# *Finite Mathematics and Applied Calculus 8th edition Waner Solutions Manual*

SKU: 9780357723630-SOLUTIONS

## Solutions Section 0.1

### Section 0.1

**1.** $2(4+(-1))(2\cdot -4)$
$= 2(3)(-8) = (6)(-8) = -48$

**2.** $3+([4-2]\cdot 9)$
$= 3+(2\times 9) = 3+18 = 21$

**3.** $20/(3*4)-1$
$= \frac{20}{12}-1 = \frac{5}{3}-1 = \frac{2}{3}$

**4.** $2-(3*4)/10$
$= 2-\frac{12}{10} = 2-\frac{6}{5} = \frac{4}{5}$

**5.** $\dfrac{3+([3+(-5)])}{3-2\times 2}$
$= \dfrac{3+(-2)}{3-4} = \dfrac{1}{-1} = -1$

**6.** $\dfrac{12-(1-4)}{2(5-1)\cdot 2-1}$
$= \dfrac{12-(-3)}{16-1} = \dfrac{15}{15} = 1$

**7.** $(2-5*(-1))/1-2*(-1)$
$= \dfrac{2-5\cdot(-1)}{1}-2\cdot(-1)$
$= \dfrac{2+5}{1}+2 = 7+2 = 9$

**8.** $2-5*(-1)/(1-2*(-1))$
$= 2-\dfrac{5\cdot(-1)}{1-2\cdot(-1)}$
$= 2-\dfrac{-5}{1+2}+2 = 2+\dfrac{5}{3} = \dfrac{11}{5}$

**9.** $2\cdot(-1)^2/2 = \dfrac{2\times(-1)^2}{2}$
$= \dfrac{2\times 1}{2} = \dfrac{2}{2} = 1$

**10.** $2+4\cdot 3^2 = 2+4\times 9 = 2+36 = 38$

**11.** $2\cdot 4^2+1$
$= 2\times 16+1 = 32+1 = 33$

**12.** $1-3\cdot(-2)^2\times 2$
$= 1-3\times 4\times 2 = 1-24 = -23$

**13.** `3^2+2^2+1`
$= 3^2+2^2+1 = 9+4+1 = 14$

**14.** `2^(2^2-2)`
$= 2^{(2^2-2)} = 2^{4-2} = 2^2 = 4$

**15.** $\dfrac{3-2(-3)^2}{-6(4-1)^2}$
$= \dfrac{3-2\times 9}{-6(3)^2} = \dfrac{3-18}{-6\times 9}$
$= \dfrac{-15}{-54} = \dfrac{5}{18}$

**16.** $\dfrac{1-2(1-4)^2}{2(5-1)^2\cdot 2}$
$= \dfrac{1-2(-3)^2}{2(4)^2\cdot 2} = \dfrac{1-2\times 9}{2\times 16\times 2}$
$= \dfrac{1-18}{64} = -\dfrac{17}{64}$

**17.** `10*(1+1/10)^3`
$= 10\left(1+\dfrac{1}{10}\right)^3 = 10(1.1)^3$
$= 10\times 1.331 = 13.31$

**18.** `121/(1+1/10)^2`
$= \dfrac{121}{\left(1+\frac{1}{10}\right)^2} = \dfrac{121}{1.1^2}$
$= \dfrac{121}{1.21} = 100$

**19.** $3\left[\dfrac{-2\cdot 3^2}{-(4-1)^2}\right]$

$= 3\left[\dfrac{-2\times 9}{-3^2}\right] = 3\left[\dfrac{-18}{-9}\right]$

$= 3\times 2 = 6$

**20.** $-\left[\dfrac{8(1-4)^2}{-9(5-1)^2}\right]$

$= -\left[\dfrac{8\times 9}{-9\times 16}\right] = -\left(\dfrac{72}{-144}\right)$

$= -\left(-\dfrac{1}{2}\right) = \dfrac{1}{2}$

**21.** $3\left[1-\left(-\dfrac{1}{2}\right)^2\right]^2+1$

$= 3\left[1-\dfrac{1}{4}\right]^2+1$

$= 3\left[\dfrac{3}{4}\right]^2+1 = 3\left[\dfrac{9}{16}\right]+1$

$= \dfrac{27}{16}+1 = \dfrac{43}{16}$

**22.** $3\left[\dfrac{1}{9}-\left(\dfrac{2}{3}\right)^2\right]^2+1$

$= 3\left[\dfrac{1}{9}-\dfrac{4}{9}\right]^2+1$

$= 3\left[\dfrac{-3}{9}\right]^2+1 = 3\left[\dfrac{-1}{3}\right]^2+1$

$= 3\,\dfrac{1}{9}+1 = \dfrac{3}{9}+1 = \dfrac{4}{3}$

**23.** `(1/2)^2-1/2^2`

$= \left[\frac{1}{2}\right]^2 - \frac{1}{2^2} = \frac{1}{4}-\frac{1}{4} = 0$

**24.** `2/(1^2)-(2/1)^2`

$= \frac{2}{1^2} - \left[\frac{2}{1}\right]^2 = \frac{2}{1}-\frac{4}{1} = -2$

**25.** $3\times(2-5)$ = `3*(2-5)`

**26.** $4+\dfrac{5}{9}$ = `4+5/9` or `4+(5/9)`

**27.** $\dfrac{3}{2-5}$ = `3/(2-5)`

**28.** $\dfrac{4-1}{3}$ = `(4-1)/3`

**29.** $\dfrac{3-1}{8+6}$ = `(3-1)/(8+6)`

**Note** `3-1/8-6` is wrong, as it corresponds to $3-\frac{1}{8}-6$.

**30.** $3+\dfrac{3}{2-9}$ = `3+3/(2-9)`

**31.** $3-\dfrac{4+7}{8}$ = `3-(4+7)/8`

**32.** $\dfrac{4\times 2}{\left(\frac{2}{3}\right)}$ = `4*2/(2/3)` or `(4*2)/(2/3)`

**33.** $\dfrac{2}{3+x}-xy^2$ = `2/(3+x)-x*y^2`

**34.** $3+\dfrac{3+x}{xy}$ = `3+(3+x)/(x*y)`

**35.** $3.1x^3-4x^{-2}-\dfrac{60}{x^2-1}$

= `3.1x^3-4x^(-2)-60/(x^2-1)`

**36.** $2.1x^{-3}-x^{-1}+\dfrac{x^2-3}{2}$

= `2.1x^(-3)-x^(-1)+(x^2-3)/2`

**37.** $\dfrac{\left(\frac{2}{3}\right)}{5}$

= `(2/3)/5`

**38.** $\dfrac{2}{\left(\frac{3}{5}\right)}$

= `2/(3/5)`

**39.** $3^{4-5} \times 6$

= `3^(4-5)*6`

Note that the entire exponent is in parentheses.

**40.** $\dfrac{2}{3+5^{7-9}}$

= `2/(3+5^(7-9))`

Note that the entire exponent is in parentheses.

**41.** $3\left(1+\dfrac{4}{100}\right)^{-3}$

= `3*(1+4/100)^(-3)`

**42.** $3\left(\dfrac{1+4}{100}\right)^{-3}$

= `3((1+4)/100)^(-3)`

**43.** $3^{2x-1}+4^{x}-1$

= `3^(2*x-1)+4^x-1`

**44.** $2^{x^2}-(2^{2x})^2$

= `2^(x^2)-(2^(2*x))^2`

**45.** $2^{2x^2-x+1}$

= `2^(2x^2-x+1)`

Note that the entire exponent is in parentheses.

**46.** $2^{2x^2-x}+1$

= `2^(2x^2-x)+1`

Note that the entire exponent is in parentheses.

**47.** $\dfrac{4e^{-2x}}{2-3e^{-2x}}$

= `4*e^(-2*x)/(2-3e^(-2*x))`

or `4(*e^(-2*x))/(2-3e^(-2*x))`

or `(4*e^(-2*x))/(2-3e^(-2*x))`

**48.** $\dfrac{e^{2x}+e^{-2x}}{e^{2x}-e^{-2x}}$

= `(e^(2*x)+e^(-2*x))/(e^(2*x)-e^(-2*x))`

**49.** $3\left(1-\left(-\frac{1}{2}\right)^2\right)^2+1$

= `3(1-(-1/2)^2)^2+1`

**50.** $3\left(\frac{1}{9}-\left(\frac{2}{3}\right)^2\right)^2+1$

= `3(1/9-(2/3)^2)^2+1`

## Section 0.2

**1.** $3^3 = 27$

**2.** $(-2)^3 = -8$

**3.** $-(2 \cdot 3)^2 = -(2^2 \cdot 3^2) = -(4 \cdot 9) = -36$
or
$-(2 \cdot 3)^2 = -6^2 = -36$

**4.** $(4 \cdot 2)^2 = 4^2 \cdot 2^2 = 16 \cdot 4 = 64$ or
$(4 \cdot 2)^2 = 8^2 = 64$

**5.** $\left(\frac{-2}{3}\right)^2 = \frac{(-2)^2}{3^2} = \frac{4}{9}$

**6.** $\left(\frac{3}{2}\right)^3 = \frac{3^3}{2^3} = \frac{27}{8}$

**7.** $(-2)^{-3} = \frac{1}{(-2)^3} = \frac{1}{-8} = -\frac{1}{8}$

**8.** $-2^{-3} = -\frac{1}{2^3} = -\frac{1}{8}$

**9.** $\left(\frac{1}{4}\right)^{-2} = \frac{1}{(1/4)^2} = \frac{1}{1/16} = 16$

**10.** $\left(\frac{-2}{3}\right)^{-2} = \frac{1}{(-2/3)^2} = \frac{1}{4/9} = \frac{9}{4}$

**11.** $2 \cdot 3^0 = 2 \cdot 1 = 2$

**12.** $3 \cdot (-2)^0 = 3 \cdot 1 = 3$

**13.** $2^3 2^2 = 2^{3+2} = 2^5 = 32$
or
$2^3 2^2 = 8 \cdot 4 = 32$

**14.** $3^2 3 = 3^2 3^1 = 3^{2+1} = 3^3 = 27$or
$3^2 3 = 9 \cdot 3 = 27$

**15.** $2^2 2^{-1} 2^4 2^{-4} = 2^{2-1+4-4} = 2^1 = 2$

**16.** $5^2 5^{-3} 5^2 5^{-2} = 5^{2-3+2-2} = 5^{-1} = \frac{1}{5}$

**17.** $x^3 x^2 = x^{3+2} = x^5$

**18.** $x^4 x^{-1} = x^{4-1} = x^3$

**19.** $-x^2 x^{-3} y = -x^{2-3} y = -x^{-1} y = -\frac{y}{x}$

**20.** $-xy^{-1}x^{-1} = -x^{1-1}y^{-1} = -x^0 y^{-1}$
$= -\frac{1}{y}$

**21.** $\frac{x^3}{x^4} = x^{3-4} = x^{-1} = \frac{1}{x}$

**22.** $\frac{y^5}{y^3} = y^{5-3} = y^2$

**23.** $\frac{x^2 y^2}{x^{-1} y} = x^{2-(-1)} y^{2-1} = x^3 y$

**24.** $\frac{x^{-1} y}{x^2 y^2} = x^{-1-2} y^{1-2} = x^{-3} y^{-1} = \frac{1}{x^3 y}$

## Solutions Section 0.2

**25.** $\dfrac{(xy^{-1}z^3)^2}{x^2yz^2} = \dfrac{x^2(y^{-1})^2(z^3)^2}{x^2yz^2}$
$= \dfrac{x^2y^{-2}z^6}{x^2yz^2} = x^{2-2}y^{-2-1}z^{6-2}$
$= x^0y^{-3}z^4 = \dfrac{z^4}{y^3}$

