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## Chapter 0

### Problems 0.1

1. True;  $-13$  is a negative integer.
2. True, because  $-2$  and  $7$  are integers and  $7 \neq 0$ .
3. False, because the natural numbers are  $1, 2, 3,$  and so on.
4. False, because  $0 = \frac{0}{1}$ .
5. True, because  $5 = \frac{5}{1}$ .
6. False, since a rational number cannot have denominator of zero. In fact,  $\frac{7}{0}$  is not a number at all because we cannot divide by  $0$ .
7. False, because  $\sqrt{25} = 5$ , which is a positive integer.
8. True;  $\sqrt{2}$  is an irrational real number.
9. False; we cannot divide by  $0$ .
10. False, because the natural numbers are  $1, 2, 3,$  and so on, and  $\sqrt{3}$  lies between  $1$  and  $2$ .
11. True
12. False, since the integer  $0$  is neither positive nor negative.

### Problems 0.2

1. False, because  $0$  does not have a reciprocal.
2. True, because  $\frac{7}{3} \cdot \frac{3}{7} = \frac{21}{21} = 1$ .
3. False; the negative of  $7$  is  $-7$  because  $7 + (-7) = 0$ .
4. False;  $2(3 \cdot 4) = 2(12) = 24$ , but  $(2 \cdot 3)(2 \cdot 4) = 6 \cdot 8 = 48$ .
5. False;  $-x + y = y + (-x) = y - x$ .
6. True;  $(x + 2)(4) = (x)(4) + (2)(4) = 4x + 8$ .

7. True;  $\frac{x+2}{2} = \frac{x}{2} + \frac{2}{2} = \frac{x}{2} + 1$ .

8. True, because  $a\left(\frac{b}{c}\right) = \frac{ab}{c}$ .

9. False; the left side is  $5xy$ , but the right side is  $5x^2y$ .

10. True; by the associative and commutative properties,  $x(4y) = (x \cdot 4)y = (4 \cdot x)y = 4xy$ .

11. distributive

12. commutative

13. associative

14. definition of division

15. commutative and distributive

16. associative

17. definition of subtraction

18. commutative

19. distributive

20. distributive

21.  $2x(y - 7) = (2x)y - (2x)7 = 2xy - (7)(2x)$   
 $= 2xy - (7 \cdot 2)x = 2xy - 14x$

22.  $(a - b) + c = [a + (-b)] + c = a + (-b + c)$   
 $= a + [c + (-b)] = a + (c - b)$

23.  $(x + y)(2) = 2(x + y) = 2x + 2y$

24.  $2[27 + (x + y)] = 2[27 + (y + x)] = 2[(27 + y) + x]$   
 $= 2[(y + 27) + x]$

25.  $x[(2y + 1) + 3] = x[2y + (1 + 3)] = x[2y + 4]$   
 $= x(2y) + x(4) = (x \cdot 2)y + 4x = (2x)y + 4x$   
 $= 2xy + 4x$

26.  $(1 + a)(b + c) = 1(b + c) + a(b + c)$   
 $= 1(b) + 1(c) + a(b) + a(c) = b + c + ab + ac$

$$\begin{aligned} 27. \quad x(y - z + w) &= x[(y - z) + w] = x(y - z) + x(w) \\ &= x[y + (-z)] + xw = x(y) + x(-z) + xw \\ &= xy - xz + xw \end{aligned}$$

$$28. \quad -2 + (-4) = -6$$

$$29. \quad -6 + 2 = -4$$

$$30. \quad 6 + (-4) = 2$$

$$31. \quad 7 - 2 = 5$$

$$32. \quad 7 - (-4) = 7 + 4 = 11$$

$$33. \quad -5 - (-13) = -5 + 13 = 8$$

$$34. \quad -a - (-b) = -a + b$$

$$35. \quad (-2)(9) = -(2 \cdot 9) = -18$$

$$36. \quad 7(-9) = -(7 \cdot 9) = -63$$

$$37. \quad (-2)(-12) = 2(12) = 24$$

$$38. \quad 19(-1) = (-1)19 = -(1 \cdot 19) = -19$$

$$39. \quad \frac{-1}{-\frac{1}{9}} = -1 \left( -\frac{9}{1} \right) = 9$$

$$40. \quad -(-6 + x) = -(-6) - x = 6 - x$$

$$41. \quad -7(x) = -(7x) = -7x$$

$$42. \quad -12(x - y) = (-12)x - (-12)(y) = -12x + 12y \\ \text{(or } 12y - 12x)$$

$$43. \quad -[-6 + (-y)] = -(-6) - (-y) = 6 + y$$

$$44. \quad -3 \div 15 = \frac{-3}{15} = -\frac{3}{15} = -\frac{1 \cdot 3}{5 \cdot 3} = -\frac{1}{5}$$

$$45. \quad -9 \div (-27) = \frac{-9}{-27} = \frac{9}{27} = \frac{9 \cdot 1}{9 \cdot 3} = \frac{1}{3}$$

