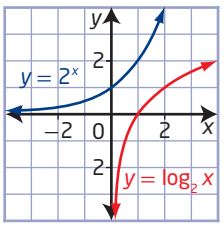
Chapter 8 Logarithmic Functions

8.1 Understanding Logarithms, pages 380 to 382

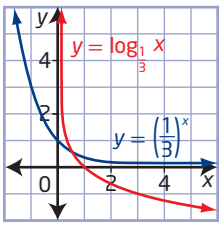
1. a) i)



ii) $y = \log_2 x$

iii) domain $\{x \mid x > 0, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$, x-intercept 1, no y-intercept, vertical asymptote $x = 0$

b) i)



ii) $y = \log_{\frac{1}{3}} x$

iii) domain $\{x \mid x > 0, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$, x-intercept 1, no y-intercept, vertical asymptote $x = 0$

2. a) $\log_{12} 144 = 2$ **b)** $\log_8 2 = \frac{1}{3}$

c) $\log_{10} 0.000\,01 = -5$ **d)** $\log_7 (y + 3) = 2x$

3. a) $5^2 = 25$ **b)** $8^{\frac{2}{3}} = 4$

c) $10^6 = 1\,000\,000$ **d)** $11^y = x + 3$

4. a) 3 **b)** 0 **c)** $\frac{1}{3}$ **d)** -3

5. $a = 4$; $b = 5$

6. a) $x > 1$ **b)** $0 < x < 1$ **c)** $x = 1$

d) Example: $x = 9$

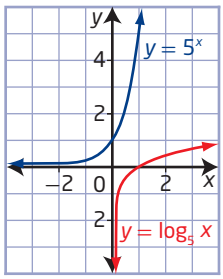
7. a) 0 raised to any non-zero power is 0.

b) 1 raised to any power is 1.

c) Exponential functions with a negative base are not continuous.

8. a) $y = \log_5 x$

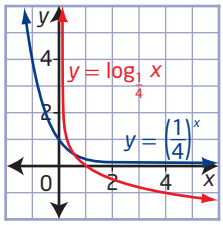
b)



domain $\{x \mid x > 0, x \in \mathrm{R}\}$,
range $\{y \mid y \in \mathrm{R}\}$,
x-intercept 1,
no y-intercept,
vertical asymptote $x = 0$

9. a) $g^{-1}(x) = \left(\frac{1}{4}\right)^x$

b)



domain $\{x \mid x \in \mathrm{R}\}$,
range $\{y \mid y > 0, y \in \mathrm{R}\}$,
no x-intercept,
y-intercept 1,
horizontal asymptote $y = 0$

10. They are reflections of each other in the line $y = x$.

11. a) They have the exact same shape.

b) One of them is increasing and the other is decreasing.

12. a) 216 **b)** 81 **c)** 64 **d)** 8

13. a) 7 **b)** 6

14. a) 0 **b)** 1

15. -1

16. 16

17. a) $t = \log_{1.1} N$ **b)** 145 days

18. The larger asteroid had a relative risk that was 1479 times as dangerous.

19. 1000 times as great

20. 5

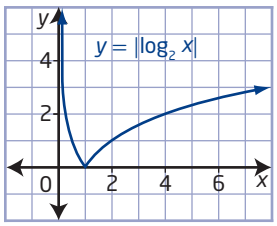
21. $m = 14$, $n = 13$

22. $4n$

23. $y = 3^{2^x}$

24. $n = 8$; $m = 3$

C1



The function has the same general shape, but instead of decreasing, after $x = 1$ the function increases without limit.

C2 Answers will vary.

C3 **Step 1: a)** $e = 2.718\,281\,828$ **b)** 10^{10}

Step 2: a) domain $\{x \mid x > 0, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$, x-intercept 1, no y-intercept, vertical asymptote $x = 0$

b) $y = \ln x$

Step 3: a) $r = 2.41$

b) i) $\theta = \frac{\ln r}{0.14}$ **ii)** $\theta = 17.75$

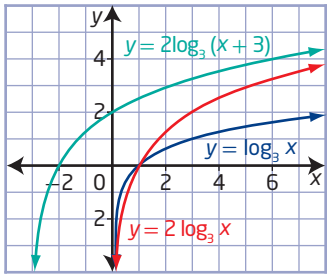
8.2 Transformations of Logarithmic Functions, pages 389 to 391

1. a) Translate 1 unit right and 6 units up.

b) Reflect in the x-axis, stretch vertically about the x-axis by a factor of 4, and stretch horizontally about the y-axis by a factor of $\frac{1}{3}$.

