STUDENT SOLUTIONS MANUAL

Laurel Technical Services

PRECALCULUS

Robert Blitzer

STUDENT SOLUTIONS MANUAL

Laurel Technical Services

PRECALCULUS

Robert Blitzer

Prentice Hall

Upper Saddle River, NJ 07458

Editor in Chief: Sally Yagan
Associate Editor: Dawn Murrin
Assistant Managing Editor: John Matthews
Production Editor: James Buckley
Supplement Cover Manager: Paul Gourhan
Supplement Cover Designer: PM Workshop Inc.
Manufacturing Buyer: Lisa McDowell

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

ISBN 0-13-028654-0

Prentice-Hall International (UK) Limited, London
Prentice-Hall of Australia Pty. Limited, Sydney
Prentice-Hall Canada, Inc., Toronto
Prentice-Hall Hispanoamericana, S.A., Mexico
Prentice-Hall of India Private Limited, New Delhi
Pearson Education Asia Pte. Ltd., Singapore
Prentice-Hall of Japan, Inc., Tokyo
Editora Prentice-Hall do Brazil, Ltda., Rio de Janeiro

Table of Contents

Chapter P

Section P.1

Check Point Exercises

1. a. $\left|1-\sqrt{2}\right|$

Because $\sqrt{2} \approx 1.4$, the number inside the absolute value bars is negative. The absolute value of x when $x < 0$ is $-x$. Thus,

$$\left|1-\sqrt{2}\right| = -\left(1-\sqrt{2}\right) = \sqrt{2}-1.$$

b. $|\pi - 3|$

Because $\pi \approx 3.14$, the number inside the absolute value bars is positive. The absolute value of a positive number is the number itself. Thus,

$$|\pi - 3| = \pi - 3.$$

c. $\frac{|x|}{x}$ if $x > 0$

If $x > 0$, then $|x| = x$. Thus,

$$\frac{|x|}{x} = \frac{x}{x} = 1.$$

2. Because the distance between a and b is given by $|a-b|$, the distance between -4 and 5 is

$$|-4-5| = |-9| = 9.$$

3. a.
$$\begin{aligned}&(3\cdot 2^2 + 8\cdot 2) \div (2^2 - 2)\\ &= (3\cdot 4 + 16) \div (4-2)\\ &= (12+16) \div 2\\ &= 28 \div 2\\ &= 14\end{aligned}$$

b.
$$\begin{aligned}&\frac{-(-6)+\sqrt{(-6)^2-4(1)(9)}}{2(1)}\\ &= \frac{6+\sqrt{36-36}}{2}\\ &= 3\end{aligned}$$

4. Simplify: $7(4x-3y)+2(5x+y)$.
Use the distributive property to remove the parentheses. Then, multiply and group like terms. Finally combine like terms.

$$\begin{aligned}&7(4x-3y)+2(5x+y).\\ &= 7\cdot 4x - 7\cdot 3y + 2\cdot 5x + 2\cdot y\\ &= 28x - 21y + 10x + 2y\\ &= (28x+10x) + (2y-21y)\\ &= 38x - 19y\end{aligned}$$

Exercise Set P.1

For Exercises 1 and 3:

a. The natural numbers are used for counting, $\{1,2,3,4,5\ldots\}$.

b. The whole numbers add 0 to the set of natural numbers, $\{0,1,2,3,4,5,\ldots\}$.

c. The integers add the negatives of the natural numbers to the set of whole numbers, $\{\ldots,-5,-4,-3,-2,-1,0,1,2,3,4,5,\ldots\}$.

d. The rational numbers can be expressed as an integer divided by a nonzero integer or a terminating or repeating decimal.

e. The irrational numbers cannot be expressed as a quotient of integers or a terminating or repeating decimal.

1. a. $\sqrt{100}$

b. $0,\ \sqrt{100}$

c. $-9,\ 0,\ \sqrt{100}$

d. $-9,\ \frac{-4}{5},\ 0,\ 0.25,\ 9.2,\ \sqrt{100}$

e. $\sqrt{3}$

3. a. $\sqrt{64}$

b. $0,\ \sqrt{64}$

c. $-11,\ 0,\ \sqrt{64}$

d. $-11,\ \frac{-5}{6},\ 0,\ 0.75,\ \sqrt{64}$

e. $\sqrt{5},\ \pi$

5. 0

7. Answers may vary.

9. True; –13 is to the left of –2 on the number line.

11. True; 4 is to the right of –7 on the number line.

13. True; $-\pi = -\pi$

15. $|300| = 300$

17. $|12 - \pi| = 12 - \pi$

19. $\left|\sqrt{2} - 5\right| = 5 - \sqrt{2}$

21. $\frac{-3}{|-3|} = \frac{-3}{3} = -1$

23. $|17 - 2| = |15| = 15$

25. $|5 - (-2)| = |7| = 7$

27. $|-4 - (-19)| = |15| = 15$

29. $|-1.4 - (-3.6)| = |2.2| = 2.2$

31. $5x + 7 = 5\,(4) + 7 = 27$

33. $4(x+3) - 11 = 4[(-5)+3] - 11$
$= 4(-2) - 11 = -19$

35. $\frac{1-[(-1)-2]^2}{1+[(-1)-2]^2} = \frac{1-(-3)^2}{1+(-3)^2}$
$= \frac{1-9}{1+9}$
$= \frac{-8}{10}$
$= -\frac{4}{5}$

