Answers

Chapter 1

Review of Prerequisite Skills, pp. 2–3

1. **a.** -3 **c.** 4 **e.** -4.1
b. -2 **d.** -4 **f.** $-\frac{1}{2}$

2. **a.** $y = 4x - 2$
b. $y = -2x + 5$
c. $y = \frac{6}{5}(x + 1) + 6$
d. $x + y - 2 = 0$
e. $x = -3$
f. $y = 5$

3. **a.** -1 **c.** -9
b. 0 **d.** 144

4. **a.** $-\frac{5}{52}$ **c.** 0
b. $-\frac{3}{13}$ **d.** $\frac{5}{52}$

5. **a.** 6 **c.** 9
b. $\sqrt{3}$ **d.** $\sqrt{6}$

6. **a.** $-\frac{1}{2}$ **c.** 5 **e.** 10^6
b. -1 **d.** 1

7. **a.** $x^2 - 4x - 12$
b. $15 + 17x - 4x^2$
c. $-x^2 - 7x$
d. $-x^2 + x + 7$
e. $a^3 + 6a^2 + 12a + 8$
f. $729a^3 - 1215a^2 + 675a - 125$

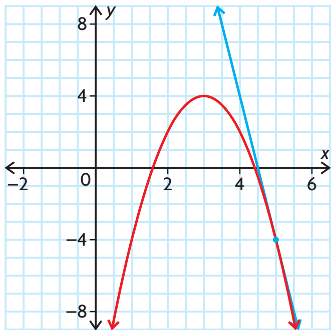
8. **a.** $x(x + 1)(x - 1)$
b. $(x + 3)(x - 2)$
c. $(2x - 3)(x - 2)$
d. $x(x + 1)(x + 1)$
e. $(3x - 4)(9x^2 + 12x + 16)$
f. $(x - 1)(2x - 3)(x + 2)$

9. **a.** $\{x \in \mathbf{R} \mid x \geq -5\}$
b. $\{x \in \mathbf{R}\}$
c. $\{x \in \mathbf{R} \mid x \neq 1\}$
d. $\{x \in \mathbf{R} \mid x \neq 0\}$
e. $\left\{x \in \mathbf{R} \mid x \neq -\frac{1}{2}, 3\right\}$
f. $\{x \in \mathbf{R} \mid x \neq -5, -2, 1\}$

10. **a.** 20.1 m/s **b.** 10.3 m/s

11. **a.** -20 L/min
b. about -13.33 L/min
c. The volume of water in the hot tub is always decreasing during that time period, a negative change.

12. **a.** **b.**



$m = -8$

c. -8

Section 1.1, p. 9

1. **a.** $2\sqrt{3} + 4$ **d.** $3\sqrt{3} - \sqrt{2}$
b. $\sqrt{3} - \sqrt{2}$ **e.** $\sqrt{2} + \sqrt{5}$
c. $2\sqrt{3} + \sqrt{2}$ **f.** $-\sqrt{5} - 2\sqrt{2}$

2. **a.** $\frac{\sqrt{6} + \sqrt{10}}{2}$ **c.** $\frac{4 + \sqrt{6}}{2}$
b. $\sqrt{6} - 3$ **d.** $\frac{3\sqrt{10} - 2}{4}$

3. **a.** $\sqrt{5} + \sqrt{2}$ **d.** $4 - 2\sqrt{5}$
b. $10 - 3\sqrt{10}$ **e.** $\frac{11\sqrt{6} - 16}{47}$
c. $5 + 2\sqrt{6}$ **f.** $\frac{35 - 12\sqrt{6}}{19}$

4. **a.** $\frac{1}{\sqrt{5} + 1}$
b. $\frac{-7}{2 + 3\sqrt{2}}$
c. $\frac{1}{12 - 5\sqrt{5}}$

5. **a.** $8\sqrt{10} + 24$
b. $8\sqrt{10} + 24$
c. The expressions are equivalent. The radicals in the denominator of part a. have been simplified in part b.

6. **a.** $-2\sqrt{3} - 4$
b. $\frac{18\sqrt{2} + 4\sqrt{3}}{23}$
c. $2\sqrt{2} + \sqrt{6}$
d. $\frac{24 + 15\sqrt{3}}{4}$
e. $-\frac{12\sqrt{15} + 15\sqrt{10}}{2}$
f. $5 + 2\sqrt{6}$

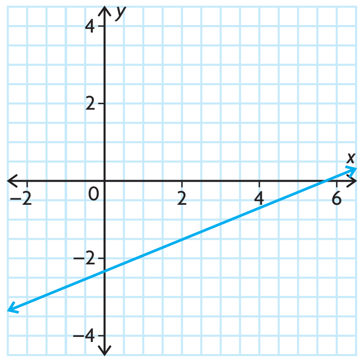
7. **a.** $\frac{1}{\sqrt{a} - 2}$
b. $\frac{1}{\sqrt{x + 4} - 2}$
c. $\frac{1}{\sqrt{x + h} + \sqrt{x}}$