$$46. \quad (-a) \div (-b) = \frac{-a}{-b} = \frac{a}{b}$$

$$47. \quad 2(-6 + 2) = 2(-4) = -8$$

$$48. \quad 3[-2(3) + 6(2)] = 3[-6 + 12] = 3[6] = 18$$

$$49. \quad (-2)(-4)(-1) = 8(-1) = -8$$

$$50. \quad (-12)(-12) = (12)(12) = 144$$

$$51. \quad X(1) = X$$

$$52. \quad 3(x - 4) = 3(x) - 3(4) = 3x - 12$$

$$53. \quad 4(5 + x) = 4(5) + 4(x) = 20 + 4x$$

$$54. \quad -(x - 2) = -x + 2$$

$$55. \quad 0(-x) = 0$$

$$56. \quad 8 \left( \frac{1}{11} \right) = \frac{8 \cdot 1}{11} = \frac{8}{11}$$

$$57. \quad \frac{5}{1} = 5$$

$$58. \quad \frac{14x}{21y} = \frac{2 \cdot 7 \cdot x}{3 \cdot 7 \cdot y} = \frac{2x}{3y}$$

$$59. \quad \frac{3}{-2x} = \frac{3}{-(2x)} = -\frac{3}{2x}$$

$$60. \quad \frac{2}{3} \cdot \frac{1}{x} = \frac{2 \cdot 1}{3 \cdot x} = \frac{2}{3x}$$

$$61. \quad \frac{a}{c}(3b) = \frac{a(3b)}{c} = \frac{3ab}{c}$$

$$62. \quad (5a) \left( \frac{7}{5a} \right) = 7$$

$$63. \quad \frac{-aby}{-ax} = \frac{-a \cdot by}{-a \cdot x} = \frac{by}{x}$$

$$64. \quad \frac{7}{y} \cdot \frac{1}{x} = \frac{7 \cdot 1}{y \cdot x} = \frac{7}{xy}$$

$$65. \quad \frac{2}{x} \cdot \frac{5}{y} = \frac{2 \cdot 5}{x \cdot y} = \frac{10}{xy}$$

$$66. \quad \frac{1}{2} + \frac{1}{3} = \frac{3}{6} + \frac{2}{6} = \frac{3+2}{6} = \frac{5}{6}$$

$$67. \quad \frac{5}{12} + \frac{3}{4} = \frac{5}{12} + \frac{9}{12} = \frac{5+9}{12} = \frac{14}{12} = \frac{2 \cdot 7}{2 \cdot 6} = \frac{7}{6}$$

$$68. \quad \frac{3}{10} - \frac{7}{15} = \frac{9}{30} - \frac{14}{30} = \frac{9-14}{30} = \frac{-5}{30} = -\frac{5 \cdot 1}{5 \cdot 6} = -\frac{1}{6}$$

$$69. \frac{4}{5} + \frac{6}{5} = \frac{4+6}{5} = \frac{10}{5} = 2$$

$$70. \frac{X}{\sqrt{5}} - \frac{Y}{\sqrt{5}} = \frac{X-Y}{\sqrt{5}}$$

$$71. \frac{3}{2} - \frac{1}{4} + \frac{1}{6} = \frac{18}{12} - \frac{3}{12} + \frac{2}{12} = \frac{18-3+2}{12} = \frac{17}{12}$$

$$72. \frac{2}{5} - \frac{3}{8} = \frac{16}{40} - \frac{15}{40} = \frac{16-15}{40} = \frac{1}{40}$$

$$73. \frac{6}{\frac{x}{y}} = 6 \div \frac{x}{y} = 6 \cdot \frac{y}{x} = \frac{6y}{x}$$

$$74. \frac{\frac{l}{3}}{m} = \frac{l}{3} \div \frac{m}{1} = \frac{l}{3} \cdot \frac{1}{m} = \frac{l}{3m}$$

$$75. \frac{\frac{-x}{y^2}}{\frac{z}{xy}} = -\frac{x}{y^2} \div \frac{z}{xy} = -\frac{x}{y^2} \cdot \frac{xy}{z} = -\frac{x^2}{yz}$$

$$76. \frac{7}{0} \text{ is not defined (we cannot divide by 0).}$$

$$77. \frac{0}{7} = 0$$

$$78. \frac{0}{0} \text{ is not defined (we cannot divide by 0).}$$

$$79. 0 \cdot 0 = 0$$

**Problems 0.3**

$$1. (2^3)(2^2) = 2^{3+2} = 2^5 (= 32)$$

$$2. x^6 x^9 = x^{6+9} = x^{15}$$

$$3. w^4 w^8 = w^{4+8} = w^{12}$$

$$4. z^3 z z^2 = z^{3+1+2} = z^6$$

$$5. \frac{x^3 x^5}{y^9 y^5} = \frac{x^{3+5}}{y^{9+5}} = \frac{x^8}{y^{14}}$$

$$6. (x^{12})^4 = x^{12 \cdot 4} = x^{48}$$

$$7. \frac{(a^3)^7}{(b^4)^5} = \frac{a^{3 \cdot 7}}{b^{4 \cdot 5}} = \frac{a^{21}}{b^{20}}$$

$$8. \left(\frac{x^2}{y^3}\right)^5 = \frac{(x^2)^5}{(y^3)^5} = \frac{x^{2 \cdot 5}}{y^{3 \cdot 5}} = \frac{x^{10}}{y^{15}}$$

$$9. (2x^2 y^3)^3 = 2^3 (x^2)^3 (y^3)^3 = 8x^{2 \cdot 3} y^{3 \cdot 3} = 8x^6 y^9$$