**26.** $\dfrac{x^2yz^2}{(xyz^{-1})^{-1}} = \dfrac{x^2yz^2}{x^{-1}y^{-1}(z^{-1})^{-1}}$
$= \dfrac{x^2yz^2}{x^{-1}y^{-1}z} = x^{2-(-1)}y^{1-(-1)}z^{2-1}$
$= x^3y^2z^4$

**27.** $\left(\dfrac{xy^{-2}z}{x^{-1}z}\right)^3 = \dfrac{(xy^{-2}z)^3}{(x^{-1}z)^3}$
$= \dfrac{x^3y^{-6}z^3}{x^{-3}z^3} = x^{3-(-3)}y^{-6}z^{3-3}$
$= x^6y^{-6}z^0 = \dfrac{x^6}{y^6}$

**28.** $\left(\dfrac{x^2y^{-1}z^0}{xyz}\right)^2 = \dfrac{(x^2y^{-1}z^0)^2}{(xyz)^2}$
$= \dfrac{x^4y^{-2}}{x^2y^2z^2} = x^{4-2}y^{-2-2}z^{-2}$
$= x^2y^{-4}z^{-2} = \dfrac{x^2}{y^4z^2}$

**29.** $\left(\dfrac{x^{-1}y^{-2}z^2}{xy}\right)^{-2} = (x^{-1-1}y^{-2-1}z^2)^{-2}$
$= (x^{-2}y^{-3}z^2)^{-2} = x^4y^6z^{-4}$
$= \dfrac{x^4y^6}{z^4}$

**30.** $\left(\dfrac{xy^{-2}}{x^2y^{-1}z}\right)^{-3} = (x^{1-2}y^{-2+1}z^{-1})^{-3}$
$= (x^{-1}y^{-1}z^{-1})^{-3} = x^3y^3z^3$

**31.** $\sqrt{4} = 2$

**32.** $\sqrt{5} \approx 2.236$

**33.** $\sqrt{\dfrac{1}{4}} = \dfrac{\sqrt{1}}{\sqrt{4}} = \dfrac{1}{2}$

**34.** $\sqrt{\dfrac{1}{9}} = \dfrac{\sqrt{1}}{\sqrt{9}} = \dfrac{1}{3}$

**35.** $\sqrt{\dfrac{16}{9}} = \dfrac{\sqrt{16}}{\sqrt{9}} = \dfrac{4}{3}$

**36.** $\sqrt{\dfrac{9}{4}} = \dfrac{\sqrt{9}}{\sqrt{4}} = \dfrac{3}{2}$

**37.** $\dfrac{\sqrt{4}}{5} = \dfrac{2}{5}$

**38.** $\dfrac{6}{\sqrt{25}} = \dfrac{6}{5}$

**39.** $\sqrt{9} + \sqrt{16} = 3 + 4 = 7$

**40.** $\sqrt{25} - \sqrt{16} = 5 - 4 = 1$

**41.** $\sqrt{9 + 16} = \sqrt{25} = 5$

**42.** $\sqrt{25 - 16} = \sqrt{9} = 3$

**43.** $\sqrt[3]{8 - 27} = \sqrt[3]{-19} \approx -2.668$

**44.** $\sqrt[4]{81 - 16} = \sqrt[4]{65} \approx 2.839$

**45.** $\sqrt[3]{27/8} = \dfrac{\sqrt[3]{27}}{\sqrt[3]{8}} = \dfrac{3}{2}$

**46.** $\sqrt[3]{8 \times 64} = \sqrt[3]{8} \cdot \sqrt[3]{64} = 2 \cdot 4 = 8$

## Solutions Section 0.2

**47.** $\sqrt{(-2)^2} = \sqrt{4} = 2$

**48.** $\sqrt{(-1)^2} = \sqrt{1} = 1$

**49.** $\sqrt{\frac{1}{4}(1+15)} = \sqrt{\frac{16}{4}} = \frac{\sqrt{16}}{\sqrt{4}} = \frac{4}{2} = 2$

**50.** $\sqrt{\frac{1}{9}(3+33)} = \sqrt{\frac{36}{9}} = \frac{\sqrt{36}}{\sqrt{9}} = \frac{6}{3} = 2$

**51.** $\sqrt{a^2b^2} = \sqrt{a^2}\sqrt{b^2} = ab$

**52.** $\sqrt{\frac{a^2}{b^2}} = \frac{\sqrt{a^2}}{\sqrt{b^2}} = \frac{a}{b}$

**53.** $\sqrt{(x+9)^2} = x+9$
$(x+9 > 0$ because $x$ is positive.)

**54.** $\left(\sqrt{x+9}\right)^2 = x+9$

**55.** $\sqrt[3]{x^3(a^3+b^3)} = \sqrt[3]{x^3}\sqrt[3]{(a^3+b^3)}$
$= x\sqrt[3]{(a^3+b^3)}$ (*Not* $x(a+b)$)

**56.** $\sqrt[4]{\frac{x^4}{a^4b^4}} = \frac{\sqrt[4]{x^4}}{\sqrt[4]{a^4}\sqrt[4]{b^4}} = \frac{x}{ab}$

**57.** $\sqrt{\frac{4xy^3}{x^2y}} = \sqrt{\frac{4y^2}{x}} = \frac{\sqrt{4}\sqrt{y^2}}{\sqrt{x}} = \frac{2y}{\sqrt{x}}$

**58.** $\sqrt{\frac{4(x^2+y^2)}{c^2}} = \frac{\sqrt{4}\sqrt{x^2+y^2}}{\sqrt{c^2}}$
$= \frac{2\sqrt{x^2+y^2}}{c}$ (*Not* $2(x+y)/c$)

## Section 0.3

**1.** $3x^{-4} = \dfrac{3}{x^4}$

**2.** $\dfrac{1}{2}x^{-4} = \dfrac{1}{2x^4}$

**3.** $\dfrac{3}{4}x^{-2/3} = \dfrac{3}{4x^{2/3}}$

**4.** $\dfrac{4}{5}y^{-3/4} = \dfrac{4}{5y^{3/4}}$

**5.** $1 - \dfrac{0.3}{x^{-2}} - \dfrac{6}{5}x^{-1} = 1 - 0.3x^2 - \dfrac{6}{5x}$

**6.** $\dfrac{1}{3x^{-4}} + \dfrac{0.1x^{-2}}{3} = \dfrac{x^4}{3} + \dfrac{0.1}{3x^2}$

**7.** $2^{2/3} = \sqrt[3]{2^2}$

**8.** $3^{4/5} = \sqrt[5]{3^4}$

**9.** $x^{4/3} = \sqrt[3]{x^4} = \sqrt[3]{x^3}\,\sqrt[3]{x} = x\sqrt[3]{x}$

**10.** $y^{7/4} = \sqrt[4]{y^7} = \sqrt[4]{y^4}\,\sqrt[4]{y^3} = |y|\sqrt[4]{y^3}$

**11.** $\left(x^{1/2}y^{1/3}\right)^{1/5} = \sqrt[5]{\sqrt{x}\,\sqrt[3]{y}}$

**12.** $x^{-1/3}y^{3/2} = \dfrac{y^{3/2}}{x^{1/3}} = \dfrac{\sqrt{y^3}}{\sqrt[3]{x}} = \dfrac{|y|\sqrt{y}}{\sqrt[3]{x}}$

**13.** $-\dfrac{3}{2}x^{-1/4} = -\dfrac{3}{2x^{1/4}} = -\dfrac{3}{2\sqrt[4]{x}}$

**14.** $\dfrac{4}{5}x^{3/2} = \dfrac{4\sqrt{x^3}}{5} = \dfrac{4|x|\sqrt{x}}{5}$

**15.** $0.2x^{-2/3} + \dfrac{3}{7x^{-1/2}} = \dfrac{0.2}{x^{2/3}} + \dfrac{3x^{1/2}}{7}$
$= \dfrac{0.2}{\sqrt[3]{x^2}} + \dfrac{3\sqrt{x}}{7}$

**16.** $\dfrac{3.1}{x^{-4/3}} - \dfrac{11}{7}x^{-1/7} = 3.1x^{4/3} - \dfrac{11}{7x^{1/7}}$
$= 3.1\sqrt[3]{x^4} - \dfrac{11}{7\sqrt[7]{x}} = 3.1x\sqrt[3]{x} - \dfrac{11}{7\sqrt[7]{x}}$

**17.** $\dfrac{3}{4(1-x)^{5/2}} = \dfrac{3}{4\sqrt{(1-x)^5}}$
$= \dfrac{3}{4\sqrt{(1-x)^4}\sqrt{1-x}}$
$= \dfrac{3}{4(1-x)^2\sqrt{1-x}}$

**18.** $\dfrac{9}{4(1-x)^{-7/3}} = \dfrac{9(1-x)^{7/3}}{4}$
$= \dfrac{9\sqrt[3]{(1-x)^7}}{4} = \dfrac{9\sqrt[3]{(1-x)^6}\,\sqrt[3]{1-x}}{4}$
$= \dfrac{9(1-x)^2\sqrt[3]{1-x}}{4}$

**19.** $\sqrt{3} = 3^{1/2}$

**20.** $\sqrt{8} = 8^{1/2}$

**21.** $\sqrt{x^3} = x^{3/2}$

**22.** $\sqrt[3]{x^2} = x^{2/3}$

## Solutions Section 0.3

**23.** $\sqrt[3]{xy^2} = (xy^2)^{1/3}$

**24.** $\sqrt{x^2y} = (x^2y)^{1/2}$

**25.** $\dfrac{x^2}{\sqrt{x}} = \dfrac{x^2}{x^{1/2}} = x^{2-1/2} = x^{3/2}$

**26.** $\dfrac{x}{\sqrt{x}} = \dfrac{x}{x^{1/2}} = x^{1-1/2} = x^{1/2}$

**27.** $\dfrac{3}{5x^2} = \dfrac{3}{5}x^{-2}$

**28.** $\dfrac{2}{5x^{-3}} = \dfrac{2}{5}x^3$

**29.** $\dfrac{3x^{-1.2}}{2} - \dfrac{1}{3x^{2.1}} = \dfrac{3}{2}x^{-1.2} - \dfrac{1}{3}x^{-2.1}$

**30.** $\dfrac{2}{3x^{-1.2}} - \dfrac{x^{2.1}}{3} = \dfrac{2}{3}x^{1.2} - \dfrac{1}{3}x^{2.1}$

**31.** $\dfrac{2x}{3} - \dfrac{x^{0.1}}{2} + \dfrac{4}{3x^{1.1}}$
$= \dfrac{2}{3}x - \dfrac{1}{2}x^{0.1} + \dfrac{4}{3}x^{-1.1}$