Section 1.2, pp. 18–21

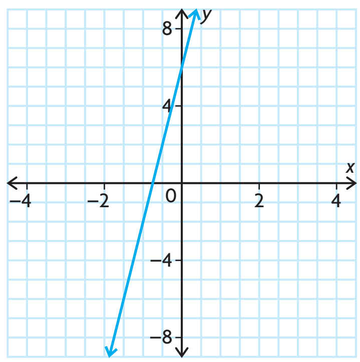
1. **a.** 3 **b.** $-\frac{5}{3}$ **c.** $-\frac{1}{3}$

2. **a.** $-\frac{1}{3}$ **b.** $-\frac{7}{13}$

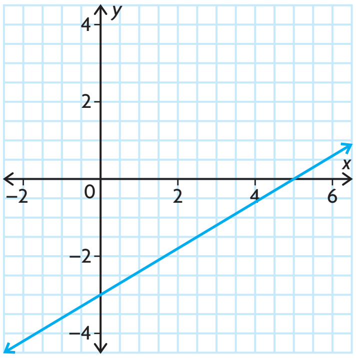
3. **a.** $7x - 17y - 40 = 0$



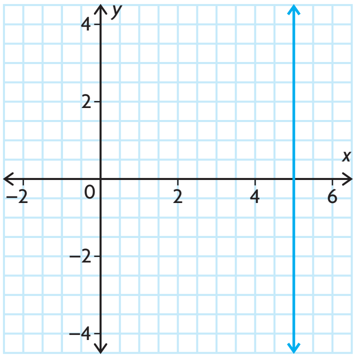
b. $y = 8x + 6$



c. $3x - 5y - 15 = 0$



d. $x = 5$



4. **a.** $75 + 15h + h^2$
b. $108 + 54h + 12h^2 + h^3$
c. $-\frac{1}{1 + h}$
d. $6 + 3h$
e. $\frac{-3}{4(4 + h)}$
f. $\frac{1}{4 + 2h}$

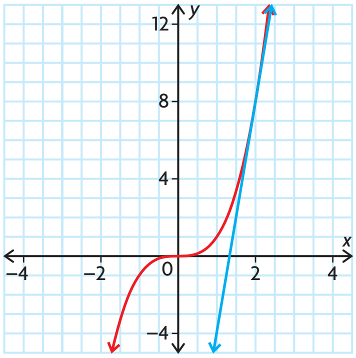
5. **a.** $\frac{1}{\sqrt{16 + h} + 4}$
b. $\frac{h + 5}{\sqrt{h^2 + 5h + 4} + 2}$
c. $\frac{1}{\sqrt{5 + h} + \sqrt{5}}$

6. **a.** $6 + 3h$
b. $3 + 3h + h^2$
c. $\frac{1}{\sqrt{9 + h} + 3}$

7. **a.**

P	*Q*	Slope of Line *PQ*
(2, 8)	(3, 27)	19
(2, 8)	(2.5, 16.625)	15.25
(2, 8)	(2.1, 9.261)	12.61
(2, 8)	(2.01, 8.120 601)	12.0601
(2, 8)	(1, 1)	7
(2, 8)	(1.5, 3.375)	9.25
(2, 8)	(1.9, 6.859)	11.41
(2, 8)	(1.99, 7.880 599)	11.9401

b. 12
c. $12 + 6h + h^2$
d. 12
e. They are the same.
f.



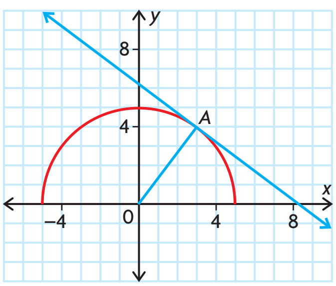
8. **a.** -12 **b.** 5 **c.** 12

9. **a.** $\frac{1}{2}$ **b.** $\frac{1}{4}$ **c.** $\frac{5}{6}$

10. **a.** -2 **b.** $-\frac{1}{2}$ **c.** $-\frac{1}{10}$

11. **a.** 1 **d.** $\frac{1}{6}$
b. -1 **e.** $-\frac{3}{4}$
c. 9 **f.** $-\frac{1}{6}$

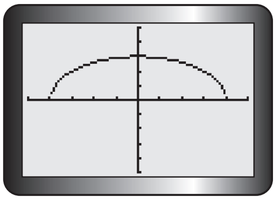
12.



$y = \sqrt{25 - x^2} \rightarrow$ Semi-circle centre (0, 0), rad 5, $y \geq 0$
OA is a radius. The slope of *OA* is $\frac{4}{3}$.
The slope of tangent is $-\frac{3}{4}$.

13. Take values of x close to the point, then determine $\frac{\Delta y}{\Delta x}$.

14.



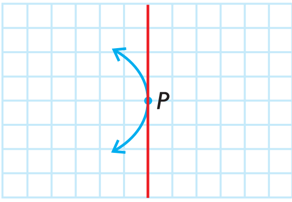
Since the tangent is horizontal, the slope is 0.