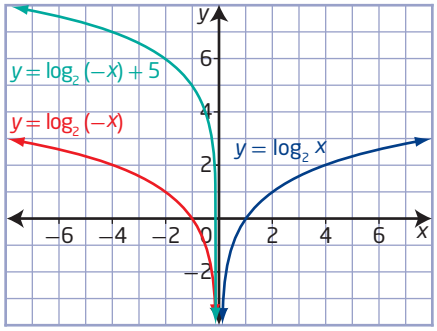
c) Reflect in the y-axis, stretch vertically about the x-axis by a factor of $\frac{1}{2}$, and translate 7 units up.

2. a)



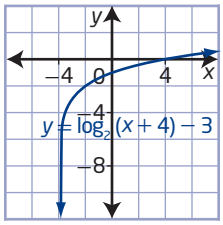
b) $y = 2 \log_3 (x + 3)$

3. a)

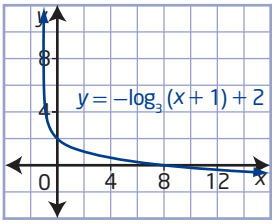


b) $y = \log_2 (-x) + 5$

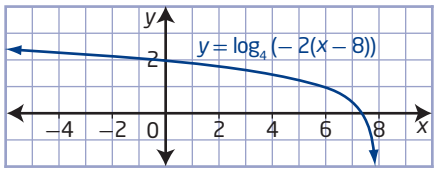
4. a)



b)



c)



5. a) **i)** vertical asymptote $x = -3$

ii) domain $\{x \mid x > -3, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

iii) y-intercept -5 **iv)** x-intercept -2

b) **i)** vertical asymptote $x = -9$

ii) domain $\{x \mid x > -9, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

iii) y-intercept 2 **iv)** x-intercept -8.75

c) **i)** vertical asymptote $x = -3$

ii) domain $\{x \mid x > -3, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

iii) y-intercept -1.3 **iv)** x-intercept 22

d) **i)** vertical asymptote $x = -1$

ii) domain $\{x \mid x > -1, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

iii) y-intercept -6 **iv)** x-intercept $-\frac{3}{4}$

6. a) $y = 5 \log x$ **b)** $y = \log_8 2x$

c) $y = \frac{1}{3} \log_2 x$ **d)** $y = \log_4 \left(\frac{x}{2}\right)$

7. a) stretch horizontally about the y-axis by a factor of $\frac{1}{4}$; translate 5 units left and 6 units up

b) stretch horizontally about the y-axis by a factor of 3; stretch vertically about the x-axis by a factor of 2; reflect in the y-axis; translate 1 unit right and 4 units down

8. a) $a = -1, b = 1, h = -6, k = 3$; $y = -\log_3 (x + 6) + 3$

b) $a = 5, b = 3, h = 0, k = 0$; $y = 5 \log_3 3x$

c) $a = 0.75, b = -0.25, h = 2, k = -5$; $y = \frac{3}{4} \log_3 \left(-\frac{1}{4}(x - 2)\right) - 5$

9. a) Reflect in the y-axis, stretch vertically about the x-axis by a factor of 5, stretch horizontally about the y-axis by a factor of $\frac{1}{4}$, and translate 3 units right and 2 units down.

b) Reflect in the x-axis, reflect in the y-axis, stretch vertically about the x-axis by a factor of $\frac{1}{4}$, translate 6 units right and 1 unit up.