$$10. \left(\frac{w^2 s^3}{y^2}\right)^2 = \frac{(w^2 s^3)^2}{(y^2)^2} = \frac{(w^2)^2 (s^3)^2}{y^{2 \cdot 2}} = \frac{w^{2 \cdot 2} s^{3 \cdot 2}}{y^4} \\ = \frac{w^4 s^6}{y^4}$$

$$11. \frac{x^9}{x^5} = x^{9-5} = x^4$$

$$12. \left(\frac{2a^4}{7b^5}\right)^6 = \frac{(2a^4)^6}{(7b^5)^6} \\ = \frac{2^6 (a^4)^6}{7^6 (b^5)^6} \\ = \frac{64a^{4 \cdot 6}}{117,649b^{5 \cdot 6}} \\ = \frac{64a^{24}}{117,649b^{30}}$$

$$13. \frac{(x^3)^6}{x(x^3)} = \frac{x^{3 \cdot 6}}{x^{1+3}} = \frac{x^{18}}{x^4} = x^{18-4} = x^{14}$$

$$14. \frac{(x^2)^3 (x^3)^2}{(x^3)^4} = \frac{x^{2 \cdot 3} x^{3 \cdot 2}}{x^{3 \cdot 4}} = \frac{x^6 x^6}{x^{12}} = \frac{x^{12}}{x^{12}} \\ x^{12-12} = x^0 = 1$$

$$15. \sqrt{25} = 5$$

$$16. \sqrt[4]{81} = 3$$

$$17. \sqrt[3]{-128} = -2$$

$$18. \sqrt{0.04} = 0.2$$

$$19. \sqrt[4]{\frac{1}{16}} = \frac{\sqrt[4]{1}}{\sqrt[4]{16}} = \frac{1}{2}$$

$$20. \sqrt[3]{\frac{-8}{27}} = \frac{\sqrt[3]{-8}}{\sqrt[3]{27}} = \frac{-2}{3} = -\frac{2}{3}$$

$$21. (49)^{1/2} = \sqrt{49} = 7$$

$$22. (64)^{1/3} = \sqrt[3]{64} = 4$$

$$23. 9^{3/2} = (\sqrt{9})^3 = (3)^3 = 27$$

$$24. (9)^{-5/2} = \frac{1}{(9)^{5/2}} = \frac{1}{(\sqrt{9})^5} = \frac{1}{3^5} = \frac{1}{243}$$

$$25. (32)^{-2/5} = \frac{1}{(32)^{2/5}} = \frac{1}{(\sqrt[5]{32})^2} = \frac{1}{(2)^2} = \frac{1}{4}$$

$$26. (0.09)^{-1/2} = \frac{1}{(0.09)^{1/2}} = \frac{1}{\sqrt{0.09}} = \frac{1}{0.3} \\ = \frac{1}{\frac{3}{10}} = \frac{10}{3}$$

$$27. \left(\frac{1}{32}\right)^{4/5} = \left(\sqrt[5]{\frac{1}{32}}\right)^4 = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$$

$$28. \left(-\frac{64}{27}\right)^{2/3} = \left(\sqrt[3]{-\frac{64}{27}}\right)^2 = \left(-\frac{4}{3}\right)^2 = \frac{16}{9}$$

$$29. \sqrt{50} = \sqrt{25 \cdot 2} = \sqrt{25} \cdot \sqrt{2} = 5\sqrt{2}$$

$$30. \sqrt[3]{54} = \sqrt[3]{27 \cdot 2} = \sqrt[3]{27} \sqrt[3]{2} = 3\sqrt[3]{2}$$

$$31. \sqrt[3]{2x^3} = \sqrt[3]{2} \sqrt[3]{x^3} = x \sqrt[3]{2}$$

$$32. \sqrt{4x} = \sqrt{4} \sqrt{x} = 2\sqrt{x}$$

$$33. \sqrt{16x^4} = \sqrt{16} \sqrt{x^4} = 4x^2$$

$$34. \sqrt[4]{\frac{x}{16}} = \frac{\sqrt[4]{x}}{\sqrt[4]{16}} = \frac{\sqrt[4]{x}}{2}$$

$$35. 2\sqrt{8} - 5\sqrt{27} + \sqrt[3]{128} = 2\sqrt{4 \cdot 2} - 5\sqrt{9 \cdot 3} + \sqrt[3]{64 \cdot 2} \\ = 2 \cdot 2\sqrt{2} - 5 \cdot 3\sqrt{3} + 4\sqrt[3]{2} \\ = 4\sqrt{2} - 15\sqrt{3} + 4\sqrt[3]{2}$$

$$36. \sqrt{\frac{3}{13}} = \sqrt{\frac{3}{13} \cdot \frac{13}{13}} = \sqrt{\frac{39}{13^2}} = \frac{\sqrt{39}}{\sqrt{13^2}} = \frac{\sqrt{39}}{13}$$

$$37. (9z^4)^{1/2} = \sqrt{9z^4} = \sqrt{3^2(z^2)^2} = \sqrt{3^2} \sqrt{(z^2)^2} \\ = 3z^2$$

$$38. (16y^8)^{3/4} = \left[\sqrt[4]{16y^8}\right]^3 = \left[\sqrt[4]{(2y^2)^4}\right]^3 = (2y^2)^3 \\ = 8y^6$$