15. $3x - y - 8 = 0$

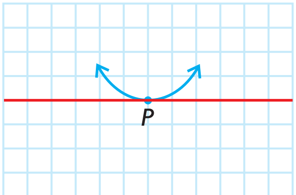
16. $3x + y - 8 = 0$

17. **a.** $(3, -2)$
b. $(5, 6)$
c. $y = 4x - 14$
d. $y = 2x - 8$
e. $y = 6x - 24$

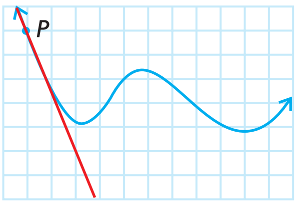
18. **a.** undefined



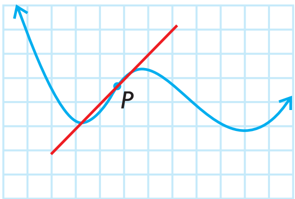
b. 0



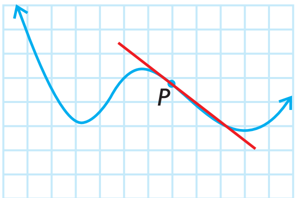
c. about -2.5



d. about 1



e. about $-\frac{7}{8}$



f. no tangent at point P

19. $-\frac{5}{4}$

20. 1600 papers

21. (2, 4)

22. $\left(-2, \frac{23}{3}\right), \left(-1, \frac{26}{3}\right), \left(1, -\frac{26}{3}\right), \left(2, -\frac{28}{3}\right)$

23. $y = x^2$ and $y = \frac{1}{2} - x^2$

$$x^2 = \frac{1}{2} - x^2$$

$$x^2 = \frac{1}{4}$$

$$x = \frac{1}{2} \text{ or } x = -\frac{1}{2}$$

The points of intersection are $P\left(\frac{1}{2}, \frac{1}{4}\right)$ and $Q\left(-\frac{1}{2}, \frac{1}{4}\right)$.

Tangent to $y = x$:

$$m = \lim_{h \to 0} \frac{(a+h)^2 - a^2}{h}$$
$$= \lim_{h \to 0} \frac{2ah + h^2}{h}$$
$$= 2a$$

The slope of the tangent at $a = \frac{1}{2}$ is $1 = m_p$ and at $a = -\frac{1}{2}$ is $-1 = m_q$.

Tangents to $y = \frac{1}{2} - x^2$:

$$m = \lim_{h \to 0} \frac{\left[\frac{1}{2} - (a+h)^2\right] - \left[\frac{1}{2} - a^2\right]}{h}$$
$$= \lim_{h \to 0} \frac{-2ah - h^2}{h}$$
$$= -2a$$

The slope of the tangents at $a = \frac{1}{2}$ is $-1 = M_P$ and at $a = -\frac{1}{2}$ is $1 = M_q$; $m_p M_P = -1$ and $m_q M_q = -1$.

Therefore, the tangents are perpendicular at the points of intersection.

24. $y = -11x + 24$

25. a. $8a + 5$
b. $(0, -2)$
c. $(-5, 73)$

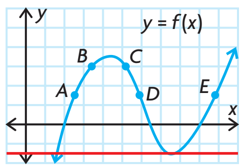
Section 1.3, pp. 29–31

1. 0 s or 4 s

2. a. Slope of the secant between the points $(2, s(2))$ and $(9, s(9))$
b. Slope of the tangent at the point $(6, s(6))$

3. Slope of the tangent to the function with equation $y = \sqrt{x}$ at the point (4, 2)

4. a. A and B
b. greater; the secant line through these two points is steeper than the tangent line at B.
c.



5. Speed is represented only by a number, not a direction.

6. Yes, velocity needs to be described by a number and a direction. Only the speed of the school bus was given, not the direction, so it is not correct to use the word "velocity."

7. a. first second = 5 m/s, third second = 25 m/s, eighth second = 75 m/s
b. 55 m/s
c. −20 m/s

8. a. i. 72 km/h
ii. 64.8 km/h
iii. 64.08 km/h
b. 64 km/h
c. 64 km/h

9. a. 15 terms
b. 16 terms/h

10. a. $-\frac{1}{3}$ mg/h
b. Amount of medicine in 1 mL of blood being dissipated throughout the system

11. $\frac{1}{50}$ s/m

12. $-\frac{12}{5}$ °C/km

13. 2 s; 0 m/s

14. a. $4800
b. $80 per ball
c. $x < 80$

15. a. 6
b. −1
c. $\frac{1}{10}$

16. $1 162 250 years since 1982

17. a. 75 m
b. 30 m/s
c. 60 m/s
d. 14 s

18. The coordinates of the point are $\left(a, \frac{1}{a}\right)$.

The slope of the tangent is $-\frac{1}{a^2}$.

The equation of the tangent is $y - \frac{1}{a} = -\frac{1}{a^2}(x - a)$, or $y = -\frac{1}{a^2}x + \frac{2}{a}$. The intercepts are $\left(0, \frac{2}{a}\right)$ and $(-2a, 0)$. The tangent line and the axes form a right triangle with legs of length $\frac{2}{a}$ and $2a$. The area of the triangle is $\frac{1}{2}\left(\frac{2}{a}\right)(2a) = 2$.

19. $C(x) = F + V(x)$
$C(x+h) = F + V(x+h)$

Rate of change of cost is

$$\lim_{x \to R} \frac{C(x+h) - C(x)}{h}$$
$$= \lim_{x \to h} \frac{V(x+h) - V(x)}{h}, h,$$

which is independent of F − (fixed costs)

20. 200π m²/m

21. Cube of dimensions x by x by x has volume $V = x^3$. Surface area is $6x^2$. $V'(x) = 3x^2 = \frac{1}{2}$ surface area.