37. $\frac{-(-20)+\sqrt{(-20)^2-4(4)(25)}}{2(4)}$
$= \frac{20+\sqrt{400-400}}{8}$
$= \frac{20}{8}$
$= \frac{5}{2}$

39. 6 + (–4) = (–4) + 6; commutative property of addition

41. 6 + (2 + 7) = (6 + 2) + 7; associative property of addition

43. (2 + 3) + (4 + 5) = (4 + 5) + (2 + 3); commutative property of addition

45. 2(–8 + 6) = –16 + 12; distributive property of multiplication over addition

47. $5(3x+4) - 4 = 5 \cdot 3x + 5 \cdot 4 - 4$
$= 15x + 20 - 4$
$= 15x + 16$

49. $5(3x-2) + 12x = 5 \cdot 3x - 5 \cdot 2 + 12x$
$= 15x - 10 + 12x$
$= 27x - 10$

51. $7(3y-5) + 2(4y+3)$
$= 7 \cdot 3y - 7 \cdot 5 + 2 \cdot 4y + 2 \cdot 3$
$= 21y - 35 + 8y + 6$
$= 29y - 29$

53. $-(-14x) = 14x$

55. $-(2x - 3y - 6) = -2x + 3y + 6$

57. $\frac{1}{3}(3x)+[(4y)+(-4y)] = x+0$
$= x$

59. Yes; The order in which you put on your shoes does not matter.

61. Answers may vary.

63. $962x + 18{,}667 = 962(7) + 18{,}667$
$= 6734 + 18{,}667$
$= 25{,}401$
$1990 + 7 = 1997$
In 1997, the average yearly earnings in the United States was \$25,401.

65. a. $0.6(220 - a) = 0.6(220) - 0.6(a)$
$= 132 - 0.6a$

b. Let $a = 20$
$0.6(220 - a) = 0.6(220 - 20)$
$= 0.6(200)$
$= 120$
$132 - 0.6a = 132 - 0.6(20)$
$= 132 - 12 = 120$

67.–71. Answers may vary.

73. a. False; For example, 1.7 is a rational number and it is not an integer.

b. False; All whole numbers, $\{0,1,2,3,\ldots\}$, are also integers.

c. True; –7.5 is a rational number and it is not positive.

d. False; $-\pi$ is an irrational number that is also negative.

(c) is true.

75. $\sqrt{2} \approx 1.4$
$1.4 < 1.5$
$\sqrt{2} < 1.5$

77. $-\frac{3.14}{2} = -1.57$
$-\frac{\pi}{2} \approx -1.571$
$-1.57 > -1.571$
$-\frac{3.14}{2} > -\frac{\pi}{2}$

Section P.2

Check Point Exercises

1. $(-4)^3 \cdot 2^2 = (-4)(-4)(-4) \cdot 2 \cdot 2$
$= -64 \cdot 4$
$= -256$

2. a. $(2x^3y^6)^4 = (2)^4(x^3)^4(y^6)^4$
$= (2)^4 x^{3\cdot4} y^{6\cdot4}$
$= 16x^{12}y^{24}$

b. $(-6x^2y^5)(3xy^3) = (-6)(3)x^2xy^5y^3$
$= -18x^{2+1}y^{5+3}$
$= -18x^3y^8$

c. $\frac{100x^{12}y^2}{20x^{16}y^{-4}} = \left(\frac{100}{20}\right)\left(\frac{x^{12}}{x^{16}}\right)\left(\frac{y^2}{y^{-4}}\right)$
$= 5x^{12-16}y^{2-(-4)}$
$= 5x^{-4}y^6$
$= \frac{5y^6}{x^4}$

d. $\left(\frac{5x}{y^4}\right)^{-2} = \frac{5^{-2}x^{-2}}{(y^4)^{-2}}$
$= \frac{5^{-2}x^{-2}}{y^{-8}}$
$= \frac{y^8}{5^2x^2}$
$= \frac{y^8}{25x^2}$

3. a. Express 7.4×10^9 in decimal notation by moving the decimal point in 7.4 nine places to the right.

$7.4\times10^9 = 7,400,000,000$

b. Express 3.017×10^{-6} in decimal notation by moving the decimal point in 3.017 six places to the left.

$3.017\times10^{-6} = 0.000003017$

4. a. To express 7,410,000,000 in scientific notation, the decimal point needs to move nine places. The exponent on 10 is positive since 7,410,000,000 is greater than 10.

$7,410,000,000 = 7.41\times10^9$

b. To express 0.000000092 in scientific notation, the decimal point needs to move eight places. The exponent on 10 is negative since 0.000000092 is between 0 and 1.

