c) The graphs are identical. The order of the transformations does not matter when performing a vertical stretch and a horizontal translation.

d) Example: a horizontal stretch by a factor of 2 and a translation 3 units up; a vertical stretch by a factor of 3 and a translation 1 unit right

e) Example: when a stretch and a translation are in the same direction

8.3 Laws of Logarithms, pages 275–281

1. a) 2 b) 3 c) 5 d) 2 e) 2
   f) 3 g) 5 h) 11 i) 16 j) 1000

2. a) $4\log_7 x + \frac{3}{2}\log_7 y$

   b) $3\log_{12} x + 6\log_{12} y + 15\log_{12} z$

   c) $3\log_8 x - \frac{1}{2}\log_8 y - \frac{5}{2}\log_8 z$

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

3. a) $2 + \frac{5}{3}\log_7 x$ b) $2 - 2\log x - 2\log y$

   c) $\frac{7}{3}\log_5 y - 3 - \log_5 x$ d) $6\log_2 x - 5 - 2\log_2 y$

4. a) $\log_6 54x^4$ b) $\log_2 \frac{y^8}{2x}$ c) $\log_4 x^{16}y^{20}$

   d) $\log_3 (xy)^{\frac{11}{3}}$ e) $\log \frac{2}{25x^{\frac{3}{2}}y^{\frac{1}{4}}}$ f) $\log_7 \frac{x^2}{\sqrt[6]{5}}$

   g) $\log \frac{2x^{\frac{5}{3}}}{3}$ h) $\log_9 x^6y^9$

5. a) $L = \log I^{10} - \log I_0^{10}$ b) $I = 10^{0.1L + \log I_0}$

6. a) $[H_3O]^+ = 10^{-pH}$

   b) $pH = \log([H_3O]^+)^{-1} = \log \frac{1}{[H_3O^+]}$

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

   b) False; the division must take place inside the logarithm.

   c) True d) True

   e) False; the exponent must apply to the entire argument of the logarithm.

8. a) $\frac{1}{6}$ b) 3 c) 8

9. a) $7P$ b) $P + 1$ c) $2P$
   d) $P - 1$ e) $-P$ f) $\frac{P}{2}$

10. a) The function $y = \log_2 x^2$ can be written as $y = 2\log_2 x$, which is a vertical stretch by a factor of 2 of $y = \log_2 x$.

    b) The function $y = \log_2 3x$ is of the form $y = \log_2 bx$. This is a horizontal stretch by a factor of $\frac{1}{3}$ of the function $y = \log_2 x$.

    c) The function $y = \log_2 3x$ can be written as $y = \log_2 x + \log_2 3$, which is a translation of $\log_2 3$ units up.

    d) No. Example: $y = \log_2 \frac{1}{x}$ can be written as $y = -\log_2 x$, which is a reflection in the x-axis, not the reciprocal transformation.

8.4 Logarithmic and Exponential Equations, pages 282–291

1. a) 1024 b) 25 c) 32
   d) 213 e) 5 f) 1005

2. a) 0.93 b) 1.13 c) −3.64 d) 8.00

3. a) $\frac{\log 205}{\log 5}$ b) $\frac{\log 311}{\log 4} + 3$

   c) $\frac{\log 7539 - 1}{2}$ d) $\frac{\log 40}{\log 4} - 2$

   e) $\frac{2\log 85}{\log 6}$

4. a) 6 b) 10 or −10

   c) 16 d) 9

5. a) $x > 0$ b) $x > 2$

   c) undefined for all x

6. a) $\frac{3\log 5}{\log 5 - 1} \approx -6.97$

   b) $\frac{-3\log 8}{2\log \frac{2}{3}} \approx 7.69$

   c) $\frac{2\log 6 + 5\log 2}{2\log 2 - \log 6} \approx -17.39$

   d) $\frac{3\log 3 + 2\log 6 + \log 2}{2\log 3 - \log 6} \approx 18.68$

7. a) $\frac{5}{2}$ b) $\frac{17}{4}$ c) 2 d) no soluion

8. a) 2 b) 6 c) 6 d) 3

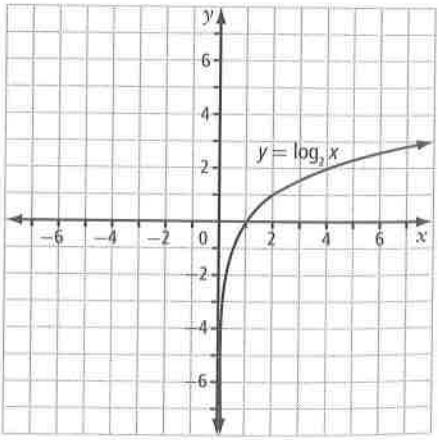
9. a) $m = 65\left(\frac{1}{2}\right)^{\frac{t}{88}}$ b) 43.84 g c) 149.6 years