22. a. 80π cm²/unit of time
b. -100π cm³/unit of time

Mid-Chapter Review, pp. 32–33

1. a. 3
b. 37
c. 61
d. 5

2. a. $\frac{6\sqrt{3} + \sqrt{6}}{3}$
b. $\frac{6 + 4\sqrt{3}}{3}$
c. $-\frac{5(\sqrt{7} + 4)}{9}$
d. $-2(3 + 2\sqrt{3})$

e. $\dfrac{10\sqrt{3} - 15}{2}$

f. $-\dfrac{3\sqrt{2}(2\sqrt{3} + 5)}{13}$

3. a. $\dfrac{2}{5\sqrt{2}}$

b. $\dfrac{3}{\sqrt{3}(6 + \sqrt{2})}$

c. $-\dfrac{9}{5(\sqrt{7} + 4)}$

d. $-\dfrac{13}{3\sqrt{2}(2\sqrt{3} + 5)}$

e. $-\dfrac{1}{(\sqrt{3} + \sqrt{7})}$

f. $\dfrac{1}{(2\sqrt{3} - \sqrt{7})}$

4. a. $\frac{2}{3}x + y - 6 = 0$

b. $x - y + 5 = 0$

c. $4x - y - 2 = 0$

d. $x - 5y - 9 = 0$

5. -2

6. a.

P	*Q*	Slope of Line *PQ*
(−1, 1)	(−2, 6)	−5
(−1, 1)	(−1.5, 3.25)	−4.5
(−1, 1)	(−1.1, 1.41)	−4.1
(−1, 1)	(−1.01, 1.0401)	−4.01
(−1, 1)	(−1.001, 1.004 001)	−4.001

P	*Q*	Slope of Line *PQ*
(−1, 1)	(0, −2)	−3
(−1, 1)	(−0.5, −0.75)	−3.5
(−1, 1)	(−0.9, 0.61)	−3.9
(−1, 1)	(−0.99, 0.960 1)	−3.99
(−1, 1)	(−0.999, 0.996 001)	−3.999

b. -4

c. $h - 4$

d. -4

e. The answers are equal.

7. a. -3 c. $-\frac{1}{4}$

b. -9 d. $\frac{1}{6}$

8. a. i. 36 km/h
ii. 30.6 km/h
iii. 30.06 km/h

b. velocity of car appears to approach 30 km/h

c. $(6h + 30)$ km/h

d. 30 km/h

9. a. -4

b. -12

10. a. -2000 L/min

b. -1000 L/min

11. a. $-9x + y + 19 = 0$

b. $8x + y + 15 = 0$

c. $4x + y + 8 = 0$

d. $-2x + y + 2 = 0$

12. a. $-3x + 4y - 25 = 0$

b. $3x + 4y + 5 = 0$

Section 1.4, pp. 37–39

1. a. $\frac{27}{99}$ b. π

2. Evaluate the function for values of the independent variable that get progressively closer to the given value of the independent variable.

3. a. A right-sided limit is the value that a function gets close to as the values of the independent variable decrease and get close to a given value.

b. A left-sided limit is the value that a function gets close to as the values of the independent variable increase and get close to a given value.

c. A (two-sided) limit is the value that a function gets close to as the values of the independent variable get close to a given value, regardless of whether the values increase or decrease toward the given value.

4. a. -5 d. -8

b. 10 e. 4

c. 100 f. 8

5. 1

6. a. 0 c. -1

b. 2 d. 2

7. a. 2

b. 1

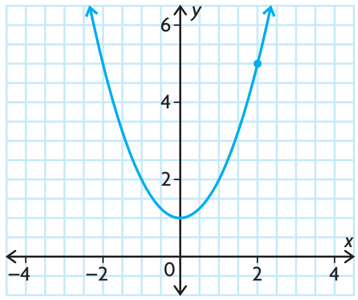
c. does not exist

8. a. 8

b. 2

c. 2

9. 5



10. a. 0 d. $-\frac{1}{2}$

b. 0 e. $\frac{1}{5}$

c. 5

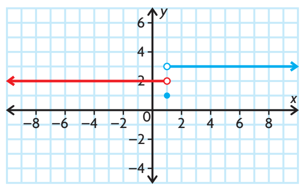
f. does not exist; substitution causes division by zero, and there is no way to remove the factor from the denominator.

11. a. does not exist c. 2

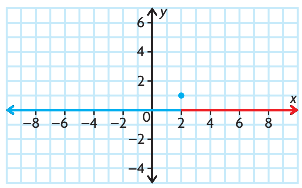
b. 2 d. does not exist

12. Answers may vary. For example:

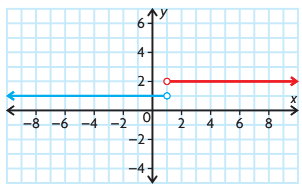
a.



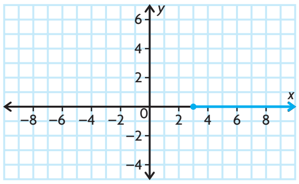
b.



c.



d.