$0.000000092 = 9.2\times10^{-8}$

5. The total distance covered by all runners is the number of people who run in the New York City Marathon, 2×10^4, multiplied by the distance of the Marathon, 26 miles.

$$(2\times10^4)\times(26) = (2\times26)\times(10^4)$$
$$= 52\times10^4$$
$$= 5.2\times10^5$$

Thus, the total distance covered by all runners is 5.2×10^5 miles.

6. $S = (1.76\times10^5)[(1.44\times10^{-2}) - r^2]$
$= (1.76\times10^5)[(1.44\times10^{-2}) - 0^2]$
$= 2534.4$

The speed of the blood at the central axis of the artery is 2534.4 centimeters per second.

Exercise Set P.2

1. $5^2\cdot2 = (5\cdot5)\cdot2 = 25\cdot2 = 50$

3. $(-2)^6 = (-2)(-2)(-2)(-2)(-2)(-2) = 64$

5. $-2^6 = -2\cdot2\cdot2\cdot2\cdot2\cdot2 = -64$

7. $(-3)^0 = 1$

9. $-3^0 = -1$

11. $4^{-3} = \dfrac{1}{4^3} = \dfrac{1}{4\cdot4\cdot4} = \dfrac{1}{64}$

13. $2^2\cdot2^3 = 2^{2+3} = 2^5 = 2\cdot2\cdot2\cdot2\cdot2 = 32$

15. $(2^2)^3 = 2^{2\cdot3} = 2^6 = 2\cdot2\cdot2\cdot2\cdot2\cdot2 = 64$

17. $\dfrac{2^8}{2^4} = 2^{8-4} = 2^4 = 2\cdot2\cdot2\cdot2 = 16$

19. $3^{-3}\cdot3 = 3^{-3+1} = 3^{-2} = \dfrac{1}{3^2} = \dfrac{1}{3\cdot3} = \dfrac{1}{9}$

21. $\dfrac{2^3}{2^7} = 2^{3-7} = 2^{-4} = \dfrac{1}{2^4} = \dfrac{1}{2\cdot2\cdot2\cdot2} = \dfrac{1}{16}$

23. $x^{-2}y = \dfrac{1}{x^2}\cdot y = \dfrac{y}{x^2}$

25. $x^0y^5 = 1\cdot y^5 = y^5$

27. $x^3\cdot x^7 = x^{3+7} = x^{10}$

29. $x^{-5}\cdot x^{10} = x^{-5+10} = x^5$

31. $(x^3)^7 = x^{3\cdot7} = x^{21}$

33. $(x^{-5})^3 = x^{-5\cdot3} = x^{-15} = \dfrac{1}{x^{15}}$

35. $\dfrac{x^{14}}{x^7} = x^{14-7} = x^7$

37. $\dfrac{x^{14}}{x^{-7}} = x^{14-(-7)} = x^{14+7} = x^{21}$

39. $(8x^3)^2 = 8^2(x^3)^2 = 8^2x^{3\cdot2} = 64x^6$

41. $\left(-\dfrac{4}{x}\right)^3 = \dfrac{(-4)^3}{x^3} = -\dfrac{64}{x^3}$

43. $(-3x^2y^5)^2 = (-3)^2(x^2)^2 \cdot (y^5)^2$
$= 9x^{2\cdot 2}y^{5\cdot 2}$
$= 9x^4y^{10}$

45. $(3x^4)(2x^7) = 3 \cdot 2x^4 \cdot x^7 = 6x^{4+7} = 6x^{11}$

47. $(-9x^3y)(-2x^6y^4) = (-9)(-2)x^3x^6yy^4$
$= 18x^{3+6}y^{1+4}$
$= 18x^9y^5$

49. $\dfrac{8x^{20}}{2x^4} = \left(\dfrac{8}{2}\right)\left(\dfrac{x^{20}}{x^4}\right) = 4x^{20-4} = 4x^{16}$

51. $\dfrac{25a^{13} \cdot b^4}{-5a^2 \cdot b^3} = \left(\dfrac{25}{-5}\right)\left(\dfrac{a^{13}}{a^2}\right)\left(\dfrac{b^4}{b^3}\right)$
$= -5a^{13-2}b^{4-3}$
$= -5a^{11}b$

53. $\dfrac{14b^7}{7b^{14}} = \left(\dfrac{14}{7}\right)\left(\dfrac{b^7}{b^{14}}\right) = 2 \cdot b^{7-14} = 2b^{-7} = \dfrac{2}{b^7}$

55. $(4x^3)^{-2} = (4^{-2})(x^3)^{-2}$
$= 4^{-2}x^{-6}$
$= \dfrac{1}{4^2x^6}$
$= \dfrac{1}{16x^6}$

57. $\dfrac{24x^3 \cdot y^5}{32x^7y^{-9}} = \dfrac{3}{4}x^{3-7}y^{5-(-9)}$
$= \dfrac{3}{4}x^{-4}y^{14}$
$= \dfrac{3y^{14}}{4x^4}$

