically with an initial velocity of 8 feet per second. The function $s(t) = -16t^2 + 128t$ describes the height of the debris above the ground, s(t), in feet, t seconds after the explosion. What is the instantaneous velocity of the debris 6 second(s) after the explosion?

A) −64 feet per second
B) 64 feet per second
C) −192 feet per second
D) 192 feet per second

2) An explosion causes debris to rise vertically with an initial velocity of 9 feet per second. The function $s(t) = -16t^2 + 144t$ describes the height of the debris above the ground, s(t), in feet, t seconds after the explosion. What is the instantaneous velocity of the debris when it hits the ground?

A) −144 feet per second
B) 144 feet per second
C) −288 feet per second
D) 288 feet per second

3) A foul tip of a baseball is hit straight upward from a height of 4 feet with an initial velocity of 48 feet per second. The function $s(t) = -16t^2 + 48t$ describes the ball's height above the ground, s(t), in feet, t seconds after it was hit. What is the instantaneous velocity of the ball 1.8 seconds after it was hit?

A) −9.6 feet per second
B) 9.6 feet per second
C) −57.6 feet per second
D) 57.6 feet per second

4) A foul tip of a baseball is hit straight upward from a height of 4 feet with an initial velocity of 64 feet per second. The function $s(t) = -16t^2 + 64t$ describes the ball's height above the ground, s(t), in feet, t seconds after it was hit. The ball reaches its maximum height above the ground when the instantaneous velocity reaches zero. After how many seconds does the ball reach its maximum height?

A) 2 seconds
B) 4 seconds
C) 64 seconds
D) $\frac{3}{32}$ seconds

Ch. 11 Introduction to Calculus
Answer Key

11.1 Finding Limits Using Tables and Graphs

1 Understand Limit Notation

1) A
2) A
3) A
4) A
5) A

2 Find Limits Using Tables

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A

3 Find Limits Using Graphs

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A
10) A
11) A
12) A
13) A
14) A
15) A
16) A
17) A
18) A
19) A
20) A
21) A

4 Find One–Sided Limits and Use Them to Determine If a Limit Exists

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A
10) A
11) A

12) A

5 Solve Apps: Use Limits

1) A
2) A
3) A

11.2 Finding Limits Using Properties of Limits

1 Find Limits of Constant Functions and the Identity Function

1) A
2) A

2 Find Limits Using Properties of Limits

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A
10) A
11) A
12) A
13) A
14) A
15) A
16) A
17) A

3 Find One-Sided Limits Using Properties of Limits

1) A
2) A
3) A
4) A
5) A
6) A

4 Find Limits of Fractional Expressions in Which the Limit of the Denominator is Zero

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A
10) A

11.3 Limits and Continuity

1 Determine Whether a Function is Continuous at a Number

1) A
2) A
3) A
4) A
5) A
6) A
7) A

8) A
9) A
10) A
11) A
12) A
13) A
14) A
15) A

2 Determine For What Numbers a Function is Discontinuous

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A

3 Solve Apps: Limits and Continuity

1) (i) 43
(ii) 47
(iii) $\lim_{x \to 60} f(x)$ does not exist; the graph shows a discontinuity at x = 60
(iv) The graph jumps at its discontinuities due to per-mile charges.

2) (i) continuous
(ii) continuous
(iii) Answers may vary. For instance if T(x) were partly defined as follows:

$$T(x) = \begin{cases} 0.13x & \text{if } 0 < x \le 6659 \\ 10{,}000 & \text{if } 6659 < x \le 30{,}687 \\ . & . \quad . \\ . & . \quad . \\ . & . \quad . \end{cases}$$

then there would be a discontinuity at 6659 and a large jump in tax owed for an amount just slightly larger than $6659 in taxable income.

11.4 Introduction to Derivatives

1 Find Slopes and Equations of Tangent Lines

1) A
2) A
3) A
4) A
5) A
6) A
7) A
8) A
9) A
10) A
11) A
12) A
13) A
14) A
15) A

2 Find the Derivative of a Function

1) A
2) A

3) A
4) A
5) A

3 Find Average and Instantaneous Rates of Change

1) A
2) A
3) A
4) A
5) A

4 Find Instantaneous Velocity

1) A
2) A
3) A
4) A