13. $m = -3; b = 1$

14. $a = 3, b = 2, c = 0$

15. **a.**

b. 6; 4
c. 2000
d. about 8.49 years

Section 1.5, pp. 45–47

1. $\lim_{x\to 2}(3 + x)$ and $\lim_{x\to 2}(x + 3)$ have the same value, but $\lim_{x\to 2} 3 + x$ does not. Since there are no brackets around the expression, the limit only applies to 3, and there is no value for the last term, x.

2. Factor the numerator and denominator. Cancel any common factors. Substitute the given value of x.

3. If the two one-sided limits have the same value, then the value of the limit is equal to the value of the one-sided limits. If the one-sided limits do not have the same value, then the limit does not exist.

4. **a.** 1 **d.** $5\pi^3$
b. 1 **e.** 2
c. $\frac{100}{9}$ **f.** $\sqrt{3}$

5. **a.** -2
b. $\sqrt{2}$

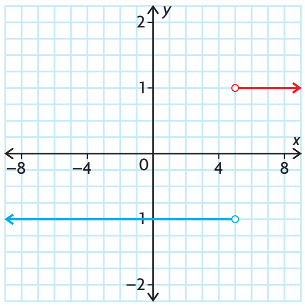
6. Since substituting $t = 1$ does not make the denominator 0, direct substitution works. $\frac{1 - 1 - 5}{6 - 1} = \frac{-5}{5}$
$= -1$

7. **a.** 4 **d.** $-\frac{1}{4}$
b. 5 **e.** $\frac{1}{4}$
c. 27 **f.** $-\frac{1}{\sqrt{7}}$

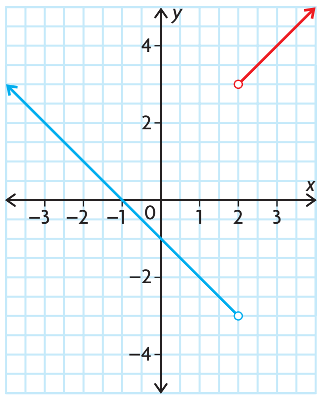
8. **a.** $\frac{1}{12}$ **d.** $\frac{1}{2}$
b. -27 **e.** $\frac{1}{12}$
c. $\frac{1}{6}$ **f.** $\frac{1}{12}$

9. **a.** 0 **d.** $\frac{1}{2}$
b. 0 **e.** $2x$
c. -1 **f.** $\frac{1}{32}$

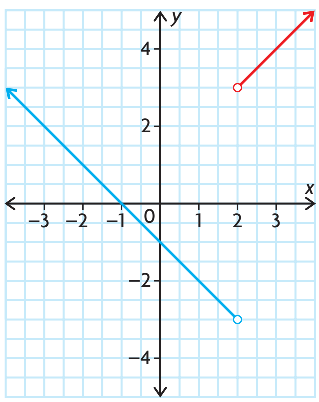
10. **a.** does not exist



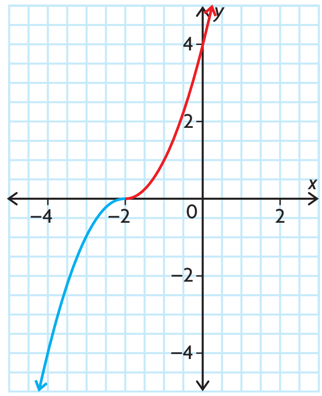
b. does not exist



c. exists



d. exists



11. **a.**

ΔT	T	V	ΔV
	−40	19.1482	
20			1.6426
	−20	20.7908	
20			1.6426
	0	22.4334	
20			1.6426
	20	24.0760	
20			1.6426
	40	25.7186	
20			1.6426
	60	27.3612	
20			1.6426
	80	29.0038	

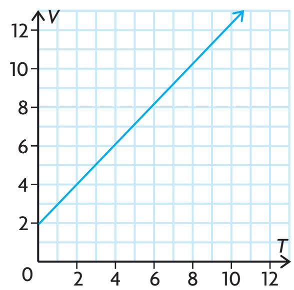
ΔV is constant; therefore, T and V form a linear relationship.

b. $V = 0.082\,13T + 22.4334$

c. $T = \frac{V - 22.4334}{0.082\,13}$

d. $\lim_{v\to 0} T = \frac{0 - 22.4334}{0.082\,13}$
$= -273.145$

e.



12. $\lim_{x\to 5} \frac{x^2 - 4}{f(x)}$
$= \frac{\lim_{x\to 5}(x^2 - 4)}{\lim_{x\to 5} f(x)}$
$= \frac{21}{3}$
$= 7$

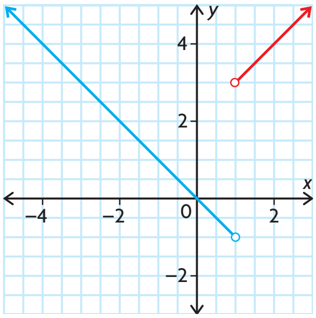
13. **a.** 27 **b.** -1 **c.** 1

14. **a.** 0 **b.** 0

15. **a.** 0 **b.** $\frac{1}{2}$

16. -2

17. does not exist

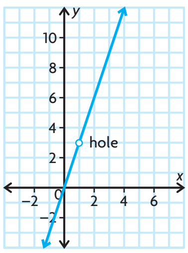


Section 1.6, pp. 51–53

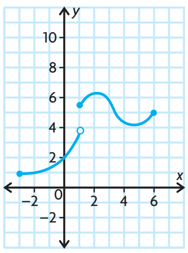
1. Anywhere that you can see breaks or jumps is a place where the function is not continuous.