59. $\left(\dfrac{5x^3}{y}\right)^{-2} = \dfrac{5^{-2}x^{3\cdot(-2)}}{y^{-2}}$
$= \dfrac{5^{-2} \cdot x^{-6}}{y^{-2}}$
$= \dfrac{y^2}{5^2 \cdot x^6}$
$= \dfrac{y^2}{25x^6}$

61. $4.7 \times 10^3 = 4700$

63. $4 \times 10^6 = 4,000,000$

65. $7.86 \times 10^{-4} = 0.000786$

67. $3.18 \times 10^{-6} = 0.00000318$

69. $3600 = 3.6 \times 10^3$

71. $220,000,000 = 2.2 \times 10^8$

73. $0.027 = 2.7 \times 10^{-2}$

75. $0.000763 = 7.63 \times 10^{-4}$

77. $(2 \times 10^3)(3 \times 10^2) = (2 \times 3) \times (10^3 \times 10^2)$
$= 6 \times 10^{3+2}$
$= 6 \times 10^5$
$= 600,000$

79. $(4.1 \times 10^2)(3 \times 10^{-4}) = (4.1 \times 3) \times (10^2 \times 10^{-4})$
$= 12.3 \times 10^{2+(-4)}$
$= 12.3 \times 10^{-2}$
$= 0.123$

81. $\dfrac{12 \times 10^6}{4 \times 10^2} = \left(\dfrac{12}{4}\right) \times \left(\dfrac{10^6}{10^2}\right)$
$= 3 \times 10^{6-2}$
$= 3 \times 10^4$
$= 30,000$

83. $\dfrac{6.3\times10^3}{3\times10^5}=\left(\dfrac{6.3}{3}\right)\times\left(\dfrac{10^3}{10^5}\right)$
$=2.1\times10^{3-5}=2.1\times10^{-2}$
$=0.021$

85. 1,694,300 million $=(1.6943\times10^6)(1\times10^6)$
$=1.6943\times10^{6+6}$
$=1.6943\times10^{12}$

87. 60 billion $=(6.0\times10)\left(1\times10^9\right)=6.0\times10^{10}$

89. $(2.7\times10^8)(120)=(2.7\times10^8)(1.2\times10^2)$
$=(2.7\times1.2)\times(10^8\times10^2)$
$=3.24\times10^{8+2}$
$=3.24\times10^{10}$

91. $\dfrac{200}{3\times10^{-8}}\approx6.7\times10^9$

The human foot is approximately 6.7×10^9 times as large as the hydrogen atom.

93. $d=rt$

$t=\dfrac{d}{r}=\dfrac{4.6\times10^9}{1.86\times10^5}\approx2.47\times10^4$

It takes about 2.47×10^4 seconds for light from the sun to reach Pluto.

95.–101. Answers may vary.

103. a. False; $\dfrac{1}{16}=4^{-2}>4^{-3}=\dfrac{1}{64}$

b. True; $\dfrac{1}{25}=5^{-2}>2^{-5}=\dfrac{1}{32}$

c. False; $16=(-2)^4\neq2^{-4}=\dfrac{1}{16}$

d. False; $1=5^2\cdot5^{-2}=2^5\cdot2^{-5}=2^0=1$

(b) is true.

105. $b^A=MN,\ b^C=M,\ b^D=N$
Since $b^A=b^C\cdot b^D$,
$A=C+D$.

Section P.3

Check Point Exercises

1. a. Since $\sqrt{a^2}=|a|$,
$\sqrt{3^2}=3$.

b. $\sqrt{5x}\cdot\sqrt{10x}=\sqrt{5x\cdot10x}$
$=\sqrt{50x^2}$
$=\sqrt{25x^2\cdot2}$
$=\sqrt{25x^2}\sqrt{2}$
$=\sqrt{25}\sqrt{x^2}\sqrt{2}$
$=5|x|\sqrt{2}$

2. a. $\sqrt{\dfrac{25}{16}}=\dfrac{\sqrt{25}}{\sqrt{16}}=\dfrac{5}{4}$

b. $\dfrac{\sqrt{150x^3}}{\sqrt{2x}}=\sqrt{\dfrac{150x^3}{2x}}=\sqrt{75x^2}$
$=\sqrt{25x^2}\sqrt{3}$
$=\sqrt{25}\sqrt{x^2}\sqrt{3}$
$=5|x|\sqrt{3}$

3. a. $8\sqrt{13}+9\sqrt{13}=(8+9)\sqrt{3}$
$=17\sqrt{13}$

b. $\sqrt{17x}-20\sqrt{17x}$
$=1\sqrt{17x}-20\sqrt{17x}$
$=(1-20)\sqrt{17x}$
$=-19\sqrt{17x}$