10. a) $y = \log_3 x - 6$ **b)** $y = \log_2 \left(\frac{x}{4}\right)$

11. Stretch vertically about the x-axis by a factor of 3 and translate 4 units right and 2 units down.

12. a) Stretch vertically about the x-axis by a factor of 0.67, stretch horizontally about the y-axis by a factor of $\frac{25}{9}$ or approximately 2.78, and translate 1.46 units up.

b) 515 649 043 kWh

13. a) 0.8 µL **b)** 78 mmHg

14. a) 172 cm **b)** 40 kg

15. $a = \frac{1}{3}$

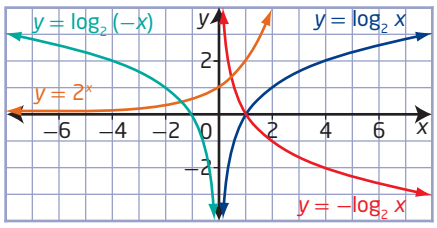
16. a) $y = -2 \log_5 x + 13$ **b)** $y = \log 2x$

17. $a = \frac{1}{2}, k = -8$

C1 $a = \frac{1}{4}, b = \frac{1}{3}, h = 4, k = -1$; $g(x) = 0.25 \log_5 \left(\frac{1}{3}\right)(x - 4) - 1$

C2 a) $y = -\log_2 x$, $y = \log_2 (-x)$, $y = 2^x$

b) Reflect in the x-axis, reflect in the y-axis, and reflect in the line $y = x$.



C3 a) $y = \frac{1}{2} \log_7 \frac{(x - 5)}{3} + \frac{1}{2}$ **b)** $y = 3^{\frac{x-8}{2}} + 1$

C4 Answers will vary.

8.3 Laws of Logarithms, pages 400 to 403

1. a) $\log_7 x + 3 \log_7 y + \frac{1}{2} \log_7 z$

b) $8(\log_5 x + \log_5 y + \log_5 z)$

c) $2 \log x - \log y - \frac{1}{3} \log z$

d) $y = \log_3 x + \left(\frac{1}{2}\right)(\log_3 y - \log_3 z)$

2. a) 2 **b)** 3 **c)** 3.5 **d)** 3

3. a) $\log_9 \left(\frac{xz^4}{y}\right)$ **b)** $y = \log_3 \frac{\sqrt{x}}{y^2}$

c) $\log_6 \left(\frac{x}{\sqrt[3]{xy^2}}\right)$ **d)** $\log \sqrt[3]{xy}$

4. a) 1.728 **b)** 1.44 **c)** 1.2

5. a) 27 **b)** 49

6. a) Stretch horizontally about the y-axis by a factor of $\frac{1}{8}$.

b) Translate 3 units up.

7. a) False; the division must take place inside the logarithm.

b) False; it must be a multiplication inside the logarithm.

c) True

d) False; the power must be inside the logarithm.

e) True

8. a) $P - Q$ **b)** $P + Q$ **c)** $P + \frac{Q}{2}$ **d)** $2Q - 2P$

9. a) $6K$ **b)** $1 + K$ **c)** $2K + 2$ **d)** $\frac{K}{5} - 3$

10. a) $\frac{1}{2} \log_5 x, x > 0$ **b)** $\frac{2}{3} \log_{11} x, x > 0$

11. a) $\log_2 \left(\frac{x + 5}{3}\right), x < -5$ or $x > 5$

b) $\log_7 \left(\frac{x + 4}{x + 2}\right), x < -4$ or $x > 4$

c) $\log_8 \left(\frac{x + 3}{x - 2}\right), x > 2$

12. a) Left Side $= \log_c 48 - (\log_c 3 + \log_c 2)$
$= \log_c 48 - \log_c 6$
$= \log_c 8$
$=$ Right Side

b) Left Side $= 7 \log_c 4$
$= 7 \log_c 2^2$
$= 2(7) \log_c 2$
$= 14 \log_c 2$
$=$ Right Side

c) Left Side $= \frac{1}{2}(\log_c 2 + \log_c 6)$
$= \frac{1}{2}(\log_c 2 + \log_c 3 + \log_c 2)$
$= \frac{1}{2}(2 \log_c 2) + \frac{1}{2} \log_c 3$
$= \log_c 2 + \log_c \sqrt{3}$
$=$ Right Side

d) Left Side $= \log_c (5c)^2$
$= 2 \log_c 5c$
$= 2 (\log_c 5 + \log_c c)$
$= 2 (\log_c 5 + 1)$
$=$ Right Side

13. a) 70 dB **b)** approximately 1995 times as loud

c) approximately 98 dB

14. Decibels must be changed to intensity to gauge loudness. The function that maps the change is not linear.

15. 3.2 V

16. a) 10^{-7} mol/L **b)** 12.6 times as acidic **c)** 3.4

17. 0.18 km/s

18. a) The graphs are the same for $x > 0$. However, the graph of $y = \log x^2$ has a second branch for $x < 0$, which is the reflection in the y-axis of the branch for $x > 0$.