2. On a given domain, you can trace the graph of the function without lifting your pencil.

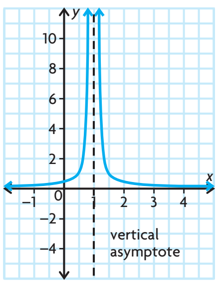
3. point discontinuity



jump discontinuity



infinite discontinuity

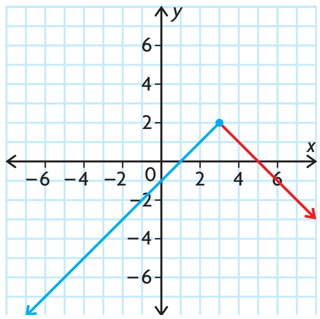


4. **a.** $x = 3$
b. $x = 0$
c. $x = 0$
d. $x = 3$ and $x = -3$
e. $x = -3$ and $x = 2$
f. $x = 3$

5. **a.** continuous for all real numbers
b. continuous for all real numbers
c. continuous for all real numbers, except 0 and 5
d. continuous for all real numbers greater than or equal to -2
e. continuous for all real numbers
f. continuous for all real numbers

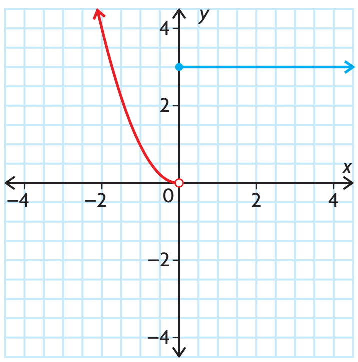
6. $g(x)$ is a linear function (a polynomial), and so is continuous everywhere, including $x = 2$.

7.



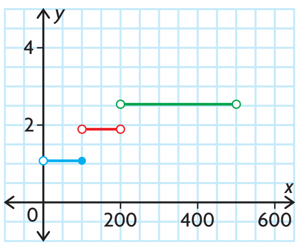
Yes, the function is continuous everywhere.

8.



The function is discontinuous at $x = 0$.

9.



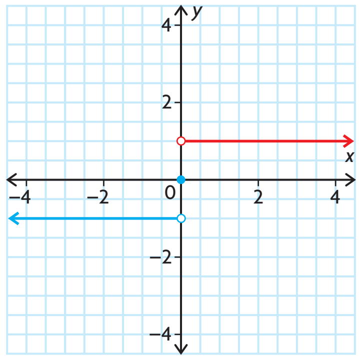
Discontinuities at 0, 100, 200, and 500

10. no

11. Discontinuous at $x = 2$

12. $k = 16$

13. **a.**



b. **i.** -1
ii. 1
iii. does not exist

c. f is not continuous since $\lim_{x\to 0} f(x)$ does not exist.

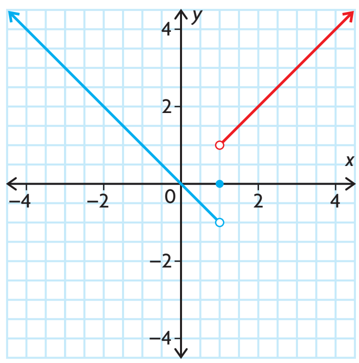
14. **a.** 2
b. 4
c. $\lim_{x\to 3^-} f(x) = 4 = \lim_{x\to 3^+} f(x)$
Thus, $\lim_{x\to 3} f(x) = 4$. But, $f(3) = 2$.
Hence, f is not continuous at $x = 2$ and also not continuous on $-3 < x < 8$.

15. (1) $A = B - 3$
(2) $4B - A \neq 6$ (if $B > 1$, then $A > -2$; if $B < 1$, then $A < -2$)

16. $a = -1, b = 6$

17. **a.** $\left.\begin{aligned}\lim_{x\to 1^-} g(x) &= -1\\ \lim_{x\to 1^+} g(x) &= 1\end{aligned}\right\}\lim_{x\to 1} g(x)$
$\lim_{x\to 1} g(x)$ does not exist.

b.



$g(x)$ is discontinuous at $x = 1$.

Review Exercise, pp. 56–59

1. **a.** -3 **b.** 7
c. $2x - y - 5 = 0$

2. **a.** $\frac{-1}{3}$ **c.** $-\frac{1}{27}$
b. $\frac{1}{2}$ **d.** $-\frac{5}{4}$

3. **a.** 2 **b.** 2

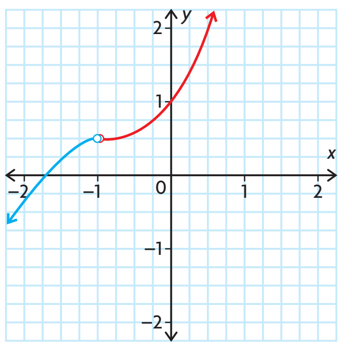
4. **a.** 1st second $= -5$ m/s, 2nd second $= -15$ m/s
b. -40 m/s
c. -60 m/s