**32.** $\dfrac{4x^2}{3} + \dfrac{x^{3/2}}{6} - \dfrac{2}{3x^2}$
$= \dfrac{4}{3}x^2 + \dfrac{1}{6}x^{3/2} - \dfrac{2}{3}x^{-2}$

**33.** $\dfrac{3\sqrt{x}}{4} - \dfrac{5}{3\sqrt{x}} + \dfrac{4}{3x\sqrt{x}}$
$= \dfrac{3x^{1/2}}{4} - \dfrac{5}{3x^{1/2}} + \dfrac{4}{3x \cdot x^{1/2}}$
$= \dfrac{3}{4}x^{1/2} - \dfrac{5}{3}x^{-1/2} + \dfrac{4}{3}x^{-3/2}$

**34.** $\dfrac{3}{5\sqrt{x}} - \dfrac{5\sqrt{x}}{8} + \dfrac{7}{2\sqrt[3]{x}}$
$= \dfrac{3}{5x^{1/2}} - \dfrac{5x^{1/2}}{8} + \dfrac{7}{2x^{1/3}}$
$= \dfrac{3}{5}x^{-1/2} - \dfrac{5}{8}x^{1/2} + \dfrac{7}{2}x^{-1/3}$

**35.** $\dfrac{3\sqrt[5]{x^2}}{4} - \dfrac{7}{2\sqrt{x^3}} = \dfrac{3x^{2/5}}{4} - \dfrac{7}{2x^{3/2}}$
$= \dfrac{3}{4}x^{2/5} - \dfrac{7}{2}x^{-3/2}$

**36.** $\dfrac{1}{8x\sqrt{x}} - \dfrac{2}{3\sqrt[5]{x^3}} = \dfrac{1}{8x^{3/2}} - \dfrac{2}{3x^{3/5}}$
$= \dfrac{1}{8}x^{-3/2} - \dfrac{2}{3}x^{-3/5}$

**37.** $\dfrac{1}{(x^2+1)^3} - \dfrac{3}{4\sqrt[3]{x^2+1}}$
$= \dfrac{1}{(x^2+1)^3} - \dfrac{3}{(x^2+1)^{1/3}}$
$= (x^2+1)^{-3} - \dfrac{3}{4}(x^2+1)^{-1/3}$

**38.** $\dfrac{2}{3(x^2+1)^{-3}} - \dfrac{3\sqrt[3]{(x^2+1)^7}}{4}$
$= \dfrac{2}{3}(x^2+1)^3 - \dfrac{3}{4}(x^2+1)^{7/3}$

**39.** $4^{-1/2}4^{7/2} = 4^{-1/2+7/2} = 4^{6/2} = 4^3 = 64$

**40.** $\dfrac{2^{1/a}}{2^{2/a}} = 2^{1/a-2/a} = 2^{-1/a} = \dfrac{1}{2^{1/a}}$

**41.** $3^{2/3}3^{-1/6} = 3^{2/3-1/6} = 3^{1/2} = \sqrt{3}$

**42.** $2^{1/3}2^{-1}2^{2/3}2^{-1/3} = 2^{1/3-1+2/3-1/3}$
$= 2^{-1/3} = \dfrac{1}{2^{1/3}}$

## Solutions Section 0.3

**43.** $\dfrac{x^{3/2}}{x^{5/2}} = x^{3/2-5/2} = x^{-1} = \dfrac{1}{x}$

**44.** $\dfrac{y^{5/4}}{y^{3/4}} = y^{5/4-3/4} = y^{1/2} = \sqrt{y}$

**45.** $\dfrac{x^{1/2}y^2}{x^{-1/2}y} = x^{1/2-(-1/2)}y^{2-1} = xy$

**46.** $\dfrac{x^{-1/2}y}{x^2y^{3/2}} = x^{-1/2-2}y^{1-3/2} = x^{-5/2}y^{-1/2}$

**47.** $\left(\dfrac{x}{y}\right)^{1/3}\left(\dfrac{y}{x}\right)^{2/3} = \dfrac{x^{1/3}}{y^{1/3}} \cdot \dfrac{y^{2/3}}{x^{2/3}}$
$= x^{1/3-2/3}y^{-1/3+2/3}$
$= x^{-1/3}y^{1/3}$ or $\left(\frac{y}{x}\right)^{1/3}$

**48.** $\left(\dfrac{x}{y}\right)^{-1/3}\left(\dfrac{y}{x}\right)^{1/3} = \dfrac{x^{-1/3}}{y^{-1/3}} \cdot \dfrac{y^{1/3}}{x^{1/3}}$
$x^{-1/3-1/3}y^{1/3+1/3}$
$= x^{-2/3}y^{2/3}$ or $\left(\frac{y}{x}\right)^{2/3}$

**49.** $x^2 - 16 = 0 \Rightarrow x^2 = 16$
$\Rightarrow x = \pm\sqrt{16} \Rightarrow x = \pm 4$

**50.** $x^2 - 1 = 0 \Rightarrow x^2 = 1$
$\Rightarrow x = \pm\sqrt{1} \Rightarrow x = \pm 1$

**51.** $x^2 - \dfrac{4}{9} = 0 \Rightarrow x^2 = \dfrac{4}{9}$
$\Rightarrow x = \pm\sqrt{\dfrac{4}{9}} \Rightarrow x = \pm\dfrac{2}{3}$

**52.** $x^2 - \dfrac{1}{10} = 0 \Rightarrow x^2 = \dfrac{1}{10}$
$\Rightarrow x = \pm\sqrt{\dfrac{1}{10}} \Rightarrow x = \pm\dfrac{1}{\sqrt{10}}$

**53.** $x^2 - (1+2x)^2 = 0 \Rightarrow x^2 = (1+2x)^2$
$\Rightarrow x = \pm 1 + 2x$
If $x = 1 + 2x$, then $-x = 1 \Rightarrow x = -1$.
If $x = -(1+2x)$, then $= -1 \Rightarrow x = -\dfrac{1}{3}$.
So, $x = 1$ or $-\dfrac{1}{3}$.

**54.** $x^2 - (2-3x)^2 = 0 \Rightarrow x^2 = (2-3x)^2$
$\Rightarrow x = \pm 2 - 3x$
If $x = 2 - 3x$, then $4x = 2 \Rightarrow x = \dfrac{1}{2}$.
If $x = -(2-3x)$, then $-2x = -2 \Rightarrow x = 1$.
So, $x = 1$ or $\dfrac{1}{2}$.

**55.** $x^5 + 32 = 0 \Rightarrow x^5 = -32$
$\Rightarrow x = \sqrt[5]{-32} = -2$

**56.** $x^4 - 81 = 0 \Rightarrow x^4 = 81$
$\Rightarrow x = \pm\sqrt[4]{81} = \pm 3$

**57.** $x^{1/2} - 4 = 0 \Rightarrow x^{1/2} = 4$
$\Rightarrow x = 4^2 = 16$

**58.** $x^{1/3} - 2 = 0 \Rightarrow x^{1/3} = 2$
$\Rightarrow x = 2^3 = 8$

**59.** $1 - \dfrac{1}{x^2} = 0 \Rightarrow 1 = \dfrac{1}{x^2}$
$\Rightarrow x^2 = 1 \Rightarrow x = \pm\sqrt{1} = \pm 1$

**60.** $\dfrac{2}{x^3} - \dfrac{6}{x^4} = 0 \Rightarrow \dfrac{2}{x^3} = \dfrac{6}{x^4}$
$\Rightarrow 2x^4 = 6x^3 \Rightarrow 2x = 6 \Rightarrow x = 3$

**61.** $(x-4)^{-1/3} = 2 \Rightarrow x - 4 = 2^{-3} = \dfrac{1}{8}$
$\Rightarrow x = 4 + \dfrac{1}{8} = \dfrac{33}{8}$

**62.** $(x-4)^{2/3} + 1 = 5 \Rightarrow (x-4)^{2/3} = 4$
$\Rightarrow x - 4 = \pm 4^{3/2} = \pm 8$
$\Rightarrow x = 4 \pm 8 = -4$ or $12$

## Section 0.4

**1.** $x(4x+6) = 4x^2 + 6x$

**2.** $(4y-2)y = 4y^2 - 2y$

**3.** $(2x-y)y = 2xy - y^2$

**4.** $x(3x+y) = 3x^2 + xy$

**5.** $(x+1)(x-3) = x^2 + x - 3x - 3$
$= x^2 - 2x - 3$

**6.** $(y+3)(y+4) = y^2 + 3y + 4y + 12$
$= y^2 + 7y + 12$

**7.** $(2y+3)(y+5) = 2y^2 + 3y + 10y + 15$
$= 2y^2 + 13y + 15$

**8.** $(2x-2)(3x-4) = 6x^2 - 6x - 8x + 8$
$= 6x^2 - 14x + 8$

**9.** $(2x-3)^2 = 4x^2 - 12x + 9$

**10.** $(3x+1)^2 = 9x^2 + 6x + 1$

**11.** $\left(x + \frac{1}{x}\right)^2 = x^2 + 2 + \frac{1}{x^2}$

**12.** $\left(y - \frac{1}{y}\right)^2 = y^2 - 2 + \frac{1}{y^2}$

**13.** $(2x-3)(2x+3) = (2x)^2 - 3^2 = 4x^2 - 9$

**14.** $(4+2x)(4-2x) = 4^2 - (2x)^2 = 16 - 4x^2$

**15.** $\left(y - \frac{1}{y}\right)\left(y + \frac{1}{y}\right) = y^2 - \left(\frac{1}{y}\right)^2 = y^2 - \frac{1}{y^2}$

**16.** $(x - x^2)(x + x^2) = x^2 - (x^2)^2 = x^2 - x^4$

**17.** $(x^2 + x - 1)(2x + 4)$
$= x^2(2x+4) + x(2x+4) - 1(2x+4)$
$= 2x^3 + 4x^2 + 2x^2 + 4x - 2x - 4$
$= 2x^3 + 6x^2 + 2x - 4$

**18.** $(3x+1)(2x^2 - x + 1)$
$= 3x(2x^2 - x + 1) + 1(2x^2 - x + 1)$
$= 6x^3 - 3x^2 + 3x + 2x^2 - x + 1$
$= 6x^3 - x^2 + 2x + 1$

**19.** $(x^2 - 2x + 1)^2 = (x^2 - 2x + 1)(x^2 - 2x + 1)$
$= x^2(x^2 - 2x + 1) - 2x(x^2 - 2x + 1) + 1(x^2 - 2x + 1)$
$= x^4 - 2x^3 + x^2 - 2x^3 + 4x^2 - 2x + x^2 - 2x + 1$
$= x^4 - 4x^3 + 6x^2 - 4x + 1$

**20.** $(x + y - xy)^2 = (x + y - xy)(x + y - xy)$
$= x(x + y - xy) + y(x + y - xy) - xy(x + y - xy)$
$= x^2 + xy - x^2y + xy + y^2 - xy^2 - x^2y - xy^2 + x^2y^2$
$= x^2 + 2xy + y^2 - 2x^2y - 2xy^2 + x^2y^2$