b) The domains are different. The function $y = \log x^2$ is defined for all values of x except 0, while the function $y = 2 \log x$ is defined only for $x > 0$.

c) $x > 0$

19. a) $y = \log_c x$
$c^y = x$
$\log_d c^y = \log_d x$
$y \log_d c = \log_d x$
$y = \dfrac{\log_d x}{\log_d c}$

b) 3.2479

c) $\varphi = -\dfrac{\log D}{\log 2}$

d) 207.9 times larger

20. a) Left Side
$= \log_{q^3} p^3$
$= \dfrac{\log_q p^3}{\log_q q^3}$
$= \dfrac{3 \log_q p}{3 \log_q q}$
$= \dfrac{\log_q p}{1}$
$=$ Right Side

b) Left Side
$= \dfrac{1}{\log_p 2} - \dfrac{1}{\log_q 2}$
$= \dfrac{1}{\frac{\log_2 2}{\log_2 p}} - \dfrac{1}{\frac{\log_2 2}{\log_2 q}}$
$= \dfrac{\log_2 p}{\log_2 2} - \dfrac{\log_2 q}{\log_2 2}$
$= \dfrac{\log_2 p - \log_2 q}{\log_2 2}$
$= \log_2 \dfrac{p}{q}$
$=$ Right Side

c)

Left Side	Right Side
$= \dfrac{1}{\log_q p} + \dfrac{1}{\log_q p}$	$= \dfrac{1}{\log_{q^2} p}$
$= \dfrac{1}{\frac{\log p}{\log q}} + \dfrac{1}{\frac{\log q}{\log p}}$	$= \dfrac{1}{\log p / \log q^2}$
$= \dfrac{\log q}{\log p} + \dfrac{\log q}{\log p}$	$= \dfrac{\log q^2}{\log p}$
$= \dfrac{2 \log q}{\log p}$	$= \dfrac{2 \log q}{\log p}$

Left Side = Right Side

d) Left Side $= \log_{\frac{1}{q}} p$
$= \dfrac{\log_q p}{\log_q q^{-1}}$
$= -\log_q p$
$= \log_q \dfrac{1}{p}$
$=$ Right Side

C1 a) Stretch vertically about the x-axis by a factor of 3.

b) Stretch vertically about the x-axis by a factor of 5 and translate 2 units left.

c) Reflect in the x-axis.

d) Reflect in the x-axis, stretch vertically about the x-axis by a factor of $\frac{1}{2}$, and translate 6 units right.

C2 -1

C3 a) log 2 **b)** 15 log 2

C4 Answers will vary.

8.4 Logarithmic and Exponential Equations, pages 412 to 415

1. a) 1000 **b)** 14 **c)** 3 **d)** 108

2. a) 1.61 **b)** 10.38 **c)** 4.13 **d)** 0.94

3. No, since $\log_3 (x - 8)$ and $\log_3 (x - 6)$ are not defined when $x = 5$.

4. a) $x = 0$ is extraneous.

b) Both roots are extraneous.

c) $x = -6$ is extraneous.

d) $x = 1$ is extraneous.

5. a) $x = 8$ **b)** $x = 25$ **c)** $x = 96$ **d)** $x = 9$

6. a) Rubina subtracted the contents of the log when she should have divided them. The solution should be
$\log_6 \left(\dfrac{2x + 1}{x - 1}\right) = \log_6 5$
$2x + 1 = 5(x - 1)$
$1 + 5 = 5x - 2x$
$6 = 3x$
$x = 2$

b) Ahmed incorrectly concluded that there was no solution. The solution is $x = 0$.

c) Jennifer incorrectly eliminated the log in the third line. The solution, from the third line on, should be
$x(x + 2) = 2^3$
$x^2 + 2x - 8 = 0$
$(x - 2)(x + 4) = 0$
So, $x = 2$ or $x = -4$.
Since $x > 0$, the solution is $x = 2$.