5. **a.** 0.0601 g
b. 6.01 g/min
c. 6 g/min

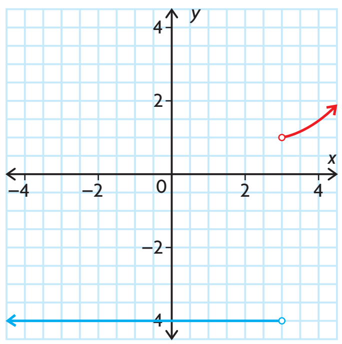
6. **a.** 700 000 t
b. 18×10^4 t per year
c. 15×10^4 t per year
d. 7.5 years

7. **a.** 10
b. 7; 0
c. $t = 3$ and $t = 4$

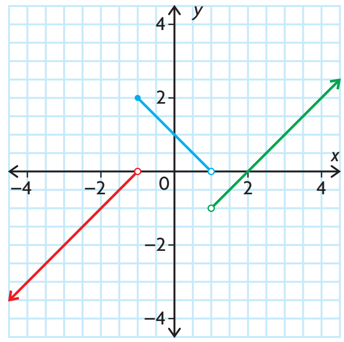
8. **a.** Answers may vary. For example:



b. Answers may vary. For example:



9. **a.**



b. $x = -1$ and $x = 1$
c. They do not exist.

10. not continuous at $x = -4$

11. **a.** $x = 1$ and $x = -2$
b. $\lim_{x\to 1} f(x) = \frac{2}{3}$,
$\lim_{x\to -2} f(x)$ does not exist.

12. **a.** $\lim_{x\to 0} f(x)$ does not exist.
b. $\lim_{x\to 0} g(x) = 0$
c. $\lim_{x\to -3} h(x)$ does not exist.

16. **a.** 10 **b.** $\frac{1}{4}$ **c.** $-\frac{1}{16}$

17. **a.** 4 **c.** $\frac{1}{\sqrt{5}}$ **e.** $-\frac{1}{8}$
b. $10a$ **d.** $\frac{1}{3}$ **f.** $-\frac{1}{4}$

18. **a.** The function is not defined for $x < 3$, so there is no left-side limit.
b. Even after dividing out common factors from numerator and denominator, there is a factor of $x - 2$ in the denominator; the graph has a vertical asymptote at $x = 2$.
c. $\lim_{x\to 1^-} f(x) = -5 \neq \lim_{x\to 1^+} f(x) = 2$
d. The function has a vertical asymptote at $x = 2$.
e. $x \to 0^-$ $|x| = -x$

$$\lim_{x\to 0^-} \frac{|x|}{x} = -1$$

$$\lim_{x\to 0^+} \frac{|x|}{x} = 1$$

$$\lim_{x\to 0^+} \frac{|x|}{x} \neq \lim_{x\to 0^-} \frac{|x|}{x}$$

13. **a.**

x	1.9	1.99	1.999	2.001	2.01	2.1
$\frac{x-2}{x^2-x-2}$	0.344 83	0.334 45	0.333 44	0.333 22	0.332 23	0.322 58

$\frac{1}{3}$

b.

x	0.9	0.99	0.999	1.001	1.01	1.1
$\frac{x-1}{x^2-1}$	0.526 32	0.502 51	0.500 25	0.499 75	0.497 51	0.476 19

$\frac{1}{2}$

14.

x	-0.1	-0.01	-0.001	0.001	0.01	0.1
$\frac{\sqrt{x+3}-\sqrt{3}}{x}$	0.291 12	0.288 92	0.2887	0.288 65	0.288 43	0.286 31

$\frac{1}{2\sqrt{3}}$; This agrees well with the values in the table.

15. **a.**

x	2.1	2.01	2.001	2.0001
$f(x)$	0.248 46	0.249 84	0.249 98	0.25

$\lim_{x\to 2} f(x) \doteq 0.25$
b. $\lim_{x\to 2} f(x) = 0.25$
c. 0.25

f. $\lim_{x\to -1^+} f(x) = -1$
$\lim_{x\to -1^-} f(x) = 5$
$\lim_{x\to -1^+} f(x) \neq \lim_{x\to -1^-} f(x)$
Therefore, $\lim_{x\to -1} f(x)$ does not exist.

19. **a.** $y = 7$
b. $y = -5x - 5$
c. $y = 18x + 9$
d. $y = -216x + 486$

20. **a.** 700 000
b. 109 000/h

Chapter 1 Test, p. 60

1. $\lim_{x \to 1^+} \frac{1}{x-1} = +\infty \neq \lim_{x \to 1^-} \frac{1}{x-1} = -\infty$

2. -13

3. **a.** $\lim_{x \to 1} f(x)$ does not exist.
b. 1
c. 1
d. $x = 1$ and $x = 2$

4. **a.** 1 km/h
b. 2 km/h

5. $\frac{\sqrt{16 + h} - \sqrt{16}}{h}$

6. -31

7. **a.** 12
b. $\frac{7}{5}$
c. 4
d. $-\frac{3}{4}$
e. $\frac{1}{6}$
f. $\frac{1}{12}$