$$39. \left(\frac{27t^3}{8}\right)^{2/3} = \left(\left[\frac{3t}{2}\right]^3\right)^{2/3} = \left[\frac{3t}{2}\right]^2 = \frac{9t^2}{4}$$

$$40. \left(\frac{256}{x^{12}}\right)^{-3/4} = \left(\left[\frac{4}{x^3}\right]^4\right)^{-3/4} = \left[\frac{4}{x^3}\right]^{-3} = \frac{4^{-3}}{(x^3)^{-3}} \\ = \frac{4^{-3}}{x^{-9}} = \frac{x^9}{4^3} = \frac{x^9}{64}$$

$$41. \frac{a^5 b^{-3}}{c^2} = a^5 \cdot b^{-3} \cdot \frac{1}{c^2} = a^5 \cdot \frac{1}{b^3} \cdot \frac{1}{c^2} = \frac{a^5}{b^3 c^2}$$

$$42. \sqrt[5]{x^2 y^3 z^{-10}} = x^{2/5} y^{3/5} z^{-10/5} = \frac{x^{2/5} y^{3/5}}{z^2}$$

$$43. 5m^{-2} m^{-7} = 5m^{-2+(-7)} = 5m^{-9} = \frac{5}{m^9}$$

$$44. x + y^{-1} = x + \frac{1}{y}$$

$$45. (3t)^{-2} = \frac{1}{(3t)^2} = \frac{1}{9t^2}$$

$$46. (3-z)^{-4} = \frac{1}{(3-z)^4}$$

$$47. \sqrt[5]{5x^2} = (5x^2)^{1/5} = 5^{1/5} (x^2)^{1/5} = 5^{1/5} x^{2/5}$$

$$48. (X^3 Y^{-3})^{-3} = (X^3)^{-3} (Y^{-3})^{-3} \\ = X^{-9} Y^9 \\ = \frac{Y^9}{X^9}$$

$$49. \sqrt{x} - \sqrt{y} = x^{1/2} - y^{1/2}$$

$$50. \frac{u^{-2}v^{-6}w^3}{vw^{-5}} = \frac{w^{3-(-5)}}{u^2v^{1-(-6)}} = \frac{w^8}{u^2v^7}$$

$$51. x^2\sqrt[4]{xy^{-2}z^3} = x^2(xy^{-2}z^3)^{1/4} = x^2x^{1/4}y^{-2/4}z^{3/4} \\ = \frac{x^{9/4}z^{3/4}}{y^{1/2}}$$

$$52. \sqrt[4]{a^{-3}b^{-2}}a^5b^{-4} = (a^{-3}b^{-2})^{1/4}a^5b^{-4} \\ = a^{-3/4}b^{-1/2}a^5b^{-4} \\ = a^{17/4}b^{-9/2} \\ = \frac{a^{17/4}}{b^{9/2}}$$

$$53. (2a-b+c)^{2/3} = \sqrt[3]{(2a-b+c)^2}$$

$$54. (ab^2c^3)^{3/4} = \sqrt[4]{(ab^2c^3)^3} = \sqrt[4]{a^3b^6c^9}$$

$$55. x^{-4/5} = \frac{1}{x^{4/5}} = \frac{1}{\sqrt[5]{x^4}}$$

$$56. 2x^{1/2} - (2y)^{1/2} = 2\sqrt{x} - \sqrt{2y}$$

$$57. 3w^{-3/5} - (3w)^{-3/5} = \frac{3}{w^{3/5}} - \frac{1}{(3w)^{3/5}} \\ = \frac{3}{\sqrt[5]{w^3}} - \frac{1}{\sqrt[5]{(3w)^3}} = \frac{3}{\sqrt[5]{w^3}} - \frac{1}{\sqrt[5]{27w^3}}$$

$$58. [(x^{-4})^{1/5}]^{1/6} = [x^{-4/5}]^{1/6} = x^{-4/30} = x^{-2/15} \\ = \frac{1}{x^{2/15}} = \frac{1}{\sqrt[15]{x^2}}$$

$$59. \frac{6}{\sqrt{5}} = \frac{6}{5^{1/2}} = \frac{6 \cdot 5^{1/2}}{5^{1/2} \cdot 5^{1/2}} = \frac{6\sqrt{5}}{5}$$

$$60. \frac{3}{\sqrt[4]{8}} = \frac{3}{8^{1/4}} = \frac{3 \cdot 2^{1/4}}{8^{1/4} \cdot 2^{1/4}} = \frac{3\sqrt[4]{2}}{\sqrt[4]{16}} = \frac{3\sqrt[4]{2}}{2}$$

$$61. \frac{4}{\sqrt{2x}} = \frac{4}{(2x)^{1/2}} = \frac{4(2x)^{1/2}}{(2x)^{1/2}(2x)^{1/2}} = \frac{4\sqrt{2x}}{2x} \\ = \frac{2\sqrt{2x}}{x}$$

$$62. \frac{y}{\sqrt{2y}} = \frac{y}{(2y)^{1/2}} = \frac{y(2y)^{1/2}}{(2y)^{1/2}(2y)^{1/2}} = \frac{y\sqrt{2y}}{2y} \\ = \frac{\sqrt{2y}}{2}$$