**21.** $(y^3 + 2y^2 + y)(y^2 + 2y - 1)$
$= y^3(y^2 + 2y - 1) + 2y^2(y^2 + 2y - 1) + y(y^2 + 2y - 1)$
$= y^5 + 2y^4 - y^3 + 2y^4 + 4y^3 - 2y^2 + y^3 + 2y^2 - y$
$= y^5 + 4y^4 + 4y^3 - y$

## Solutions Section 0.4

**22.** $(x^3 - 2x^2 + 4)(3x^2 - x + 2)$
$= x^3(3x^2 - x + 2) - 2x^2(3x^2 - x + 2) + 4(3x^2 - x + 2)$
$= 3x^5 - x^4 + 2x^3 - 6x^4 + 2x^3 - 4x^2 + 12x^2 - 4x + 8$
$= 3x^5 - 7x^4 + 4x^3 + 8x^2 - 4x + 8$

**23.** $(x + 1)(x + 2) + (x + 1)(x + 3)$
$= (x + 1)(x + 2 + x + 3)$
$= (x + 1)(2x + 5)$

**24.** $(x + 1)(x + 2)^2 + (x + 1)^2(x + 2)$
$= (x + 1)(x + 2)(x + 2 + x + 1)$
$= (x + 1)(x + 2)(2x + 3)$

**25.** $(x^2 + 1)^5(x + 3)^4 + (x^2 + 1)^6(x + 3)^3$
$= (x^2 + 1)^5(x + 3)^3(x + 3 + x^2 + 1)$
$= (x^2 + 1)^5(x + 3)^3(x^2 + x + 4)$

**26.** $10x(x^2 + 1)^4(x^3 + 1)^5 + 15x^2(x^2 + 1)^5(x^3 + 1)^4$
$= 5x(x^2 + 1)^4(x^3 + 1)^4[2(x^3 + 1) + 3x(x^2 + 1)]$
$= 5x(x^2 + 1)^4(x^3 + 1)^4(5x^3 + 3x + 2)$

**27.** $(x^3 + 1)\sqrt{x + 1} - (x^3 + 1)^2\sqrt{x + 1}$
$= (x^3 + 1)\sqrt{x + 1} \cdot [1 - (x^3 + 1)]$
$= -x^3(x^3 + 1)\sqrt{x + 1}$

**28.** $(x^2 + 1)\sqrt{x + 1} - \sqrt{(x + 1)^3}$
$= \sqrt{x + 1} \cdot [x^2 + 1 - \sqrt{(x + 1)^2}]$
$= \sqrt{x + 1} \cdot [x^2 + 1 - (x + 1)]$
$= (x^2 - x)\sqrt{x + 1}$
$= x(x - 1)\sqrt{x + 1}$

**29.** $\sqrt{(x + 1)^3} + \sqrt{(x + 1)^5}$
$= \sqrt{(x + 1)^3} \cdot [1 + \sqrt{(x + 1)^2}]$
$= \sqrt{(x + 1)^3} \cdot (1 + x + 1)$
$= (x + 2)\sqrt{(x + 1)^3}$

**30.** $(x^2 + 1)\sqrt[3]{(x + 1)^4} - \sqrt[3]{(x + 1)^7}$
$= \sqrt[3]{(x + 1)^4} \cdot [x^2 + 1 - \sqrt[3]{(x + 1)^3}]$
$= \sqrt[3]{(x + 1)^4} \cdot [x^2 + 1 - (x + 1)]$
$= (x^2 - x)\sqrt[3]{(x + 1)^4}$
$= x(x - 1)\sqrt[3]{(x + 1)^4}$

**31.** $a = 2, b = 6, c = 5$, so that the discriminant is
$b^2 - 4ac = 6^2 - 4(2)(5) = 36 - 40 = -4$
As the discriminant is negative, the expression does not factor at all.

**32.** $a = 4, b = -6, c = 2$, so that the discriminant is
$b^2 - 4ac = (-6)^2 - 4(4)(2) = 36 - 32 = 4 = 2^2$
As the discriminant is a perfect square, the expression factors over the integers.

**33.** $a = -3, b = -2, c = 3$, so that the discriminant is
$b^2 - 4ac = (-2)^2 - 4(-3)(3) = 4 + 36 = 40$
As the discriminant is positive but not a perfect square, the expression factors, but not over the integers.

**34.** $a = 1, b = -4, c = -7$, so that the discriminant is
$b^2 - 4ac = (-4)^2 - 4(1)(-7) = 16 + 28 = 44$
As the discriminant is positive but not a perfect square, the expression factors, but not over the integers.

**35.** $a = 8, b = 12, c = 4$, so that the discriminant is
$b^2 - 4ac = 12^2 - 4(8)(4) = 144 - 128 = 16 = 4^2$
As the discriminant is a perfect square, the expression factors over the integers.

## Solutions Section 0.4

**36.** $a = 1, b = 2, c = 19$, so that the discriminant is
$b^2 - 4ac = 2^2 - 4(1)(19) = 4 - 76 = -72$
As the discriminant is negative, the expression does not factor at all.

**37.** $a = 40, b = -64, c = 24$, so that the discriminant is
$b^2 - 4ac = (-64)^2 - 4(40)(24) = 4{,}096 - 3{,}840 = 256 = 16^2$
As the discriminant is a perfect square, the expression factors over the integers.

**38.** $a = -10, b = -32, c = -32$, so that the discriminant is
$b^2 - 4ac = (-32)^2 - 4(-10)(-32) = 1{,}024 - 1{,}280 = -256$
As the discriminant is negative, the expression does not factor at all.

**39.** $a = 6, b = -22, c = 16$, so that the discriminant is
$b^2 - 4ac = (-22)^2 - 4(6)(16) = 484 - 384 = 100 = 10^2$
As the discriminant is a perfect square, the expression factors over the integers.

**40.** $a = 48, b = 32, c = 4$, so that the discriminant is
$b^2 - 4ac = 32^2 - 4(48)(4) = 1{,}024 - 768 = 256 = 16^2$
As the discriminant is a perfect square, the expression factors over the integers.

**41. a.** $2x + 3x^2 = x(2 + 3x)$
**b.** $x(2 + 3x) = 0$
$x = 0$ or $2 + 3x = 0$
$x = 0$ or $-2/3$

**42. a.** $y^2 - 4y = y(y - 4)$
**b.** $y(y - 4) = 0$
$y = 0$ or $y - 4 = 0$
$y = 0$ or $4$

**43. a.** $6x^3 - 2x^2 = 2x^2(3x - 1)$
**b.** $2x^2(3x - 1) = 0$
$x^2 = 0$ or $3x - 1 = 0$
$x = 0$ or $1/3$

**44. a.** $3y^3 - 9y^2 = 3y^2(y - 3)$
**b.** $3y^2(y - 3) = 0$
$y^2 = 0$ or $y - 3 = 0$
$y = 0$ or $3$

**45. a.** $x^2 - 8x + 7 = (x - 1)(x - 7)$
**b.** $(x - 1)(x - 7) = 0$
$x - 1 = 0$ or $x - 7 = 0$
$x = 1$ or $7$

**46. a.** $y^2 + 6y + 8 = (y + 2)(y + 4)$
**b.** $(y + 2)(y + 4) = 0$
$y + 2 = 0$ or $y + 4 = 0$
$y = -2$ or $-4$

**47. a.** $x^2 + x - 12 = (x - 3)(x + 4)$
**b.** $(x - 3)(x + 4) = 0$
$x - 3 = 0$ or $x + 4 = 0$
$x = 3$ or $-4$

**48. a.** $y^2 + y - 6 = (y - 2)(y + 3)$
**b.** $(y - 2)(y + 3) = 0$
$y - 2 = 0$ or $y + 3 = 0$
$y = 2$ or $-3$

**49. a.** $2x^2 - 3x - 2 = (2x + 1)(x - 2)$
**b.** $(2x + 1)(x - 2) = 0$
$2x + 1 = 0$ or $x - 2 = 0$
$x = -1/2$ or $2$

**50. a.** $3y^2 - 8y - 3 = (3y + 1)(y - 3)$
**b.** $(3y + 1)(y - 3) = 0$
$3y + 1 = 0$ or $y - 3 = 0$
$y = -1/3$ or $3$

## Solutions Section 0.4

**51. a.** $6x^2 + 13x + 6 = (2x + 3)(3x + 2)$
**b.** $(2x + 3)(3x + 2) = 0$
$2x + 3 = 0$ or $3x + 2 = 0$
$x = -3/2$ or $-2/3$

**52. a.** $6y^2 + 17y + 12 = (3y + 4)(2y + 3)$
**b.** $(3y + 4)(2y + 3) = 0$
$3y + 4 = 0$ or $2y + 3 = 0$
$y = -4/3$ or $-3/2$

**53. a.** $12x^2 + x - 6 = (3x - 2)(4x + 3)$
**b.** $(3x - 2)(4x + 3) = 0$
$3x - 2 = 0$ or $4x + 3 = 0$
$x = 2/3$ or $-3/4$

**54. a.** $20y^2 + 7y - 3 = (4y - 1)(5y + 3)$
**b.** $(4y - 1)(5y + 3) = 0$
$4y - 1 = 0$ or $5y + 3 = 0$
$y = 1/4$ or $-3/5$

**55. a.** $x^2 + 4xy + 4y^2 = (x + 2y)^2$
**b.** $(x + 2y)^2 = 0$
$x + 2y = 0$
$x = -2y$

**56. a.** $4y^2 - 4xy + x^2 = (2y - x)^2$
**b.** $(2y - x)^2 = 0$
$2y - x = 0$
$y = x/2$

**57. a.** $x^4 - 5x^2 + 4 = (x^2 - 1)(x^2 - 4)$
$= (x + 1)(x - 1)(x + 2)(x - 2)$
**b.** $(x + 1)(x - 1)(x + 2)(x - 2) = 0$
$x + 1 = 0$ or $x - 1 = 0$ or
$x + 2 = 0$ or $x - 2 = 0$
$x = \pm 1$ or $\pm 2$

**58. a.** $y^4 + 2y^2 - 3 = (y^2 - 1)(y^2 + 3)$
$= (y + 1)(y - 1)(y^2 + 3)$
**b.** $(y + 1)(y - 1)(y^2 + 3) = 0$
$y + 1 = 0$ or $y - 1 = 0$ or $y^2 + 3 = 0$
$y = \pm 1$
(Notice that $y^2 + 3 = 0$ has no real solutions.)