7. a) 0.65 **b)** -0.43 **c)** 81.37 **d)** 4.85

8. a) no solution ($x = -3$ not possible)

b) $x = 10$ **c)** $x = 4$ **d)** $x = 2$ **e)** $x = -8, 4$

9. a) about 2.64 pc **b)** about 8.61 light years

10. 64 kg

11. a) 10 000 **b)** 3.5%

c) approximately 20.1 years

12. a) 248 Earth years **b)** 228 million kilometres

13. a) 2 years **b)** 44 days **c)** 20.5 years

14. 30 years

15. approximately 9550 years

16. 8 days

17. 34.0 m

18. $x = 4.5$, $y = 0.5$

19. a) The first line is not true.

b) To go from line 4 to line 5, you are dividing by a negative quantity, so the inequality sign must change direction.

20. a) $x = 100$ **b)** $x = \dfrac{1}{100}, 100$ **c)** $x = 1, 100$

21. a) $x = 16$ **b)** $x = 9$

22. $x = -5, 2, 4$

C1 a) $\log 8 + \log 2^x = \log 512$
$x \log 2 = \log 512 - \log 8$
$x \log 2 = \log 64$
$x = 6$

b) She could have divided by 8 as the first step.

c) Answers will vary.

C2 12

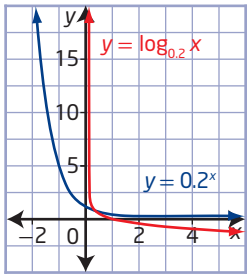
C3 14

C4 a) $x = \dfrac{\pi}{4}, \dfrac{7\pi}{4}$ **b)** $x = \dfrac{\pi}{2}$

C5 Answers will vary.

Chapter 8 Review, pages 416 to 418

1. a)



b) i) domain $\{x \mid x > 0, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

ii) x-intercept 1

iii) no y-intercept

iv) vertical asymptote $x = 0$

c) $y = \log_{0.2} x$

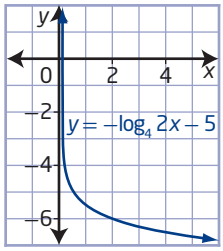
2. $c = 4$

3. $2^4 = 16$ and $2^5 = 32$, so the answer must be between 4 and 5.

4. **a)** 25 **b)** −2 **c)** 3.5 **d)** 16 **e)** 0.01

5. 40 times as great

6. **a)**



b) $a = -1$, $b = 2$, $c = 4$, $h = 0$, $k = -5$

7. $y = \log_2 4x$

8. **a)** Reflect in the x-axis, stretch horizontally about the y-axis by a factor of $\frac{1}{3}$, and translate 12 units right and 2 units up.

b) Reflect in the y-axis, stretch vertically about the x-axis by a factor of $\frac{1}{4}$, and translate 6 units right and 7 units down.

9. **a)** $x = -8$

b) domain $\{x \mid x > -8, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

c) y-intercept 15 **d)** x-intercept −7.75

10. **a)** Transform by stretching the graph horizontally about the y-axis by a factor of 440 and stretching vertically about the x-axis by a factor of 12.

b) 5 notes above **c)** 698.46 Hz

11. **a)** $5 \log_5 x - \log_5 y - \frac{1}{3} \log_5 z$

b) $\frac{1}{2}(\log x + 2 \log y - \log z)$

12. **a)** $\log \frac{xz^{\frac{2}{3}}}{y^3}$ **b)** $\log_7 \frac{x}{y^{\frac{1}{2}} z^{\frac{3}{2}}}$

13. **a)** $\log \sqrt{x}$, $x > 0$ **b)** $\log \frac{x-5}{x+5}$, $x < -5$ or $x > 5$

14. **a)** 2 **b)** 0.5

15. 6.3 times as acidic

16. 398 107 times as bright

17. 93 dB

18. **a)** 1.46 **b)** 4.03

19. **a)** 5 **b)** 10 **c)** $\frac{5}{3}$ **d)** −4, 25

20. 6.5 years

21. 35 kg

22. 2.5 h

23. **a)** 14 years **b)** 25.75 years

Chapter 8 Practice Test, pages 419 to 420

1. D **2.** A **3.** B **4.** A **5.** C **6.** B

7. **a)** $\frac{1}{81}$ **b)** 25 **c)** 5 **d)** 3 **e)** $\frac{13}{3}$

8. $m = 2.5$, $n = 0.5$

9. Example: Stretch vertically about the x-axis by a factor of 5, stretch horizontally about the y-axis by a factor of $\frac{1}{8}$, reflect in the x-axis, and translate 1 unit right.