10. a) $p = 974(1.015)^t$ b) 1049 c) 14 years

11. a) $\frac{3}{2}$ or 1 b) −3 or $\frac{3}{2}$

Chapter 8 Review, pages 292–295

1. a)



domain: $\{x \mid x > 0, x \in R\}$;
range: $\{y \mid y \in R\}$; x-intercept 1;
vertical asymptote $x = 0$

c) The graphs are identical. The order of the transformations does not matter when performing a vertical stretch and a horizontal translation.

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1. **a)** 2 **b)** 3 **c)** 5 **d)** 2 **e)** 2
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d) $\frac{1}{2} \log x - \frac{3}{2} \log y$

3. **a)** $2 + \frac{5}{3} \log_7 x$ **b)** $2 - 2 \log x - 2 \log y$

c) $\frac{7}{}$ $\log_5 x$ **d)** $6 \log_2 x - 5 - 2 \log_2 y$

$\log_2 \frac{y^8}{2x}$ **c)** $\log_4 x^{16} y^{20}$

$\frac{2}{25x^{\frac{3}{2}} y^{\frac{1}{4}}}$ **f)** $\log_7 \frac{x^{\frac{9}{2}}}{\sqrt[6]{5}}$

$x^6 y^9$

$I = 10^{0.1L + \log I_0}$

$\frac{1}{[H_3O^+]}$

tion inside the

ce inside the

apply to the entire

garithm.

8. **b)** 3 **c)** 8

9. **b)** $P + 1$ **c)** $2P$
d) $P - 1$ **e)** $-P$ **f)** $\frac{P}{2}$

10. **a)** The function $y = \log_2 x^2$ can be written as $y = 2 \log_2 x$, which is a vertical stretch by a factor of 2 of $y = \log_2 x$.

b) The function $y = \log_2 3x$ is of the form $y = \log_2 bx$. This is a horizontal stretch by a factor of $\frac{1}{3}$ of the function $y = \log_2 x$.

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8.4 Logarithmic and Exponential Equations, pages 282–291

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d) 213 **e)** 5 **f)** 1005

2. **a)** 0.93 **b)** 1.13 **c)** −3.64 **d)** 8.00

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c) $\frac{\log 7539 - 1}{2}$ **d)** $\frac{\log 40}{\log 4} - 2$

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4. **a)** 6 **b)** 10 or −10
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d) $\frac{3 \log 3 + 2 \log 6 + \log 2}{2 \log 3 - \log 6} \approx 18.68$

7. **a)** $\frac{5}{2}$ **b)** $\frac{17}{4}$ **c)** 2 **d)** no soluion

8. **a)** 2 **b)** 6 **c)** 6 **d)** 3

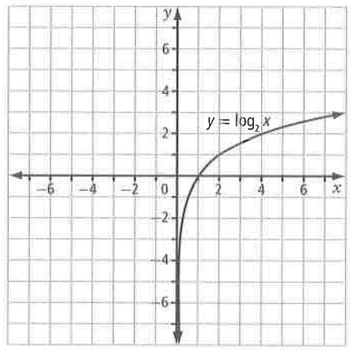
9. **a)** $m = 65\left(\frac{1}{2}\right)^{\frac{t}{88}}$ **b)** 43.84 g **c)** 149.6 years

10. **a)** $p = 974(1.015)^t$ **b)** 1049 **c)** 14 years

11. **a)** $\frac{3}{2}$ or 1 **b)** −3 or $\frac{3}{2}$

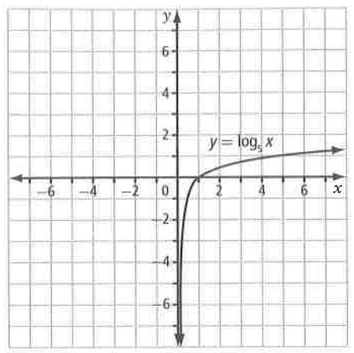
Chapter 8 Review, pages 292–295

1. **a)**



domain: $\{x \mid x > 0, x \in \mathbb{R}\}$;
range: $\{y \mid y \in \mathbb{R}\}$; x-intercept 1;
vertical asymptote $x = 0$

b)



domain: $\{x \mid x > 0, x \in \mathbb{R}\}$;
range: $\{y \mid y \in \mathbb{R}\}$; x-intercept 1;
vertical asymptote $x = 0$