$$63. \frac{1}{\sqrt[3]{3x}} = \frac{1}{(3x)^{1/3}} = \frac{1(3x)^{2/3}}{(3x)^{1/3}(3x)^{2/3}} = \frac{\sqrt[3]{(3x)^2}}{3x} \\ = \frac{\sqrt[3]{9x^2}}{3x}$$

$$64. \frac{2}{3\sqrt[3]{y^2}} = \frac{2}{3y^{2/3}} = \frac{2 \cdot y^{1/3}}{3y^{2/3} \cdot y^{1/3}} = \frac{2y^{1/3}}{3y} = \frac{2\sqrt[3]{y}}{3y}$$

$$65. \frac{\sqrt{12}}{\sqrt{3}} = \sqrt{\frac{12}{3}} = \sqrt{4} = 2$$

$$66. \sqrt{\frac{18}{2}} = \sqrt{9} = 3$$

$$67. \frac{\sqrt[5]{2}}{\sqrt[4]{a^2b}} = \frac{\sqrt[5]{2}}{a^{2/4}b^{1/4}} = \frac{\sqrt[5]{2} \cdot a^{1/2}b^{3/4}}{a^{1/2}b^{1/4} \cdot a^{1/2}b^{3/4}} \\ = \frac{2^{1/5}a^{1/2}b^{3/4}}{ab} = \frac{2^{4/20}a^{10/20}b^{15/20}}{ab} \\ = \frac{(2^4a^{10}b^{15})^{1/20}}{ab} = \frac{\sqrt[20]{16a^{10}b^{15}}}{ab}$$

$$68. \frac{\sqrt{2}}{\sqrt[3]{3}} = \frac{\sqrt{2}}{3^{1/3}} = \frac{2^{1/2} \cdot 3^{2/3}}{3^{1/3} \cdot 3^{2/3}} = \frac{2^{3/6}3^{4/6}}{3} \\ = \frac{(2^33^4)^{1/6}}{3} = \frac{\sqrt[6]{648}}{3}$$

$$69. 2x^2y^{-3}x^4 = 2x^6y^{-3} = \frac{2x^6}{y^3}$$

$$70. \frac{3}{u^{5/2}v^{1/2}} = \frac{3 \cdot u^{1/2}v^{1/2}}{u^{5/2}v^{1/2} \cdot u^{1/2}v^{1/2}} = \frac{3u^{1/2}v^{1/2}}{u^3v}$$

$$71. \frac{\sqrt{243}}{\sqrt{3}} = \sqrt{\frac{243}{3}} = \sqrt{81} = 9$$

$$72. \{[(3a^3)^2]^{-5}\}^{-2} = \{[3^2 a^6]^{-5}\}^{-2} \\ = \{3^{-10} a^{-30}\}^{-2} \\ = 3^{20} a^{60}$$

$$73. \frac{2^0}{(2^{-2} x^{1/2} y^{-2})^3} = \frac{1}{2^{-6} x^{3/2} y^{-6}} = \frac{2^6 y^6}{x^{3/2}} \\ = \frac{64 y^6 \cdot x^{1/2}}{x^{3/2} \cdot x^{1/2}} = \frac{64 y^6 x^{1/2}}{x^2}$$

$$74. \frac{\sqrt{s^5}}{\sqrt[3]{s^2}} = \frac{s^{5/2}}{s^{2/3}} = \frac{s^{15/6}}{s^{4/6}} = s^{11/6}$$

$$75. \sqrt[3]{x^2 y z^3} \sqrt[3]{x y^2} = \sqrt[3]{(x^2 y z^3)(x y^2)} = \sqrt[3]{x^3 y^3 z^3} \\ = xyz$$

$$76. (\sqrt[4]{3})^8 = (3^{1/4})^8 = 3^{8/4} = 3^2 = 9$$

$$77. 3^2 (32)^{-2/5} = 3^2 (2^5)^{-2/5} \\ = 3^2 (2^{-2}) \\ = 3^2 \cdot \frac{1}{2^2} \\ = \frac{9}{4}$$

$$78. (\sqrt[5]{x^2 y})^{2/5} = [(x^2 y)^{1/5}]^{2/5} = (x^2 y)^{2/25} \\ = x^{4/25} y^{2/25}$$

$$79. (2x^{-1} y^2)^2 = 2^2 x^{-2} y^4 = \frac{4y^4}{x^2}$$

$$80. \frac{3}{\sqrt[3]{y^4 \sqrt{x}}} = \frac{3}{y^{1/3} x^{1/4}} = \frac{3 \cdot y^{2/3} x^{3/4}}{y^{1/3} x^{1/4} \cdot y^{2/3} x^{3/4}} \\ = \frac{3x^{3/4} y^{2/3}}{xy}$$

$$81. \sqrt{x} \sqrt{x^2 y^3} \sqrt{xy^2} = x^{1/2} (x^2 y^3)^{1/2} (xy^2)^{1/2} \\ = x^{1/2} (xy^{3/2}) (x^{1/2} y) = x^2 y^{5/2}$$

$$82. \sqrt{75k^4} = (75k^4)^{1/2} = [(25k^4)(3)]^{1/2} \\ = [(5k^2)^2 3]^{1/2} = 5k^2 3^{1/2}$$