4. a. $5\sqrt{27}+\sqrt{12}$
$=5\sqrt{9\cdot 3}+\sqrt{4\cdot 3}$
$=5\cdot 3\sqrt{3}+2\sqrt{3}$
$=15\sqrt{3}+2\sqrt{3}$
$=(15+2)\sqrt{3}$
$=17\sqrt{3}$

b. $6\sqrt{18x}-4\sqrt{8x}$
$=6\sqrt{9\cdot 2x}-4\sqrt{4\cdot 2x}$
$=6\cdot 3\sqrt{2x}-4\cdot 2\sqrt{2x}$
$=18\sqrt{2x}-8\sqrt{2x}$
$=(18-8)\sqrt{2x}$
$=10\sqrt{2x}$

5. a. If we multiply numerator and denominator by $\sqrt{3}$, the denominator becomes $\sqrt{3}\cdot\sqrt{3}=\sqrt{9}=3$. Therefore, multiply by 1, choosing $\frac{\sqrt{3}}{\sqrt{3}}$ for 1.

$$\frac{5}{\sqrt{3}}=\frac{5}{\sqrt{3}}\cdot\frac{\sqrt{3}}{\sqrt{3}}=\frac{5\sqrt{3}}{\sqrt{9}}=\frac{5\sqrt{3}}{3}$$

b. The *smallest* number that will produce a perfect square in the denominator of $\frac{6}{\sqrt{12}}$ is $\sqrt{3}$ because $\sqrt{12}\cdot\sqrt{3}=\sqrt{36}=6$. So multiply by 1, choosing $\frac{\sqrt{3}}{\sqrt{3}}$ for 1.

$$\frac{6}{\sqrt{12}}=\frac{6}{\sqrt{12}}\cdot\frac{\sqrt{3}}{\sqrt{3}}=\frac{6\sqrt{3}}{\sqrt{36}}=\frac{6\sqrt{3}}{6}=\sqrt{3}$$

6. The denominator will not contain a radical if multiplied by $4-\sqrt{5}$. Therefore, multiply by 1, choosing $\frac{4-\sqrt{5}}{4-\sqrt{5}}$ for 1.

$$\frac{8}{4+\sqrt{5}}=\frac{8}{4+\sqrt{5}}\cdot\frac{4-\sqrt{5}}{4-\sqrt{5}}$$
$$=\frac{8(4-\sqrt{5})}{4^2-(\sqrt{5})^2}$$
$$=\frac{8(4-\sqrt{5})}{16-5}$$
$$=\frac{8(4-\sqrt{5})}{11}\text{ or }\frac{32-8\sqrt{5}}{11}$$

7. a. $\sqrt[3]{40}=\sqrt[3]{8\cdot 5}=\sqrt[3]{8}\cdot\sqrt[3]{5}=2\sqrt[3]{5}$

b. $\sqrt[5]{8}\cdot\sqrt[5]{8}=\sqrt[5]{8\cdot 8}$
$=\sqrt[5]{64}$
$=\sqrt[5]{32}\cdot\sqrt[5]{2}$
$=2\sqrt[5]{2}$

c. $\sqrt[3]{\frac{125}{27}}=\frac{\sqrt[3]{125}}{\sqrt[3]{27}}=\frac{5}{3}$

8. $3\sqrt[3]{81}-4\sqrt[3]{3}$
$=3\sqrt[3]{27\cdot 3}-4\sqrt[3]{3}$
$=3\cdot 3\sqrt[3]{3}-4\sqrt[3]{3}$
$=9\sqrt[3]{3}-4\sqrt[3]{3}$
$=(9-4)\sqrt[3]{3}$
$=5\sqrt[3]{3}$

9. a. $81^{1/2}=\sqrt{81}=9$

b. $27^{1/3}=\sqrt[3]{27}=3$

c. $32^{-1/5}=\frac{1}{32^{1/5}}=\frac{1}{\sqrt[5]{32}}=\frac{1}{2}$

10. a. $4^{3/2}=(\sqrt{4})^3=2^3=8$

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

11. a. $\left(2x^{4/3}\right)\left(5x^{8/3}\right)$
$= 2 \cdot 5x^{4/3} - x^{8/3}$
$= 10x^{(4/3)+(8/3)}$
$= 10x^{12/3}$
$= 10x^4$

b. $\dfrac{20x^4}{5x^{3/2}} = \left(\dfrac{20}{5}\right)\left(\dfrac{x^4}{x^{3/2}}\right)$
$= 4x^{4-(3/2)}$
$= 4x^{(8/2)-(3/2)}$
$= 4x^{5/2}$

12. $\sqrt[6]{x^3} = x^{3/6} = x^{1/2} = \sqrt{x}$

Exercise Set P.3

1. $\sqrt{36} = \sqrt{6^2} = 6$

3. $\sqrt{-36}$ is not a real number.