**59. a.** $x^2 - 3 = (x - \sqrt{3})(x + \sqrt{3})$
**b.** $(x - \sqrt{3})(x + \sqrt{3}) = 0$
$x - \sqrt{3} = 0$ or $x + \sqrt{3} = 0$
$x = \pm\sqrt{3}$

**60. a.** $y^2 - 7 = (y - \sqrt{7})(y + \sqrt{7})$
**b.** $(y - \sqrt{7})(y + \sqrt{7}) = 0$
$y - \sqrt{7} = 0$ or $y + \sqrt{7} = 0$
$y = \pm\sqrt{7}$

## Section 0.5

**1.** $\dfrac{x-4}{x+1}\cdot\dfrac{2x+1}{x-1}=\dfrac{(x-4)(2x+1)}{(x+1)(x-1)}=\dfrac{2x^2-7x-4}{x^2-1}$

**2.** $\dfrac{2x-3}{x-2}\cdot\dfrac{x+3}{x+1}=\dfrac{(2x-3)(x+3)}{(x-2)(x+1)}=\dfrac{2x^2+3x-9}{x^2-x-2}$

**3.** $\dfrac{x-4}{x+1}+\dfrac{2x+1}{x-1}=\dfrac{(x-4)(x-1)+(x+1)(2x+1)}{(x+1)(x-1)}=\dfrac{3x^2-2x+5}{x^2-1}$

**4.** $\dfrac{2x-3}{x-2}+\dfrac{x+3}{x+1}=\dfrac{(2x-3)(x+1)+(x-2)(x+3)}{(x-2)(x+1)}=\dfrac{3x^2-9}{x^2-x-2}$

**5.** $\dfrac{x^2}{x+1}-\dfrac{x-1}{x+1}=\dfrac{x^2-(x-1)}{x+1}=\dfrac{x^2-x+1}{x+1}$

**6.** $\dfrac{x^2-1}{x-2}-\dfrac{1}{x-1}=\dfrac{(x^2-1)(x-1)-(x-2)}{(x-2)(x-1)}=\dfrac{x^3-x^2-2x+3}{x^2-3x+2}$

**7.** $\dfrac{1}{\left(\frac{x}{x-1}\right)}+x-1=\dfrac{x-1}{x}+x-1=\dfrac{x-1+x(x-1)}{x}=\dfrac{x^2-1}{x}$

**8.** $\dfrac{2}{\left(\frac{x-2}{x^2}\right)}-\dfrac{1}{x-2}=\dfrac{2x^2}{x-2}-\dfrac{1}{x-2}=\dfrac{2x^2-1}{x-2}$

**9.** $\dfrac{1}{x}\left[\dfrac{x-3}{xy}+\dfrac{1}{y}\right]=\dfrac{1}{x}\left[\dfrac{x-3+x}{xy}\right]=\dfrac{2x-3}{x^2y}$

**10.** $\dfrac{y^2}{x}\left[\dfrac{2x-3}{y}+\dfrac{x}{y}\right]=\dfrac{y^2}{x}\left[\dfrac{2x-3+x}{xy}\right]=\dfrac{y^2(3x-3)}{xy}=\dfrac{y(3x-3)}{x}=\dfrac{3xy-3y}{x}$

**11.** $\dfrac{(x+1)^2(x+2)^3-(x+1)^3(x+2)^2}{(x+2)^6}=\dfrac{(x+1)^2(x+2)^2[(x+2)-(x+1)]}{(x+2)^6}=\dfrac{(x+1)^2}{(x+2)^4}$

**12.** $\dfrac{6x(x^2+1)^2(x^3+2)^3-9x^2(x^2+1)^3(x^3+2)^2}{(x^3+2)^6}$

$=\dfrac{3x(x^2+1)^2(x^3+2)^2[2(x^3+2)-3x(x^2+1)]}{(x^3+2)^6}=\dfrac{3x(x^2+1)^2(-x^3-3x+4)}{(x^3+2)^4}$

**13.** $\dfrac{(x^2-1)\sqrt{x^2+1}-\frac{x^4}{\sqrt{x^2+1}}}{x^2+1}=\dfrac{(x^2-1)(x^2+1)-x^4}{(x^2+1)\sqrt{x^2+1}}=\dfrac{-1}{\sqrt{(x^2+1)^3}}$

**14.** $\dfrac{x\sqrt{x^3-1}-\frac{3x^4}{\sqrt{x^3-1}}}{x^3-1}=\dfrac{x(x^3-1)-3x^4}{(x^3-1)\sqrt{x^3-1}}=\dfrac{-2x^4-x}{\sqrt{(x^3-1)^3}}=\dfrac{-x(2x^3+1)}{\sqrt{(x^3-1)^3}}$

**15.** $$\frac{\frac{1}{(x+y)^2}-\frac{1}{x^2}}{y}=\frac{x^2-(x+y)^2}{yx^2(x+y)^2}=\frac{x^2-x^2-2xy-y^2}{yx^2(x+y)^2}=\frac{-y(2x+y)}{yx^2(x+y)^2}=\frac{-(2x+y)}{x^2(x+y)^2}$$

**16.** $$\frac{\frac{1}{(x+y)^3}-\frac{1}{x^3}}{y}=\frac{x^2-(x+y)^2}{yx^2(x+y)^2}=\frac{x^3-x^3-3x^2y-3xy^2-y^3}{yx^3(x+y)^3}$$
$$=\frac{-y(3x^2+3xy+y^2)}{yx^3(x+y)^3}=\frac{-(3x^2+3xy+y^2)}{x^3(x+y)^3}$$

## Solutions Section 0.6

### Section 0.6

**1.** $x+1=0 \Rightarrow x=0-1 \Rightarrow x=-1$

**2.** $x-3=1 \Rightarrow x=1+3 \Rightarrow x=4$

**3.** $-x+5=0 \Rightarrow -x=-5 \Rightarrow x=5$

**4.** $2x+4=1 \Rightarrow 2x=-3 \Rightarrow x=-\dfrac{3}{2}$

**5.** $4x-5=8 \Rightarrow 4x=13 \Rightarrow x=\dfrac{13}{4}$

**6.** $\dfrac{3}{4}x+1=0 \Rightarrow \dfrac{3}{4}x=-1 \Rightarrow x=-\dfrac{4}{3}$

**7.** $7x+55=98 \Rightarrow 7x=43 \Rightarrow x=-\dfrac{43}{7}$

**8.** $3x+1=x \Rightarrow 2x=-1 \Rightarrow x=-\dfrac{1}{2}$

**9.** $x+1=2x+2 \Rightarrow -x=1 \Rightarrow x=-1$

**10.** $x+1=3x+1 \Rightarrow -2x=0 \Rightarrow x=0$

**11.** $ax+b=c \Rightarrow ax=c-b \Rightarrow x=\dfrac{c-b}{a}$

**12.** $x-1=cx+d \Rightarrow (1-c)x=d+1 \Rightarrow x=\dfrac{d+1}{1-c}$

**13.** $2x^2+7x-4=0 \Rightarrow (2x-1)(x+4)=0 \Rightarrow x=-4, \dfrac{1}{2}$

**14.** $x^2+x+1=0 \Rightarrow \Delta=b^2-4ac=-3<0$, so this equation has no real solutions.

**15.** $x^2-x+1=0 \Rightarrow \Delta=b^2-4ac=-3<0$, so this equation has no real solutions.

**16.** $2x^2-4x+3 \Rightarrow \Delta=b^2-4ac=-8<0$, so this equation has no real solutions.

**17.** $2x^2-5=0 \Rightarrow x^2=\dfrac{5}{2} \Rightarrow x=\pm\sqrt{\dfrac{5}{2}}$

**18.** $3x^2-1=0 \Rightarrow x^2=\dfrac{1}{3} \Rightarrow x=\pm\dfrac{1}{\sqrt{3}}$

**19.** $-x^2-2x-1=0 \Rightarrow -(x+1)^2=0 \Rightarrow x=-1$

**20.** $2x^2-x-3=0 \Rightarrow (2x-3)(x+1)=0 \Rightarrow x=\dfrac{3}{2}, -1$

**21.** $\dfrac{1}{2}x^2-x-\dfrac{3}{2}=0 \Rightarrow x^2-2x-3=0 \Rightarrow (x+1)(x-3)=0 \Rightarrow x=-1, 3$

**22.** $-\dfrac{1}{2}x^2-\dfrac{1}{2}x+1=0 \Rightarrow x^2+x-2=0 \Rightarrow (x+2)(x-1)=0 \Rightarrow x=-2, 1$

## Solutions Section 0.6

**23.** $x^2 - x = 1 \Rightarrow x^2 - x - 1 = 0 \Rightarrow x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{1 \pm \sqrt{5}}{2}$

**24.** $16x^2 = -24x - 9 \Rightarrow 16x^2 + 24x + 9 = 0 (4x + 3)^2 = 0 \Rightarrow x = -\dfrac{3}{4}$

**25.** $x = 2 - \dfrac{1}{x} \Rightarrow x^2 = 2x - 1 \Rightarrow x^2 - 2x + 1 = 0 \Rightarrow (x - 1)^2 = 0 \Rightarrow x = 1$

**26.** $x + 4 = \dfrac{1}{x - 2} \Rightarrow (x + 4)(x - 2) = 1 \Rightarrow x^2 + 2x - 8 = 1 \Rightarrow x^2 + 2x - 9 - 0$

$\Rightarrow x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \dfrac{-2 \pm \sqrt{40}}{2} = -1 \pm \sqrt{10}$

**27.** $x^4 - 10x^2 + 9 = 0 \Rightarrow (x^2 - 1)(x^2 - 9) = 0 \Rightarrow x^2 = 1$ or $x^2 = 0 \Rightarrow x = \pm 1, \pm 3$

**28.** $x^4 - 2x^2 + 1 = 0 \Rightarrow (x^2 - 1)^2 = 0$

$\Rightarrow x = \pm 1$

**29.** $x^4 + x^2 - 1 = 0 \Rightarrow x^2 = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a} \Rightarrow x^2 = \dfrac{-1 \pm \sqrt{5}}{2} \Rightarrow x = \pm\sqrt{\dfrac{-1 \pm \sqrt{5}}{2}}$

**30.** $x^3 + 2x^2 + x = 0 \Rightarrow x(x^2 + 2x + 1) = 0 \Rightarrow x(x + 1)^2 = 0 \Rightarrow x = 0, -1$

**31.** $x^3 + 16x^2 + 11x + 6 = 0 \Rightarrow (x + 1)(x + 2)(x + 3) = 0 \Rightarrow x = -1, -2, -3$

**32.** $x^3 - 6x^2 + 12x - 8 = 0 \Rightarrow (x - 2)^3 = 0 \Rightarrow x = 2$

**33.** $x^3 + 4x^2 + 4x + 3 = 0 \Rightarrow (x + 3)(x^2 + x + 1) = 0 \Rightarrow x = -3$
(For $x^2 + x + 1 = 0$, $\Delta = b^2 - 4ac = -3 < 0$, so there are no real solutions to this quadratic equation.)

**34.** $y^3 + 64 = 0 \Rightarrow y^3 = -64 \Rightarrow y = \sqrt[3]{-64} = -4$

**35.** $x^3 - 1 = 0 \Rightarrow x^3 = 1 \Rightarrow x = \sqrt[3]{1} = 1$

**36.** $x^3 - 27 = 0$

$\Rightarrow x^3 = 27 \Rightarrow x = \sqrt[3]{27} = 3$

**37.** $y^3 + 3y^2 + 3y + 2 = 0 \Rightarrow (y + 2)(y^2 + y + 1) = 0 \Rightarrow y = -2$
(For $y^2 + y + 1 = 0$, $\Delta = b^2 - 4ac = -3 < 0$, so there are no real solutions to this quadratic equation.)