$$83. \frac{(ab^{-3}c)^8}{(a^{-1}c^2)^{-3}} = \frac{a^8 b^{-24} c^8}{a^3 c^{-6}} = \frac{a^5 c^{14}}{b^{24}}$$

$$84. \sqrt[3]{7(49)} = \sqrt[3]{7 \cdot 7^2} = \sqrt[3]{7^3} = 7$$

$$85. \frac{(x^2)^3}{x^4} \div \left[ \frac{x^3}{(x^3)^2} \right]^2 = \frac{x^6}{x^4} \div \frac{(x^3)^2}{(x^6)^2} \\ = x^2 \div \frac{x^6}{x^{12}} = x^2 \div x^{6-12} = x^2 \div x^{-6} \\ = x^2 \div \frac{1}{x^6} = x^2 \cdot x^6 = x^8$$

$$86. \sqrt{(-6)(-6)} = \sqrt{36} = 6 \\ \text{Note that } \sqrt{(-6)^2} \neq -6 \text{ since } -6 < 0.$$

$$87. -\frac{8s^{-2}}{2s^3} = -\frac{4}{s^3 s^2} = -\frac{4}{s^5}$$

$$88. (a^5 b^{-3} \sqrt{c})^3 = (a^5)^3 (b^{-3})^3 (c^{1/2})^3 \\ = a^{15} b^{-9} c^{3/2} \\ = \frac{a^{15} c^{3/2}}{b^9}$$

$$89. (3x^3 y^2 \div 2y^2 z^{-3})^4 = \left( \frac{3x^3 y^2}{2y^2 z^{-3}} \right)^4 \\ = \left( \frac{3x^3 z^3}{2} \right)^4 \\ = \frac{(3x^3 z^3)^4}{(2)^4} \\ = \frac{3^4 x^{12} z^{12}}{2^4} \\ = \frac{81x^{12} z^{12}}{16}$$

$$90. \frac{1}{\left( \frac{\sqrt{2x^{-2}}}{\sqrt{16x^3}} \right)^2} = \frac{1}{\left( \frac{2^{1/2}}{16^{1/2}} \right)^2 (x^{-2})^2} = \frac{1}{\frac{2x^{-4}}{16x^6}} = \frac{1}{8x^{10}} = 8x^{10}$$

## Problems 0.4

1.  $8x - 4y + 2 + 3x + 2y - 5 = 11x - 2y - 3$
2.  $6x^2 - 10xy + 2 + 2z - xy + 4$   
 $= 6x^2 - 11xy + 2z + 6$
3.  $8t^2 - 6s^2 + 4s^2 - 2t^2 + 6 = 6t^2 - 2s^2 + 6$
4.  $\sqrt{x} + 2\sqrt{x} + \sqrt{x} + 3\sqrt{x} = 7\sqrt{x}$
5.  $\sqrt{a} + 2\sqrt{3b} - \sqrt{c} + 3\sqrt{3b}$   
 $= \sqrt{a} + 5\sqrt{3b} - \sqrt{c}$
6.  $3a + 7b - 9 - 5a - 9b - 21 = -2a - 2b - 30$
7.  $6x^2 - 10xy + \sqrt{2} - 2z + xy - 4$   
 $= 6x^2 - 9xy - 2z + \sqrt{2} - 4$
8.  $\sqrt{x} + 2\sqrt{x} - \sqrt{x} - 3\sqrt{x} = -\sqrt{x}$
9.  $\sqrt{x} + \sqrt{2y} - \sqrt{x} - \sqrt{3z} = \sqrt{2y} - \sqrt{3z}$
10.  $8z - 4w - 3w + 6z = 14z - 7w$
11.  $9x + 9y - 21 - 24x + 6y - 6 = -15x + 15y - 27$
12.  $u - 3v - 5u - 4v + u - 3 = -3u - 7v - 3$
13.  $5x^2 - 5y^2 + xy - 3x^2 - 8xy - 28y^2$   
 $= 2x^2 - 33y^2 - 7xy$
14.  $2 - [3 + 4s - 12] = 2 - [4s - 9] = 2 - 4s + 9$   
 $= 11 - 4s$
15.  $2\{3[3x^2 + 6 - 2x^2 + 10]\} = 2\{3[x^2 + 16]\}$   
 $= 2\{3x^2 + 48\} = 6x^2 + 96$
16.  $4\{3t + 15 - t[1 - t - 1]\} = 4\{3t + 15 - t[-t]\}$   
 $= 4\{3t + 15 + t^2\} = 4t^2 + 12t + 60$
17.  $-5(8x^3 + 8x^2 - 2(x^2 - 5 + 2x))$   
 $= -5(8x^3 + 8x^2 - 2x^2 + 10 - 4x)$   
 $= -5(8x^3 + 6x^2 - 4x + 10)$   
 $= -40x^3 - 30x^2 + 20x - 50$
18.  $- \{-6a - 6b + 6 + 10a + 15b - a[2b + 10]\}$   
 $= -\{4a + 9b + 6 - 2ab - 10a\}$   
 $= -\{-6a + 9b + 6 - 2ab\}$   
 $= 6a - 9b - 6 + 2ab$
19.  $x^2 + (4+5)x + 4(5) = x^2 + 9x + 20$
20.  $u^2 + (5+2)u + 2(5) = u^2 + 7u + 10$
21.  $(w+2)(w-5) = w^2 + (-5+2)w + 2(-5)$   
 $= w^2 - 3w - 10$
22.  $z^2 + (-7-3)z + (-7)(-3) = z^2 - 10z + 21$
23.  $(2x)(5x) + [(2)(2) + (3)(5)]x + 3(2)$   
 $= 10x^2 + 19x + 6$
24.  $(t)(2t) + [(1)(7) + (-5)(2)]t + (-5)(7)$   
 $= 2t^2 - 3t - 35$
25.  $X^2 + 2(X)(2Y) + (2Y)^2 = X^2 + 4XY + 4Y^2$
26.  $(2x)^2 - 2(2x)(1) + 1^2 = 4x^2 - 4x + 1$
27.  $x^2 - 2(5)x + 5^2 = x^2 - 10x + 25$
28.  $(1 \cdot 2)(\sqrt{x})^2 + [(1)(5) + (-1)(2)]\sqrt{x} + (-1)(5)$   
 $= 2x + 3\sqrt{x} - 5$
29.  $(\sqrt{3x})^2 + 2(\sqrt{3x})(5) + (5)^2$   
 $= 3x + 10\sqrt{3x} + 25$
30.  $(\sqrt{y})^2 - 3^2 = y - 9$
31.  $(2s)^2 - 1^2 = 4s^2 - 1$
32.  $(z^2)^2 - (3w)^2 = z^4 - 9w^2$
33.  $x^2(x+4) - 3(x+4)$   
 $= x^3 + 4x^2 - 3x - 12$
34.  $x(x^2 + x + 3) + 1(x^2 + x + 3)$   
 $= x^3 + x^2 + 3x + x^2 + x + 3$   
 $= x^3 + 2x^2 + 4x + 3$