5. $\sqrt{(-13)^2} = |-13| = 13$

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

9. $\sqrt{45x^2} = \sqrt{9x^2 \cdot 5}$
$= \sqrt{9x^2}\sqrt{5}$
$= \sqrt{9}\sqrt{x^2}\sqrt{5}$
$= 3|x|\sqrt{5}$

11. $\sqrt{2x} \cdot \sqrt{6x} = \sqrt{2x \cdot 6x}$
$= \sqrt{12x^2}$
$= \sqrt{4x^2 \cdot 3}$
$= \sqrt{4x^2}\sqrt{3}$
$= \sqrt{4}\sqrt{x^2}\sqrt{3}$
$= 2|x|\sqrt{3}$

13. $\sqrt{x^3} = \sqrt{x^2 \cdot x} = |x|\sqrt{x}$

15. $\sqrt{2x^2} \cdot \sqrt{6x} = \sqrt{2x^2 \cdot 6x}$
$= \sqrt{12x^3}$
$= \sqrt{4x^2}\sqrt{x}$
$= 2|x|\sqrt{3x}$

17. $\sqrt{\dfrac{1}{81}} = \dfrac{\sqrt{1}}{\sqrt{81}} = \dfrac{1}{9}$

19. $\sqrt{\dfrac{49}{16}} = \dfrac{\sqrt{49}}{\sqrt{16}} = \dfrac{7}{4}$

21. $\dfrac{\sqrt{48x^3}}{\sqrt{3x}} = \sqrt{\dfrac{48x^3}{3x}} = \sqrt{16x^2} = 4|x|$

23. $\dfrac{\sqrt{150x^4}}{\sqrt{3x}} = \sqrt{\dfrac{150x^4}{3x}}$
$= \sqrt{50x^3}$
$= \sqrt{25x^2}\sqrt{2x}$
$= 5|x|\sqrt{2x}$

25. $7\sqrt{3} + 6\sqrt{3} = (7+6)\sqrt{3} = 13\sqrt{3}$

27. $6\sqrt{17x} - 8\sqrt{17x} = (6-8)\sqrt{17x} = -2\sqrt{17x}$

29. $\sqrt{8} + 3\sqrt{2} = \sqrt{4 \cdot 2} + 3\sqrt{2}$
$= 2\sqrt{2} + 3\sqrt{2}$
$= (2+3)\sqrt{2}$
$= 5\sqrt{2}$

31. $\sqrt{50x} - \sqrt{8x} = \sqrt{25 \cdot 2x} - \sqrt{4 \cdot 2x}$
$= 5\sqrt{2x} - 2\sqrt{2x}$
$= (5-2)\sqrt{2x}$
$= 3\sqrt{2x}$

33. $3\sqrt{18} + 5\sqrt{50} = 3\sqrt{9 \cdot 2} + 5\sqrt{25 \cdot 2}$
$= 3 \cdot 3\sqrt{2} + 5 \cdot 5\sqrt{2}$
$= 9\sqrt{2} + 25\sqrt{2}$
$= (9+25)\sqrt{2}$
$= 34\sqrt{2}$

35. $\dfrac{1}{\sqrt{7}} = \dfrac{1}{\sqrt{7}} \cdot \dfrac{\sqrt{7}}{\sqrt{7}} = \dfrac{\sqrt{7}}{7}$

37. $\dfrac{\sqrt{2}}{\sqrt{5}} = \dfrac{\sqrt{2}}{\sqrt{5}} \cdot \dfrac{\sqrt{5}}{\sqrt{5}} = \dfrac{\sqrt{10}}{5}$

39. $\dfrac{13}{3+\sqrt{11}} = \dfrac{13}{3+\sqrt{11}} \cdot \dfrac{3-\sqrt{11}}{3-\sqrt{11}}$

$= \dfrac{13(3-\sqrt{11})}{3^2-(\sqrt{11})^2}$

$= \dfrac{13(3-\sqrt{11})}{9-11}$

$= \dfrac{13(3-\sqrt{11})}{-2}$

41. $\dfrac{7}{\sqrt{5}-2} = \dfrac{7}{\sqrt{5}-2} \cdot \dfrac{\sqrt{5}+2}{\sqrt{5}+2}$

$= \dfrac{7(\sqrt{5}+2)}{(\sqrt{5})^2-2^2}$

$= \dfrac{7(\sqrt{5}+2)}{5-4}$

$= 7(\sqrt{5}+2)$

43. $\dfrac{6}{\sqrt{5}+\sqrt{3}} = \dfrac{6}{\sqrt{5}+\sqrt{3}} \cdot \dfrac{\sqrt{5}-\sqrt{3}}{\sqrt{5}-\sqrt{3}}$

$= \dfrac{6(\sqrt{5}-\sqrt{3})}{(\sqrt{5})^2-(\sqrt{3})^2}$

$= \dfrac{6(\sqrt{5}-\sqrt{3})}{5-3}$

$= \dfrac{6(\sqrt{5}-\sqrt{3})}{2}$

$= 3(\sqrt{5}-\sqrt{3})$

45. $\sqrt[3]{125} = \sqrt[3]{5^3} = 5$

47. $\sqrt[3]{-8} = \sqrt[3]{(-2)^3} = -2$

49. $\sqrt[4]{-16}$ is not a real number.