**38.** $y^3 - 2y^2 - 2y - 3 = 0 \Rightarrow (y - 3)(y^2 + y + 1) = 0 \Rightarrow y = 3$
(For $y^2 + y + 1 = 0$, $\Delta = b^2 - 4ac = -3 < 0$, so there are no real solutions to this quadratic equation.)

**39.** $x^3 - x^2 - 5x + 5 = 0 \Rightarrow (x - 1)(x^2 - 5) = 0 \Rightarrow x = 1, \pm\sqrt{5}$

**40.** $x^3 - x^2 - 3x + 3 = 0 \Rightarrow (x - 1)(x^2 - 3) = 0 \Rightarrow x = 1, \pm\sqrt{3}$

## Solutions Section 0.6

**41.** $2x^6 - x^4 - 2x^2 + 1 = 0 \Rightarrow (2x^2 - 1)(x^4 - 1) = 0 \Rightarrow (2x^2 - 1)(x^2 - 1)(x^2 + 1) = 0$

(Think of the cubic you get by substituting $y$ for $x^2$)

$\Rightarrow x = \pm 1, \ \pm \dfrac{1}{\sqrt{2}}$

**42.** $3x^6 - x^4 - 12x^2 + 4 = 0 \Rightarrow (3x^2 - 1)(x^4 - 4) = 0$

$\Rightarrow (3x^2 - 1)(x^2 - 2)(x^2 + 2) = 0$

(Think of the cubic you get by substituting $y$ for $x^2$)

$\Rightarrow x = \pm\sqrt{2}, \ \pm \dfrac{1}{\sqrt{3}}$

**43.** $(x^2 + 3x + 2)(x^2 - 5x + 6) = 0 \Rightarrow (x + 2)(x + 1)(x - 2)(x - 3) = 0$

$\Rightarrow x = -2, -1, 2, 3$

**44.** $(x^2 - 4x + 4)^2(x^2 + 6x + 5)^3 = 0 \Rightarrow (x - 2)^4(x + 1)^3(x + 5)^3 = 0$

$\Rightarrow x = -5, -1, 2$

## Section 0.7

**1.** $x^4 - 3x^3 = 0$, $x^3(x-3) = 0$, $x = 0, 3$

**2.** $x^6 - 9x^4 = 0$, $x^4(x^2-9) = 0$, $x = 0, \pm 3$

**3.** $x^4 - 4x^2 = -4$, $x^4 - 4x^2 + 4 = 0$, $(x^2-2)^2 = 0$, $x = \pm\sqrt{2}$

**4.** $x^4 - x^2 = 6$, $x^4 - x^2 - 6 = 0$, $(x^2-3)(x^2+2) = 0$, $x = \pm\sqrt{3}$

**5.** $(x+1)(x+2) + (x+1)(x+3) = 0$, $(x+1)(x+2+x+3) = 0$,
$(x+1)(2x+5) = 0$, $x = -1, -5/2$

**6.** $(x+1)(x+2)^2 + (x+1)^2(x+2) = 0$, $(x+1)(x+2)(x+2+x+1) = 0$,
$(x+1)(x+2)(2x+3) = 0$, $x = -1, -2, -3/2$

**7.** $(x^2+1)^5(x+3)^4 + (x^2+1)^6(x+3)^3 = 0$,
$(x^2+1)^5(x+3)^3(x+3+x^2+1) = 0$,
$(x^2+1)^5(x+3)^3(x^2+x+4) = 0$, $x = -3$
(Neither $x^2+1 = 0$ nor $x^2+x+4 = 0$ has a real solution.)

**8.** $10x(x^2+1)^4(x^3+1)^5 - 10x^2(x^2+1)^5(x^3+1)^4 = 0$,
$10x(x^2+1)^4(x^3+1)^4[x^3+1-x(x^2+1)] = 0$,
$10x(x^2+1)^4(x^3+1)^4(1-x) = 0$, $x = -1, 0, 1$

**9.** $(x^3+1)\sqrt{x+1} - (x^3+1)^2\sqrt{x+1} = 0$,
$(x^3+1)\sqrt{x+1}\,[1-(x^3+1)] = 0$,
$-x^3(x^3+1)\sqrt{x+1} = 0$, $x = 0, -1$

**10.** $(x^2+1)\sqrt{x+1} - \sqrt{(x+1)^3} = 0$,
$\sqrt{x+1}\,[x^2+1-(x+1)] = 0$,
$(x^2-x)\sqrt{x+1} = 0$, $x(x-1)\sqrt{x+1} = 0$, $x = -1, 0, 1$

**11.** $\sqrt{(x+1)^3} + \sqrt{(x+1)^5} = 0$,
$\sqrt{(x+1)^3}\,(1+x+1) = 0$,
$(x+2)\sqrt{(x+1)^3} = 0$, $x = -1$
($x = -2$ is not a solution because $\sqrt{(x+1)^3}$ is not defined for $x = -2$.)

**12.** $(x^2+1)\sqrt[3]{(x+1)^4} - \sqrt[3]{(x+1)^7} = 0$,
$\sqrt[3]{(x+1)^4}\,[x^2+1-(x+1)] = 0$,
$(x^2-x)\sqrt[3]{(x+1)^4} = 0$, $x(x-1)\sqrt[3]{(x+1)^4} = 0$,
$x = -1, 0, 1$

**13.** $(x+1)^2(2x+3) - (x+1)(2x+3)^2 = 0$,
$(x+1)(2x+3)(x+1-2x-3) = 0$,
$(x+1)(2x+3)(-x-2) = 0$,
$x = -2, -3/2, -1$

**14.** $(x^2-1)^2(x+2)^3-(x^2-1)^3(x+2)^2=0,$
$(x^2-1)^2(x+2)^2(x+2-x^2+1)=0,$
$-(x^2-1)^2(x+2)^2(x^2-x-3)=0,$
$x=-2,-1,1,(1\pm\sqrt{13})/2$

**15.** $\dfrac{(x+1)^2(x+2)^3-(x+1)^3(x+2)^2}{(x+2)^6}=0,$
$\dfrac{(x+1)^2(x+2)^2[(x+2)-(x+1)]}{(x+2)^6}=0,$
$\dfrac{(x+1)^2}{(x+2)^4}=0,\ (x+1)^2=0,\ x=-1$

**16.** $\dfrac{6x(x^2+1)^2(x^2+2)^4-8x(x^2+1)^3(x^2+2)^3}{(x^2+2)^8}=0,$
$\dfrac{2x(x^2+1)^2(x^2+2)^3[3(x^2+2)-4(x^2+1)]}{(x^2+2)^8}=0,$
$\dfrac{-2x(x^2+1)^2(x^2-2)}{(x^2+2)^5}=0,$
$-2x(x^2+1)^2(x^2-2)=0,\ x=0,\pm\sqrt{2}$

**17.** $\dfrac{2(x^2-1)\sqrt{x^2+1}-\frac{x^4}{\sqrt{x^2+1}}}{x^2+1}=0,\ \dfrac{2(x^2-1)(x^2+1)-x^4}{(x^2+1)\sqrt{x^2+1}}=0,$
$\dfrac{x^4-2}{(x^2+1)\sqrt{x^2+1}}=0,\ x^4-2=0,\ x=\pm\sqrt[4]{2}$

**18.** $\dfrac{4x\sqrt{x^3-1}-\frac{3x^4}{\sqrt{x^3-1}}}{x^3-1}=0,\ \dfrac{4x(x^3-1)-3x^4}{(x^3-1)\sqrt{x^3-1}}=0,$
$\dfrac{x^4-4x}{(x^3-1)\sqrt{x^3-1}}=0,\ x^4-4x=0,\ x(x^3-4)=0,\ x=0,\pm\sqrt[3]{4}$

**19.** $x-\dfrac{1}{x}=0,\ x^2-1=0,\ x=\pm1$

**20.** $1-\dfrac{4}{x^2}=0,\ x^2-4=0,\ x=\pm2$

**21.** $\dfrac{1}{x}-\dfrac{9}{x^3}=0,\ x^2-9=0,\ x=\pm3$

**22.** $\dfrac{1}{x^2}-\dfrac{1}{x+1}=0,\ x+1-x^2=0,\ x^2-x-1=0,\ x=(1\pm\sqrt{5})/2$

**23.** $\dfrac{x-4}{x+1}-\dfrac{x}{x-1}=0,\ \dfrac{(x-4)(x-1)-x(x+1)}{(x+1)(x-1)}=0,$
$\dfrac{-6x+4}{(x+1)(x-1)}=0,\ -6x+4=0,\ x=2/3$

**24.** $\dfrac{2x-3}{x-1}-\dfrac{2x+3}{x+1}=0,\ \dfrac{(2x-3)(x+1)-(2x+3)(x-1)}{(x-1)(x+1)}=0,$

$\dfrac{-2x}{(x-1)(x+1)}=0,\ -2x=0,\ x=0$

**25.** $\dfrac{x+4}{x+1}+\dfrac{x+4}{3x}=0,\ \dfrac{3x(x+4)+(x+1)(x+4)}{3x(x+1)}=0,$

$\dfrac{(x+4)(3x+x+1)}{3x(x+1)}=0,\ \dfrac{(x+4)(4x+1)}{3x(x+1)}=0,$

$(x+4)(4x+1)=0,\ x=-4,\ -1/4$

**26.** $\dfrac{2x-3}{x}-\dfrac{2x-3}{x+1}=0,\ \dfrac{(2x-3)(x+1)-x(2x-3)}{x(x+1)}=0,$

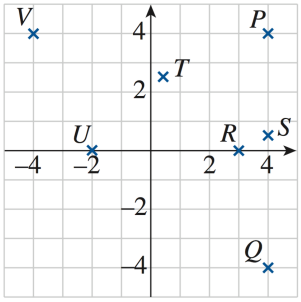
$\dfrac{(2x-3)(x+1-x)}{x(x+1)}=0,\ \dfrac{(2x-3)}{x(x+1)}=0,\ 2x-3=0,\ x=3/2$

## Section 0.8

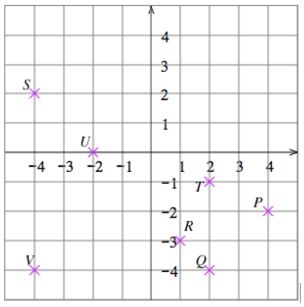
**1.** $P(0,2), Q(4,-2), R(-2,3), S(-3.5,-1.5), T(-2.5,0), U(2,2.5)$

**2.** $P(-2,2), Q(3.5,2), R(0,-3), S(-3.5,-1.5), T(2.5,0), U(-2,2.5)$

**3.**



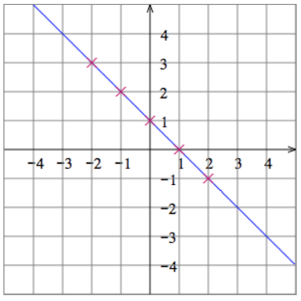

**4.**




**5.** Solve the equation $x + y = 1$ for $y$ to get $y = 1 - x$. Then plot some points:

| $x$ | $-2$ | $-1$ | $0$ | $1$ | $2$ |
|---|---|---|---|---|---|
| $y = 1 - x$ | $3$ | $2$ | $1$ | $0$ | $-1$ |