$$\begin{aligned}
 35. \quad & x^2(3x^2 + 2x - 1) - 4(3x^2 + 2x - 1) \\
 &= 3x^4 + 2x^3 - x^2 - 12x^2 - 8x + 4 \\
 &= 3x^4 + 2x^3 - 13x^2 - 8x + 4
 \end{aligned}$$

$$\begin{aligned}
 36. \quad & 3y(4y^3 + 2y^2 - 3y) - 2(4y^3 + 2y^2 - 3y) \\
 &= 12y^4 + 6y^3 - 9y^2 - 8y^3 - 4y^2 + 6y \\
 &= 12y^4 - 2y^3 - 13y^2 + 6y
 \end{aligned}$$

$$\begin{aligned}
 37. \quad & x\{2(x^2 - 2x - 35) + 4[2x^2 - 12x]\} \\
 &= x\{2x^2 - 4x - 70 + 8x^2 - 48x\} \\
 &= x\{10x^2 - 52x - 70\} \\
 &= 10x^3 - 52x^2 - 70x
 \end{aligned}$$

$$\begin{aligned}
 38. \quad & [(2z)^2 - 1^2](4z^2 + 1) = [4z^2 - 1](4z^2 + 1) \\
 &= (4z^2)^2 - 1^2 = 16z^4 - 1
 \end{aligned}$$

$$\begin{aligned}
 39. \quad & x(3x + 2y - 4) + y(3x + 2y - 4) + 2(3x + 2y - 4) \\
 &= 3x^2 + 2xy - 4x + 3xy + 2y^2 - 4y + 6x + 4y - 8 \\
 &= 3x^2 + 2y^2 + 5xy + 2x - 8
 \end{aligned}$$

$$\begin{aligned}
 40. \quad & [x^2 + (x+1)]^2 \\
 &= (x^2)^2 + 2x^2(x+1) + (x+1)^2 \\
 &= x^4 + 2x^3 + 2x^2 + x^2 + 2x + 1 \\
 &= x^4 + 2x^3 + 3x^2 + 2x + 1
 \end{aligned}$$

$$\begin{aligned}
 41. \quad & (2a)^3 + 3(2a)^2(3) + 3(2a)(3)^2 + (3)^3 \\
 &= 8a^3 + 36a^2 + 54a + 27
 \end{aligned}$$

$$\begin{aligned}
 42. \quad & (3y)^3 - 3(3y)^2(2) + 3(3y)(2)^2 - (2)^3 \\
 &= 27y^3 - 54y^2 + 36y - 8
 \end{aligned}$$

$$\begin{aligned}
 43. \quad & (2x)^3 - 3(2x)^2(3) + 3(2x)(3)^2 - 3^3 \\
 &= 8x^3 - 36x^2 + 54x - 27
 \end{aligned}$$

$$\begin{aligned}
 44. \quad & x^3 + 3x^2(2y) + 3x(2y)^2 + (2y)^3 \\
 &= x^3 + 6x^2y + 12xy^2 + 8y^3
 \end{aligned}$$

$$45. \quad \frac{z^2}{z} - \frac{18z}{z} = z - 18$$

$$46. \quad \frac{2x^3}{x} - \frac{7x}{x} + \frac{4}{x} = 2x^2 - 7 + \frac{4}{x}$$

$$47. \quad \frac{6x^5}{2x^2} + \frac{4x^3}{2x^2} - \frac{1}{2x^2} = 3x^3 + 2x - \frac{1}{2x^2}$$