10. **a)** $x = -5$

b) domain $\{x \mid x > -5, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$

c) y-intercept 8 **d)** $-4\frac{124}{125}$

11. **a)** no solution **b)** $x = 6$ **c)** $x = -2, 4$

12. **a)** 1.46 **b)** 21.09

13. 33 years

14. 875 times as great

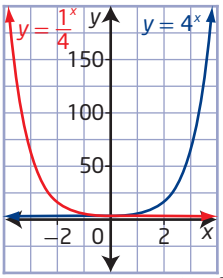
15. She should not be worried: adding another refrigerator will only increase the decibels to 48 dB.

16. 4.8 h

17. 2029

Cumulative Review, Chapters 7–8, pages 422 to 423

1. **a)**



b) The two functions have the same domain, $x \in \mathrm{R}$; the same range, $y > 0$; the same y-intercept, 1; and the same horizontal asymptote, $y = 0$.

c) $y = 4^x$ is a increasing function: as x increases, the corresponding values of y also increase.

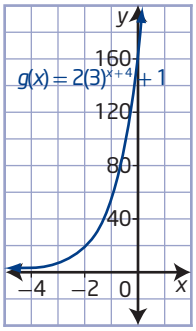
$y = \frac{1}{4}^x$ is a decreasing function: as x increases, the corresponding values of y decrease.

2. **a)** B **b)** D **c)** A **d)** C

3. **a)** 1000 **b)** 3 h **c)** 256 000 **d)** 21 h

4. **a)** a vertical stretch by a factor of 2 about the x-axis, a horizontal translation of 4 units left, and a vertical translation of 1 unit up

b)



c) The domain remains the same: $x \in \mathrm{R}$; the range changes from $y > 0$ to $y > 1$ due to the vertical translation; the equation of the horizontal asymptote changes from $y = 0$ to $y = 1$ due to the vertical translation; the y-intercept changes from 1 to 163 due to the vertical stretch and the vertical translation.

5. **a)** 2^{3x+6} and 2^{3x-15} or 8^{x+2} and 8^{x-5}

b) 3^{12-3x} and 3^{-4x} or $\left(\frac{1}{3}\right)^{3x-12}$ and $\left(\frac{1}{3}\right)^{4x}$

6. **a)** −1 **b)** $\frac{1}{8}$

7. **a)** −0.72 **b)** 0.63

8. **a)** 39% **b)** 3.7 s

9. **a)** $\log_3 y = x$ **b)** $\log_2 m = a + 1$

10. **a)** $x^4 = 3$ **b)** $a^b = x + 5$

11. **a)** −4 **b)** 4.5 **c)** −1 **d)** 49

12. **a)** 2 **b)** 32 **c)** $\frac{1}{125}$ **d)** $\frac{243}{32}$

13. a vertical stretch by a factor of $\frac{1}{3}$ about the x-axis, a horizontal stretch by a factor of $\frac{1}{2}$ about the y-axis, a horizontal translation of 4 units right and a vertical translation of 5 units up

14. **a)** $y = 3 \log (x + 5)$ **b)** $y = -\log 2x - 2$

15. **a)** 1.6×10^{-8} mol/L to 6.3×10^{-7} mol/L

b) yes

16. **a)** $\log \frac{m^2}{\sqrt{n}p^3}$, $m > 0$, $n > 0$, $p > 0$

b) $\log_a 3x^{\frac{13}{6}}$, $x > 0$ **c)** $\log (x + 1)$, $x > 1$

d) $\log_2 3^{2x}$, $x \in \mathrm{R}$

17. In the last step, Zack incorrectly factored the quadratic equation; $x = -5$ and 13.

18. **a)** 0.53 **b)** 9 **c)** 3 **d)** 2

19. **a)** $E = 10^{10}$ J and $E = 10^{11.4}$ J

b) approximately 25.1 times

20. 54.25 years

Unit 3 Test, pages 424 to 425

1. D **2.** B **3.** A **4.** C **5.** A **6.** A **7.** D

8. $y = -2\left(\frac{1}{4}\right)^{x-3}$

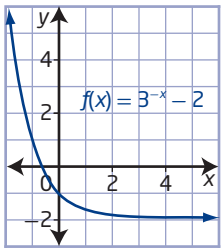
9. 3^{-1}

10. $(2, -2)$

11. 0.001

12. -2

13. a)