51. $\sqrt[4]{(-3)^4} = |-3| = 3$

53. $\sqrt[5]{(-3)^5} = -3$

55. $\sqrt[3]{32} = \sqrt[3]{8 \cdot 4} = \sqrt[3]{8}\sqrt[3]{4} = 2 \cdot \sqrt[3]{4}$

57. $\sqrt[3]{x^4} = \sqrt[3]{x^3 \cdot x} = x \cdot \sqrt[3]{x}$

59. $\sqrt[3]{9} \cdot \sqrt[3]{6} = \sqrt[3]{54} = \sqrt[3]{27 \cdot 2} = \sqrt[3]{27}\sqrt[3]{2} = 3\sqrt[3]{2}$

61. $\dfrac{\sqrt[5]{64x^6}}{\sqrt[5]{2x}} = \sqrt[5]{\dfrac{64x^6}{2x}} = \sqrt[5]{32x^5} = 2x$

63. $36^{1/2} = \sqrt{36} = 6$

65. $8^{1/3} = \sqrt[3]{8} = 2$

67. $125^{2/3} = \left(\sqrt[3]{125}\right)^2 = 5^2 = 25$

69. $32^{-4/5} = \dfrac{1}{32^{4/5}} = \dfrac{1}{2^4} = \dfrac{1}{16}$

71. $\left(7x^{1/3}\right)\left(2x^{1/4}\right) = 7 \cdot 2x^{1/3} \cdot x^{1/4}$

$= 14 \cdot x^{1/3+1/4}$

$= 14x^{7/12}$

73. $\dfrac{20x^{1/2}}{5x^{1/4}} = \left(\dfrac{20}{5}\right)\left(\dfrac{x^{1/2}}{x^{1/4}}\right)$

$= 4 \cdot x^{1/2-1/4}$

$= 4x^{1/4}$

75. $\left(x^{2/3}\right)^3 = x^{2/3 \cdot 3} = x^2$

77. $(25x^4y^6)^{1/2} = 25^{1/2}x^{4 \cdot 1/2}y^{6 \cdot 1/2} = 5x^2|y|^3$

79. $\sqrt[4]{5^2} = 5^{2/4} = 5^{1/2} = \sqrt{5}$

81. $\sqrt[3]{x^6} = x^{6/3} = x^2$

83. $\sqrt[6]{x^4} = x^{4/6} = |x|^{2/3}$

85. $2\sqrt{5L}$ with $L = 40$ gives

$$\begin{aligned} 2\sqrt{5 \cdot 40} &= 2\sqrt{200} \\ &= 2\sqrt{100 \cdot 2} \\ &= 2 \cdot 10\sqrt{2} \\ &= 20\sqrt{2} \end{aligned}$$

The speed of the car prior to the accident was $20\sqrt{2}$ miles per hour.

87.

$$\begin{aligned} \frac{w}{h} &= \frac{2}{\sqrt{5}-1} \\ &= \frac{2}{\sqrt{5}-1} \cdot \frac{\sqrt{5}+1}{\sqrt{5}+1} \\ &= \frac{2(\sqrt{5}+1)}{(\sqrt{5})^2 - 1^2} \\ &= \frac{2(\sqrt{5}+1)}{5-1} \\ &= \frac{2(\sqrt{5}+1)}{4} \\ &= \frac{\sqrt{5}+1}{2} \\ &\approx 1.62 \end{aligned}$$

89.

$$\begin{aligned} \frac{7\sqrt{2 \cdot 2 \cdot 3}}{6} &= \frac{7\sqrt{2^2 \cdot 3}}{6} \\ &= \frac{7\sqrt{2^2}\sqrt{3}}{6} \\ &= \frac{7 \cdot 2\sqrt{3}}{6} \\ &= \frac{7}{3}\sqrt{3} \end{aligned}$$

91.

$$\begin{aligned} 0.07d^{3/2} &= 0.07 \cdot 9^{3/2} \\ &= 0.07(\sqrt{9})^3 \\ &= 0.07 \cdot 3^3 \\ &= 0.07 \cdot 27 \\ &= 1.89 \end{aligned}$$

The duration of a storm whose diameter is 9 miles is 1.89 hours.

93.–97. Answers may vary.

99. $60.19x^{0.025}$

x	$60.19x^{0.025}$	x	$60.19x^{0.025x}$
1	60.19	17	64.61
2	61.24	18	64.70
3	61.87	19	64.79
4	62.31	20	64.87
5	62.66	21	64.95
6	62.95	22	65.03
7	63.19	23	65.10
8	63.40	24	65.17
9	63.59	25	65.23
10	63.76	26	65.30
11	63.91	27	65.36
12	64.05	28	65.42
13	64.18	29	65.48
14	64.30	30	65.53
15	64.41	31	65.59
16	64.51		

At the beginning of 1990, the expected lifespan was 64.95 years. During 1990, the lifespan of African American men first exceeded 65 years. At the beginning of 1991, the expected lifespan was 65.03 years.

101. a. False; $(-8)^{1/3} = \sqrt[3]{-8} = -2$, which is a real number.

b. False; $\sqrt{x^2 + y^2} \neq \sqrt{(x+y)^2} = x + y$, if $x + y \geq 0$.

c. False; $\frac{1}{2} = 8^{-1/3} \neq -2$

d. True; $2^1 = 2^{1/2}2^{1/2} = 2$

(d) is true.