$$\begin{aligned}
 48. \quad & \frac{3y - 4 - 9y - 5}{3y} \\
 &= \frac{-6y - 9}{3y} \\
 &= \frac{-6y}{3y} - \frac{9}{3y} \\
 &= -2 - \frac{3}{y}
 \end{aligned}$$

$$\begin{aligned}
 49. \quad & x + 5 \overline{)x^2 + 5x - 3} \\
 & \quad \underline{x^2 + 5x} \phantom{-3} \\
 & \quad \phantom{x^2 + 5x} -3 \\
 & \text{Answer: } x + \frac{-3}{x+5}
 \end{aligned}$$

$$\begin{aligned}
 50. \quad & x - 4 \overline{)x^2 - 5x + 4} \\
 & \quad \underline{x^2 - 4x} \phantom{+4} \\
 & \quad \phantom{x^2 - 4x} -x + 4 \\
 & \quad \quad \underline{-x + 4} \\
 & \quad \quad \quad 0 \\
 & \text{Answer: } x - 1
 \end{aligned}$$

$$\begin{aligned}
 51. \quad & x + 2 \overline{)3x^3 - 2x^2 + x - 3} \\
 & \quad \underline{3x^3 + 6x^2} \phantom{+ x - 3} \\
 & \quad \phantom{3x^3 + 6x^2} -8x^2 + x \phantom{- 3} \\
 & \quad \quad \underline{-8x^2 - 16x} \phantom{- 3} \\
 & \quad \quad \phantom{-8x^2 - 16x} 17x - 3 \\
 & \quad \quad \quad \underline{17x + 34} \\
 & \quad \quad \quad \quad -37 \\
 & \text{Answer: } 3x^2 - 8x + 17 + \frac{-37}{x+2}
 \end{aligned}$$

$$\begin{array}{r}
 52. \quad x-1 \overline{) \begin{array}{l} x^3 + x^2 + 3x + 3 \\ x^4 + 0x^3 + 2x^2 + 0x + 1 \\ \hline x^4 - x^3 \\ \hline x^3 + 2x^2 \\ x^3 - x^2 \\ \hline 3x^2 + 0x \\ 3x^2 - 3x \\ \hline 3x + 1 \\ 3x - 3 \\ \hline 4 \end{array} }
 \end{array}$$

$$\text{Answer: } x^3 + x^2 + 3x + 3 + \frac{4}{x-1}$$

$$\begin{array}{r}
 53. \quad x+2 \overline{) \begin{array}{l} x^2 - 2x + 4 \\ x^3 + 0x^2 + 0x + 0 \\ \hline x^3 + 2x^2 \\ \hline -2x^2 + 0 \\ -2x^2 - 4x \\ \hline 4x + 0 \\ 4x + 8 \\ \hline -8 \end{array} }
 \end{array}$$

$$\text{Answer: } x^2 - 2x + 4 - \frac{8}{x+2}$$

$$\begin{array}{r}
 54. \quad 2x+3 \overline{) \begin{array}{l} 3x - \frac{1}{2} \\ 6x^2 + 8x + 1 \\ \hline 6x^2 + 9x \\ \hline -x + 1 \\ -x - \frac{3}{2} \\ \hline \frac{5}{2} \end{array} }
 \end{array}$$

$$\text{Answer: } 3x - \frac{1}{2} + \frac{5}{2x+3}$$

$$\begin{array}{r}
 55. \quad 3x+2 \overline{) \begin{array}{l} x-2 \\ 3x^2 - 4x + 3 \\ \hline 3x^2 + 2x \\ \hline -6x + 3 \\ -6x - 4 \\ \hline 7 \end{array} }
 \end{array}$$

$$\text{Answer: } x - 2 + \frac{7}{3x+2}$$

$$\begin{array}{r}
 56. \quad z^2 - z + 1 \overline{) \begin{array}{l} z+2 \\ z^3 + z^2 + z \\ \hline z^3 - z^2 + z \\ \hline 2z^2 \\ 2z^2 - 2z + 2 \\ \hline 2z - 2 \end{array} }
 \end{array}$$

$$\text{Answer: } z + 2 + \frac{2z-2}{z^2-z+1}$$

**Problems 0.5**

1.  $2(ax + b)$

2.  $2y(3y - 2)$

3.  $5x(2y + z)$

4.  $3x^2y(1 - 3xy^2)$

5.  $4bc(2a^3 - 3ab^2d + b^3cd^2)$

6.  $6u^2v(uv^2 + 3w^4 - 12v^2)$

7.  $z^2 - 7^2 = (z+7)(z-7)$

8.  $(x+2)(x-3)$

9.  $(p+3)(p+1)$

10.  $(s-4)(s-2)$

11.  $(4x)^2 - 3^2 = (4x+3)(4x-3)$

12.  $(x+6)(x-4)$

13.  $(a+7)(a+5)$

14.  $(2t)^2 - (3s)^2 = (2t+3s)(2t-3s)$

15.  $x^2 + 2(3)(x) + 3^2 = (x+3)^2$

16.  $(y-10)(y-5)$

17.  $5(x^2 + 5x + 6)$   
 $= 5(x+3)(x+2)$

18.  $3(t^2 + 4t - 5)$   
 $= 3(t-1)(t+5)$