8. **a.** $a = 1, b = -\frac{18}{5}$

Chapter 2

Review of Prerequisite Skills, pp. 62–63

1. **a.** a^8
b. $-8a^6$
c. $2p$
d. $\frac{1}{a^2b^7}$
e. $48e^{18}$
f. $-\frac{b}{2a^6}$

2. **a.** $x^{\frac{7}{6}}$ **b.** $4x^4$ **c.** $a^{\frac{1}{3}}$

3. **a.** $-\frac{3}{2}$
b. 2
c. $-\frac{3}{5}$
d. 1

4. **a.** $x - 6y - 21 = 0$
b. $3x - 2y - 4 = 0$
c. $4x + 3y - 7 = 0$

5. **a.** $2x^2 - 5xy - 3y^2$
b. $x^3 - 5x^2 + 10x - 8$
c. $12x^2 + 36x - 21$
d. $-13x + 42y$
e. $29x^2 - 2xy + 10y^2$
f. $-13x^3 - 12x^2y + 4xy^2$

6. **a.** $\frac{15}{2}x; x \neq 0, -2$
b. $\frac{y - 5}{4y^2(y + 2)}; y \neq -2, 0, 5$
c. $\frac{8}{9}; h \neq -k$
d. $\frac{2}{(x + y)^2}; x \neq -y, +y$
e. $\frac{11x^2 - 8x + 7}{2x(x - 1)}; x \neq 0, 1$
f. $\frac{4x + 7}{(x + 3)(x - 2)}; x \neq -3, 2$

7. **a.** $(2k + 3)(2k - 3)$
b. $(x - 4)(x + 8)$
c. $(a + 1)(3a - 7)$
d. $(x^2 + 1)(x + 1)(x - 1)$
e. $(x - y)(x^2 + xy + y^2)$
f. $(r + 1)(r - 1)(r + 2)(r - 2)$

8. **a.** $(a - b)(a^2 + ab + b^2)$
b. $(a - b)(a^4 + a^3b + a^2b^2 + ab^3 + b^4)$
c. $(a - b)(a^6 + a^5b + a^4b^2 + a^3b^3 + a^2b^4 + ab^5 + b^6)$
d. $a^n - b^n = (a - b)(a^{n-1} + a^{n-2}b + a^{n-3}b^2 + a^3b^{n-3} + ab^{n-2} + b^{n-1})$

9. **a.** -17
b. 10
c. $\frac{53}{8}$
d. about 7.68

10. **a.** $\frac{3\sqrt{2}}{2}$
b. $\frac{4\sqrt{3} - \sqrt{6}}{3}$
c. $-\frac{30 + 17\sqrt{2}}{23}$
d. $-\frac{11 - 4\sqrt{6}}{5}$

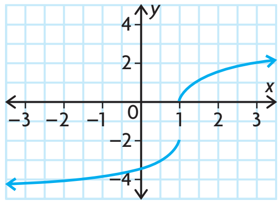
11. **a.** $3h + 10$; expression can be used to determine the slope of the secant line between $(2, 8)$ and $(2 + h, f(2 + h))$
b. For $h = 0.01$: 10.03
c. value represents the slope of the secant line through $(2, 8)$ and $(2.01, 8.1003)$

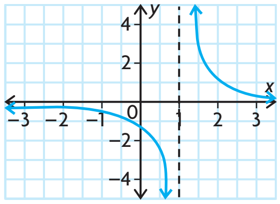
Section 2.1, pp. 73–75

1. **a.** $\{x \in \mathbf{R} \mid x \neq -2\}$
b. $\{x \in \mathbf{R} \mid x \neq 2\}$
c. $\{x \in \mathbf{R}\}$
d. $\{x \in \mathbf{R} \mid x \neq 1\}$
e. $\{x \in \mathbf{R}\}$
f. $\{x \in \mathbf{R} \mid x > 2\}$

2. The derivative of a function represents the slope of the tangent line at a give value of the independent variable or the instantaneous rate of change of the function at a given value of the independent variable.

3. Answers may vary. For example:





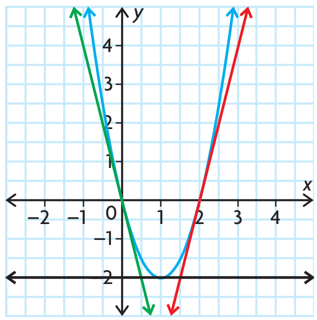
4. **a.** $5a + 5h - 2; 5h$
b. $a^2 + 2ah + h^2 + 3a + 3h - 1; 2ah + h^2 + 3h$
c. $a^3 + 3a^{2h} + 3ah^2 + h^3 - 4a - 4h + 1; 3a^2h + 3ah^2 + h^3 - 4h$
d. $a^2 + 2ah + h^2 + a + h - 6; 2ah + h^2 + h$
e. $-7a - 7h + 4; -7h$
f. $4 - 2a - 2h - a^2 - 2ah - h^2; -2h - h^2 - 2ah$

5. **a.** 2
b. 9
c. $\frac{1}{2}$
d. -5

6. **a.** -5
b. $4x + 4$
c. $18x^2 - 7$
d. $\frac{3}{2\sqrt{3x + 2}}$

7. **a.** -7
b. $-\frac{2}{(x - 1)^2}$
c. $6x$

8. $f'(0) = -4; f'(1) = 0; f'(2) = 4$



9. **a.**