b) domain $\{x \mid x \in \mathrm{R}\}$, range $\{y \mid y > -2, y \in \mathrm{R}\}$

c) $x = -0.6$

14. a) -7 **b)** 2

15. a) domain $\{x \mid x > 2, x \in \mathrm{R}\}$, range $\{y \mid y \in \mathrm{R}\}$, asymptote $x = 2$

b) $y = 10^{1-x} + 2$ **c)** 12

16. a) $\frac{1}{3}$, 4 **b)** 7

17. Giovanni multiplied the base by 2, which is not correct. The second line should be $3^x = 4$. Giovanni also incorrectly applied the quotient law of logarithms in the sixth line. This line should be deleted. This leads to the solution $x = 1.26$.

18. 5.0

19. a) $P(t) = 6(1.013^t)$, where t is the number of years since 2000

b) year 2040

20. 12 deposits

Chapter 9 Rational Functions

9.1 Exploring Rational Functions Using Transformations, pages 442 to 445

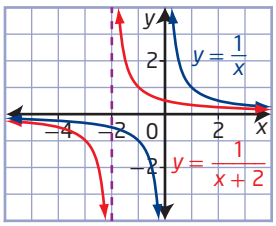
1. a) Since the graph has a vertical asymptote at $x = -1$, it has been translated 1 unit left; $B(x) = \frac{2}{x+1}$.

b) Since the graph has a horizontal asymptote at $y = -1$, it has been translated 1 unit down; $A(x) = \frac{2}{x} - 1$.

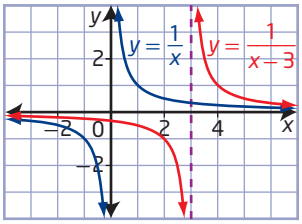
c) Since the graph has a horizontal asymptote at $y = 1$, it has been translated 1 unit up; $D(x) = \frac{2}{x} + 1$.

d) Since the graph has a vertical asymptote at $x = 1$, it has been translated 1 unit right; $C(x) = \frac{2}{x-1}$.

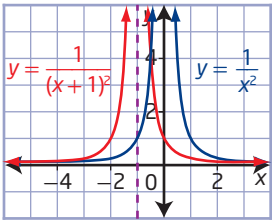
2. a) Base function $y = \frac{1}{x}$; vertical asymptote $x = -2$, horizontal asymptote $y = 0$



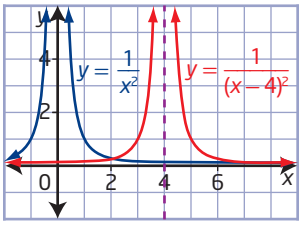
b) Base function $y = \frac{1}{x}$; vertical asymptote $x = 3$, horizontal asymptote $y = 0$



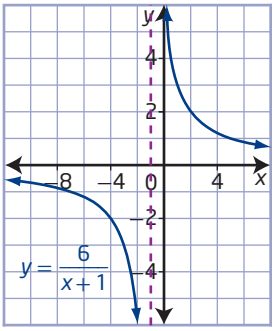
c) Base function $y = \frac{1}{x^2}$; vertical asymptote $x = -1$, horizontal asymptote $y = 0$



d) Base function $y = \frac{1}{x^2}$; vertical asymptote $x = 4$, horizontal asymptote $y = 0$



3. a) Apply a vertical stretch by a factor of 6, and then a translation of 1 unit left to the graph of $y = \frac{1}{x}$. domain $\{x \mid x \neq -1, x \in \mathrm{R}\}$, range $\{y \mid y \neq 0, y \in \mathrm{R}\}$, no x-intercept, y-intercept 6, horizontal asymptote $y = 0$, vertical asymptote $x = -1$



b) Apply a vertical stretch by a factor of 4, and then a translation of 1 unit up to the graph of $y = \frac{1}{x}$. domain $\{x \mid x \neq 0, x \in \mathrm{R}\}$, range $\{y \mid y \neq 1, y \in \mathrm{R}\}$, x-intercept -4, no y-intercept, horizontal asymptote $y = 1$, vertical asymptote $x = 0$