Graph:

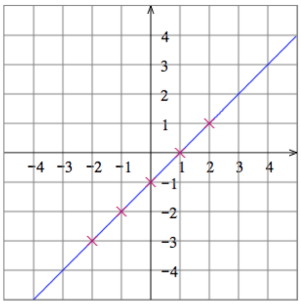


**6.** Solve the equation $y - x = -1$ for $y$ to get $y = -1 + x$. Then plot some points:

| $x$ | $-2$ | $-1$ | $0$ | $1$ | $2$ |
|---|---|---|---|---|---|
| $y = -1 + x$ | $-3$ | $-2$ | $-1$ | $0$ | $1$ |

## Solutions Section 0.8

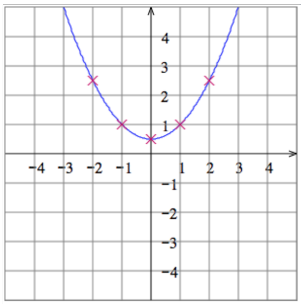
Graph:



**7.** Solve the equation $2y - x^2 = 1$ for $y$ to get $y = \dfrac{1+x^2}{2}$. Then plot some points:

| $x$ | $-2$ | $-1$ | $0$ | $1$ | $2$ |
|---|---|---|---|---|---|
| $y = \dfrac{1+x^2}{2}$ | 2.5 | 1 | 0.5 | 1 | 2.5 |

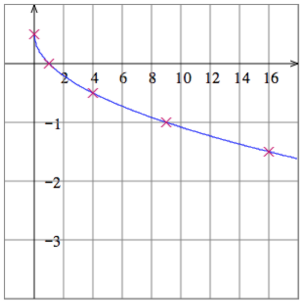
Graph:



**8.** Solve the equation $2y + \sqrt{x} = 1$ for $y$ to get $y = \dfrac{1-\sqrt{x}}{2}$. Then plot some points:

| $x$ | 0 | 1 | 4 | 9 | 16 |
|---|---|---|---|---|---|
| $y = \dfrac{1-\sqrt{x}}{2}$ | 0.5 | 0 | $-0.5$ | $-1$ | $-1.5$ |

Graph:

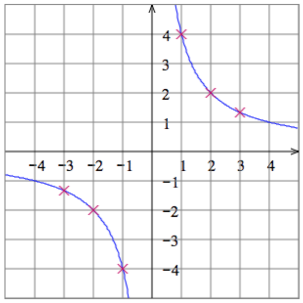


## Solutions Section 0.8

**9.** Solve the equation $xy = 4$ for $y$ to get $y = \dfrac{4}{x}$. Then plot some points:

| $x$ | $-3$ | $-2$ | $-1$ | $1$ | $2$ | $3$ |
|---|---|---|---|---|---|---|
| $y = \dfrac{4}{x}$ | $-\frac{4}{3}$ | $-2$ | $-4$ | $4$ | $2$ | $\frac{4}{3}$ |

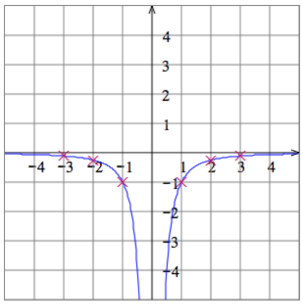
Graph:



**10.** Solve the equation $x^2y = -1$ for $y$ to get $y = -\dfrac{1}{x^2}$. Then plot some points:

| $x$ | $-3$ | $-2$ | $-1$ | $1$ | $2$ | $3$ |
|---|---|---|---|---|---|---|
| $y = -\dfrac{1}{x^2}$ | $-\frac{1}{9}$ | $-\frac{1}{4}$ | $-1$ | $-1$ | $-\frac{1}{4}$ | $-\frac{1}{9}$ |

Graph:

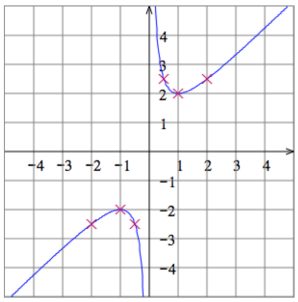


**11.** Solve the equation $xy = x^2 + 1$ for $y$ to get $y = x + \dfrac{1}{x}$. Then plot some points:

| $x$ | $-2$ | $-1$ | $-\frac{1}{2}$ | $\frac{1}{2}$ | $1$ | $2$ |
|---|---|---|---|---|---|---|
| $y = x + \dfrac{1}{x}$ | $-\frac{5}{2}$ | $-2$ | $-\frac{5}{2}$ | $\frac{5}{2}$ | $2$ | $\frac{5}{2}$ |

## Solutions Section 0.8

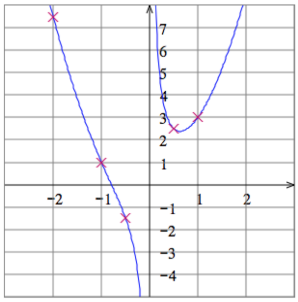
Graph:



**12.** Solve the equation $xy = 2x^3 + 1$ for $y$ to get $y = 2x^2 + \frac{1}{x}$. Then plot some points:

| $x$ | $-2$ | $-1$ | $-\frac{1}{2}$ | $\frac{1}{2}$ | $1$ | $2$ |
|---|---|---|---|---|---|---|
| $y = 2x^2 + \frac{1}{x}$ | $\frac{15}{2}$ | $1$ | $-\frac{3}{2}$ | $\frac{5}{2}$ | $3$ | $\frac{17}{2}$ |

Graph:



**13.** $\sqrt{(2-1)^2 + (-2+1)^2} = \sqrt{2}$

**14.** $\sqrt{(6-1)^2 + (1-0)^2} = \sqrt{26}$

**15.** $\sqrt{(0-a)^2 + (b-0)^2} = \sqrt{a^2 + b^2}$

**16.** $\sqrt{(b-a)^2 + (b-0)^2} = \sqrt{2(b-a)^2}$ or $\sqrt{2}|b-a|$

**17.** Set the two distances equal and solve:

$$\sqrt{(1-0)*2 + (k-0)^2} = \sqrt{(1-2)^2 + (k-1)^2}$$
$$\Rightarrow \sqrt{1+k^2} = \sqrt{2-2k+k^2}$$
$$\Rightarrow 1 + k^2 = 2 - 2k + k^2$$
$$\Rightarrow 2k = 1 \Rightarrow k = \frac{1}{2}$$

**18.** Set the two distances equal and solve:

$$\sqrt{(k+1)*2 + (k-0)^2} = \sqrt{(k-0)^2 + (k-2)^2}$$
$$\Rightarrow \sqrt{2k^2+2k+1} = \sqrt{2k^2-4k+4}$$
$$\Rightarrow 2k^2 + 2k + 1 = 2k^2 - 4k + 4$$
$$\Rightarrow 6k = 3 \Rightarrow k = \frac{1}{2}$$

**19.** Circle with center $(0, 0)$ and radius 3.

**20.** The single point $(0, 0)$.

## Section 0.9

**1.**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Exponential Form** | $10^2 = 100$ | $4^3 = 64$ | $4^4 = 256$ | $0.45^0 = 1$ | $8^{1/2} = 2\sqrt{2}$ | $4^{-3} = \frac{1}{64}$ |
| **Logarithmic Form** | $\log_{10} 100 = 2$ | $\log_4 64 = 3$ | $\log_4 256 = 4$ | $\log_{0.45} 1 = 0$ | $\log_8 2\sqrt{2} = \frac{1}{2}$ | $\log_4\left(\frac{1}{64}\right) = -3$ |

**2.**

| | | | |
|---|---|---|---|
| **Exponential Form** | $10^1 = 10$ | $5^5 = 3{,}125$ | $6^3 = 216$ |
| **Logarithmic Form** | $\log_{10} 10 = 1$ | $\log_5 3{,}125 = 5$ | $\log_6 216 = 3$ |
| **Exponential Form** | $0.5^3 = 0.125$ | $4^{1/4} = \sqrt{2}$ | $3^{-4} = \frac{1}{81}$ |
| **Logarithmic Form** | $\log_{0.5} 0.125 = 3$ | $\log_4 \sqrt{2} = \frac{1}{4}$ | $\log_3\left(\frac{1}{81}\right) = -4$ |

**3.**

| | | | |
|---|---|---|---|
| **Exponential Form** | $0.3^2 = 0.09$ | $\left(\frac{1}{2}\right)^0 = 1$ | $10^{-3} = 0.001$ |
| **Logarithmic Form** | $\log_{0.3} 0.09 = 2$ | $\log_{1/2} 1 = 0$ | $\log_{10} 0.001 = -3$ |
| **Exponential Form** | $9^{-2} = \frac{1}{81}$ | $2^{10} = 1{,}024$ | $64^{-1/3} = \frac{1}{4}$ |
| **Logarithmic Form** | $\log_9 \frac{1}{81} = -2$ | $\log_2 1{,}024 = 10$ | $\log_{64} \frac{1}{4} = -\frac{1}{3}$ |

**4.**

| | | | |
|---|---|---|---|
| **Exponential Form** | $2^{-1} = \frac{1}{2}$ | $10^5 = 100{,}000$ | $10^{-5} = 0.00001$ |
| **Logarithmic Form** | $\log_2 \frac{1}{2} = -1$ | $\log_{10} 100{,}000 = 5$ | $\log_{10} 0.00001 = -5$ |
| **Exponential Form** | $2^{11} = 2{,}048$ | $16^{-1/4} = \frac{1}{2}$ | $0.25^2 = 0.0625$ |
| **Logarithmic Form** | $\log_2 2{,}048 = 11$ | $\log_{16} \frac{1}{2} = -\frac{1}{4}$ | $\log_{0.25} 0.0625 = 2$ |

**5.** $\log_4 16$ = the power to which we need to raise 4 in order to get 16. Because $4^{\boxed{2}} = 16$, this power is 2, so $\log_4 16 = 2$.

**6.** $\log_5 125$ = the power to which we need to raise 5 in order to get 125. Because $5^{\boxed{3}} = 125$, this power is 3, so $\log_5 125 = 3$.

**7.** $\log_5 \frac{1}{25}$ = the power to which we need to raise 5 in order to get $\frac{1}{25}$. Because $5^{\boxed{-2}} = \frac{1}{25}$, this power is $-2$, so $\log_5 \frac{1}{25} = -2$.

**8.** $\log_4 \frac{1}{64}$ = the power to which we need to raise 4 in order to get $\frac{1}{64}$. Because $4^{\boxed{-3}} = \frac{1}{64}$, this power is $-3$, so $\log_4 \frac{1}{64} = -3$.

## Solutions Section 0.9

**9.** $\log 100{,}000 = \log_{10} 100{,}000$ = the power to which we need to raise 10 in order to get 100,000. Because $10^{\boxed{5}} = 100{,}000$, this power is 5, so $\log 100{,}000 = 5$.

**10.** $\log 1{,}000 = \log_{10} 1{,}000$ = the power to which we need to raise 10 in order to get 1,000. Because $10^{\boxed{3}} = 1{,}000$, this power is 3, so $\log 1{,}000 = 3$.