2. **a)** $\log_6 216 = 3$ **b)** $\log_2 1024 = 10$
c) $\log 0.001 = -3$ **d)** $\log_5 125 = x$

3. **a)** $3^4 = 81$ **b)** $25^{\frac{1}{2}} = 5$
c) $10^0 = 1$ **d)** $2^9 = 3x - 4$

4. **a)** vertically stretched by a factor of 2, translated 1 unit left; domain: $\{x \mid x > -1, x \in \mathbb{R}\}$; range: $\{y \mid y \in \mathbb{R}\}$; x-intercept: 0; y-intercept: 0

b) translated 3 units right and 5 units up; domain: $\{x \mid x > 3, x \in \mathbb{R}\}$; range: $\{y \mid y \in \mathbb{R}\}$; x-intercept: 3.0; no y-intercept

5. **a)** $y = \log(x - 5) - 4$; domain: $\{x \mid x > 5, x \in \mathbb{R}\}$; range: $\{y \mid y \in \mathbb{R}\}$

b) $y = 3 \log(x + 2) - 6$; domain: $\{x \mid x > -2, x \in \mathbb{R}\}$; range: $\{y \mid y \in \mathbb{R}\}$

c) $y = \log(3x) + 1$; domain: $\{x \mid x > 0, x \in \mathbb{R}\}$; range: $\{y \mid y \in \mathbb{R}\}$

6. **a)** 2 **b)** 3 **c)** 2 **d)** 0

7. **a)** $2 + 4 \log_5 x + \frac{3}{4} \log_5 y$

b) $5 \log y - 2 - \frac{1}{2} \log x$

8. **a)** $3 \log_4 xy$ **b)** $\log \frac{x^5}{\sqrt{y^5}}$

9. **a)** $\frac{2}{\log 3} \approx 4.19$ **b)** $\frac{\log 517}{\log 7} + 3 \approx 6.21$

c) $\frac{\log 5500 - 1}{2} \approx 1.37$ **d)** $\frac{4 \log 2}{\log 2 - \log 5} \approx -3.03$

10. **a)** 128 **b)** $\frac{117}{2}$ **c)** no solution **d)** 5

11. Example: $10^{9.3 - 9.0} \approx 2$

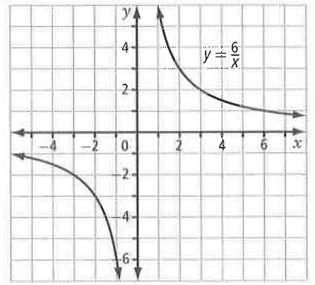
12. **a)** $N = 40(2)^{\frac{t}{4}}$ **b)** 18.58 h
c) 6.34 h; does not depend on the number of bacteria present at the beginning

13. **a)** $P = 100(0.6)^n$ **b)** 21.6%
c) 9 filters

Chapter 9

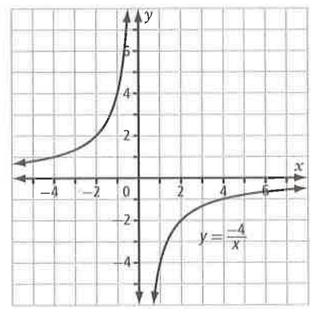
9.1 Exploring Rational Functions Using Transformations, pages 297–304

1. **a)**



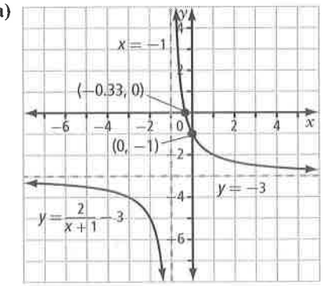
vertical asymptote: $x = 0$
horizontal asymptote: $y = 0$

b)



vertical asymptote: $x = 0$
horizontal asymptote: $y = 0$

2. **a)**



b)