**11.** $\log_{16} 16$ = the power to which we need to raise 16 in order to get 16. Because $16^{\boxed{1}} = 16$, this power is 1, so $\log_{16} 16 = 1$.

**12.** $\log_{1/2} \frac{1}{2}$ = the power to which we need to raise $\frac{1}{2}$ in order to get $\frac{1}{2}$. Because $\left(\frac{1}{2}\right)^{\boxed{1}} = \frac{1}{2}$, this power is 1, so $\log_{1/2} \frac{1}{2} = 1$.

**13.** $\log_4 \frac{1}{16}$ = the power to which we need to raise 4 in order to get $\frac{1}{16}$. Because $4^{\boxed{-2}} = \frac{1}{16}$, this power is $-2$, so $\log_4 \frac{1}{16} = -2$.

**14.** $\log_2 \frac{1}{8}$ = the power to which we need to raise 2 in order to get $\frac{1}{8}$. Because $2^{\boxed{-3}} = \frac{1}{8}$, this power is $-3$, so $\log_2 \frac{1}{8} = -3$.

**15.** $\log_2 \sqrt{2}$ = the power to which we need to raise 2 in order to get $\sqrt{2}$. Because $2^{\boxed{1/2}} = \sqrt{2}$, this power is $\frac{1}{2}$, so $\log_2 \sqrt{2} = \frac{1}{2}$.

**16.** $\log_4 \sqrt{2}$ = the power to which we need to raise 4 in order to get $\sqrt{2}$. Because $4^{\boxed{1/4}} = \sqrt{2}$, this power is $\frac{1}{4}$, so $\log_4 \sqrt{2} = \frac{1}{4}$.

**17.** By Identity (1), $\log_b 3 + \log_b 4 = \log_b(3 \times 4) = \log_b \boxed{12}$.

**18.** By Identity (2), $\log_b 3 - \log_b 4 = \log_b \boxed{\frac{3}{4}}$.

**19.** $\log_b 2 - \log_b 5 - \log_b 4 = \log_b 2 - (\log_b 5 + \log_b 4) = \log_b 2 - (\log_b(5 \times 4))$ (Identity 1)
$= \log_b\left(\frac{2}{5 \times 4}\right)$ (Identity 2) $= \log_b \boxed{\frac{1}{10}}$

**20.** $\log_b 3 + \log_b 2 - \log_b 7 = \log_b(3 \times 2) - \log_b 7$ (Identity 1) $= \log_b\left(\frac{3 \times 2}{7}\right)$ (Identity 2) $= \log_b \boxed{\frac{6}{7}}$

**21.** $\log_b 3 - 3 \log_b 2 = \log_b 3 - \log_b 2^3$ (Identity 3) $= \log_b\left(\frac{3}{2^3}\right)$ (Identity 2) $= \log_b \boxed{\frac{3}{8}}$

**22.** $3 \log_b 2 + 2 \log_b 3 = \log_b 2^3 + \log_b 3^2$ (Identity 3) $= \log_b(2^3 \times 3^2)$ (Identity 1) $= \log_b \boxed{72}$

**23.** $4 \log_b x + 5 \log_b y = \log_b x^4 + \log_b y^5$ (Identity 3) $= \log_b \boxed{x^4 y^5}$ (Identity 1)

**24.** $3\log_b p - 2\log_b q = \log_b p^3 - \log_b q^2$ (Identity 3) $= \log_b \boxed{\dfrac{p^3}{q^2}}$ (Identity 2)

**25.** $2\log_b x + 3\log_b y - 4\log_b z = \log_b x^2 + \log_b y^3 - \log_b z^4$ (Identity 3)

$= \log_b(x^2y^3) - \log_b z^4$ (Identity 1) $= \log_b \boxed{\dfrac{x^2y^3}{z^4}}$ (Identity 2)

**26.** $4\log_b p - 3\log_b q - 2\log_b r = \log_b p^4 - \log_b q^3 - \log_b r^2$ (Identity 3)

$= \log_b p^4 - (\log_b q^3 + \log_b r^2) = \log_b p^4 - \log_b(q^3r^2)$ (Identity 1) $= \log_b \boxed{\dfrac{p^4}{q^3r^2}}$ (Identity 2)

**27.** $x\log_b 2 - 2\log_b x = \log_b 2^x - \log_b x^2$ (Identity 3) $= \log_b \boxed{\dfrac{2^x}{x^2}}$ (Identity 2)

**28.** $p\log_b q + q\log_b p = \log_b q^p + \log_b p^q$ (Identity 3) $= \log_b \boxed{q^p p^q}$ (Identity 1)

**29.** $\log 21 = \log(3 \times 7) = \log 3 + \log 7 = b + c$ (Identity 1)

**30.** $\log 14 = \log(2 \times 7) = \log 2 + \log 7 = a + c$ (Identity 1)

**31.** $\log 42 = \log(2 \times 3 \times 7) = \log 2 + \log 3 + \log 7 = a + b + c$ (Identity 1)

**32.** $\log 28 = \log(2 \times 2 \times 7) = \log 2 + \log 2 + \log 7 = 2a + c$ (Identity 1)

**33.** $\log\left(\dfrac{1}{7}\right) = -\log 7 = -c$ (Identity 5)

**34.** $\log\left(\dfrac{1}{3}\right) = -\log 3 = -b$ (Identity 5)

**35.** $\log\left(\dfrac{2}{3}\right) = \log 2 - \log 3 = a - b$ (Identity 2)

**36.** $\log\left(\dfrac{7}{2}\right) = \log 7 - \log 2 = c - a$ (Identity 2)

**37.** $\log\left(\dfrac{4}{7}\right) = \log 4 - \log 7$ (Identity 2) $= \log 2 + \log 2 - \log 7$ (Identity 1) $= 2a - c$

**38.** $\log\left(\dfrac{2}{9}\right) = \log 2 - \log 9$ (Identity 2) $= \log 2 - (\log 3 + \log 3)$ (Identity 1) $= a - 2b$

**39.** $\log 16 = \log 2^4 = 4\log 2 = 4a$ (Identity 3)

**40.** $\log 81 = \log 3^4 = 4\log 3 = 4b$ (Identity 3)

**41.** $\log 0.03 = \log\left(\dfrac{3}{10^2}\right) = \log 3 - \log 10^2 = \log 3 - 2\log 10 = b - 2$

**42.** $\log 7{,}000 = \log(7 \times 10^3) = \log 7 + \log 10^3 = \log 7 + 3\log 10 = c + 3$

**43.** $\log 5 = \log\left(\frac{10}{2}\right) = \log 10 - \log 2 = 1 - a$ (Identity 2)

**44.** $\log 25 = \log\left(\frac{100}{4}\right) = \log 100 - \log 4 = \log 10^2 - \log 2^2 = 2\log 10 - 2\log 2 = 2 - 2a$

**45.** $\log \sqrt{7} = \log(7^{1/2}) = \frac{1}{2}\log 7 = \frac{c}{2}$

**46.** $\log\left(\frac{2}{\sqrt{3}}\right) = \log(2) - \log\sqrt{3} = \log(2) - \log(3^{1/2}) = \log 2 - \frac{1}{2}\log 3 = a - \frac{b}{2}$

**47.** $4 = 2^x$ is exactly the equation we solve in order to calculate $\log_2 4$; answer: 2. Alternatively, write the equation $4 = 2^x$ in logarithmic form to get $x = \log_2 4 = 2$.

**48.** $81 = 3^x$ is exactly the equation we solve in order to calculate $\log_3 81$; answer: 4. Alternatively, write the equation $81 = 3^x$ in logarithmic form to get $x = \log_3 81 = 4$.

**49.** Take the base 3 logarithm of both sides of the given equation $27 = 3^{2x-1}$ to get

$\log_3 27 = \log_3 3^{2x-1}$

$3 = (2x-1)\log_3 3$ By Identity 3

$3 = 2x - 1$ By Identity 4

$x = \frac{3+1}{2} = 2$ Solve for $x$.

**50.** Take the base 4 logarithm of both sides of the given equation $4^{2-3x} = 256$ to get

$\log_4 4^{2-3x} = \log_4 256$

$(2-3x)\log_4 4 = 4$ By Identity 3

$2 - 3x = 4$ By Identity 4

$x = \frac{2-4}{3} = -\frac{2}{3}$ Solve for $x$.

**51.** Take the base 5 logarithm of both sides of the given equation $5^{-x+1} = \frac{1}{125}$ to get

$\log_5 5^{-x+1} = \log_5\left(\frac{1}{125}\right)$

$(-x+1)\log_5 5 = -\log_5 125$ By Identities 3 and 5

$-x + 1 = -3$ By Identity 4

$x = 1 + 3 = 4$ Solve for $x$.

**52.** Take the base 3 logarithm of both sides of the given equation $3^{x^2-12} = \frac{1}{27}$ to get

$\log_3 3^{x^2-12} = \log_3\left(\frac{1}{27}\right)$

$(x^2-12)\log_3 3 = -\log_3 27$ By Identities 3 and 5

$x^2 - 12 = -3$ By Identity 4

$x = \pm\sqrt{9} = \pm 3$ Solve for $x$.

**53.** First divide both sides of the given equation by 50 to get $2.4 = 2^{3t}$. Take the common logarithm of both sides:

$\log 2.4 = \log(2^{3t})$

$\log 2.4 = 3t \log 2$ By Identity 3

$3t = \dfrac{\log 2.4}{\log 2}$ Divide.

$t = \dfrac{\log 2.4}{3 \log 2} \approx 0.4210$ Solve for $t$.

If instead you take the base-2 logarithm, the answer is represented as $\dfrac{\log_2(2.4)}{3}$.

**54.** First divide both sides of the given equation by 500 to get $2 = 1.1^{2t}$. Take the common logarithm of both sides:

$\log 2 = \log(1.1^{2t})$

$\log 2 = 2t \log 1.1$ By Identity 3

$2t = \dfrac{\log 2}{\log 1.1}$ Divide.

$t = \dfrac{\log 2}{2 \log 1.1} \approx 3.6363$ Solve for $t$.

**55.** First divide both sides of the given equation by 300 to get $\dfrac{10}{3} = 1.3^{4t-1}$. Take the common logarithm of both sides:

$\log\left(\dfrac{10}{3}\right) = \log(1.3^{4t-1})$

$\log 10 - \log 3 = (4t - 1) \log 1.3$ By Identities 2 and 3

$4t - 1 = \dfrac{\log 10 - \log 3}{\log 1.3}$ Divide.

$t = \dfrac{1}{4}\left(\dfrac{\log 10 - \log 3}{\log 1.3} + 1\right) \approx 1.3972$ Solve for $t$.

**56.** First divide both sides of the given equation by 700 to get $\dfrac{100}{7} = 1.04^{3t+1}$. Take the common logarithm of both sides:

$\log\left(\dfrac{100}{7}\right) = \log(1.04^{3t+1})$

$\log 100 - \log 7 = (3t + 1) \log 1.04$ By Identities 2 and 3

$3t + 1 = \dfrac{\log 100 - \log 7}{\log 1.04}$ Divide.

$t = \dfrac{1}{3}\left(\dfrac{\log 100 - \log 7}{\log 1.04} - 1\right) \approx 22.2675$ Solve for $t$.