103. $\sqrt{\square \cdot x^{\square}} = 5 \cdot x^7$

$\left(\square \cdot x^{\square}\right)^{1/2} = 5 \cdot x^7$

Square both sides.

$\square \cdot x^{\square} = 25 \cdot x^{14}$

Let $\square = 25$ and $\square = 14$.

105. a. $3^{1/2} \square 3^{1/3}$

Square both sides. $3\square 3^{2/3} = 9^{1/3}$

Raise to the third power on both sides.

$3^3 = 27 \boxed{>} \left(9^{1/3}\right)^3 = 9$

b. $\sqrt{7} + \sqrt{18} \square \sqrt{7+18}$

$\sqrt{7} + \sqrt{18} \square \sqrt{7+18} = \sqrt{25} = 5$

Square both sides.

$(\sqrt{7} + \sqrt{18})^2 = 7 + 2\sqrt{126} + 18$

$= 25 + 3\sqrt{14} \boxed{>} 25$

Section P.4

Check Point Exercises

1. a. $(-17x^3 + 4x^2 - 11x - 5) + (16x^3 - 3x^2 + 3x - 15)$

$= (-17x^3 + 16x^3) + (4x^2 - 3x^2) + (-11x + 3x) + (-5 - 15)$

$= -x^3 + x^2 - 8x - 20$

b. $(13x^3 - 9x^2 - 7x + 1) - (7x^3 + 2x^2 - 5x + 9)$

$= (13x^3 - 9x^2 - 7x + 1) + (7x^3 - 2x^2 + 5x - 9)$

$= (13x^3 + 7x^3) + (-9x^2 - 2x^2) + (-7x + 5x) + (1 - 9)$

$= 20x^3 - 11x^2 - 2x - 8$

2. $(5x-2)(3x^2-5x+4)$
$= 5x(3x^2-5x+4)-2(3x^2-5x+4)$
$= 5x\cdot 3x^2-5x\cdot 5x+5x\cdot 4-2\cdot 3x^2+2\cdot 5x-2\cdot 4$
$= 15x^3-25x^2+20x-6x^2+10x-8$
$= 15x^3-31x^2+30x-8$

3. $(7x-5)(4x-3) = 7x\cdot 4x+7x(-3)+(-5)4x+(-5)(-3)$
$= 28x^2-21x-20x+15$
$= 28x^2-41x+15$

4. a. $(7x-6y)(3x-y) = (7x)(3x)+(7x)(-y)+(-6y)(3x)+(-6y)(-y)$
$= 21x^2-7xy-18xy+6y^2$
$= 21x^2-25xy+6y^2$

b. $(x^2+5y)^2 = (x^2)^2+2(x^2)(5y)+(5y)^2$
$= x^4+10x^2y+25y^2$

5. a. $(3x+2+5y)(3x+2-5y) = (3x+2)^2-(5y)^2$
$= 9x^2+12x+4-25y^2$
$= 9x^2+12x-25y^2+4$

b. $(2x+y+3)^2 = (2x+y)^2+2(2x+y)(3)+3^2$
$= 4x^2+4xy+y^2+12x+6y+9$
$= 4x^2+4xy+12x+y^2+6y+9$

Exercise Set P.4

1. Yes; $2x+3x^2-5 = 3x^2+2x-5$

3. No; The form of a polynomial involves addition and subtraction, not division.

5. $3x^2$ has degree 2
$-5x$ has degree 1
4 has degree 0
$3x^2-5x+4$ has degree 2.

7. x^2 has degree 2
$-4x^3$has degree 3
$9x$ has degree 1
$-12x^4$ has degree 4
63 has degree 0
$x^2-4x^3+9x-12x^4+63$ has degree 4.

9. $(-6x^3+5x^2-8x+9)+(17x^3+2x^2-4x-13)=(-6x^3+17x^3)+(5x^2+2x^2)+(-8x-4x)+(9-13)$
$=11x^3+7x^2-12x-4$

The degree is 3.

11. $(17x^3-5x^2+4x-3)-(5x^3-9x^2-8x+11)=(17x^3-5x^2+4x-3)+(-5x^3+9x^2+8x-11)$
$=(17x^3-5x^3)+(-5x^2+9x^2)+(4x+8x)+(-3-11)$
$=12x^3+4x^2+12x-14$

The degree is 3.

13. $(5x^2-7x-8)+(2x^2-3x+7)-(x^2-4x-3)=(5x^2-7x-8)+(2x^2-3x+7)+(-x^2+4x+3)$
$=(5x^2+2x^2-x^2)+(-7x-3x+4x)+(-8+7+3)$
$=6x^2-6x+2$

The degree is 2.

15. $(x+1)(x^2-x+1)=x(x^2)-x\cdot x+x\cdot 1+1(x^2)-1\cdot x+1\cdot 1$
$=x^3-x^2+x+x^2-x+1$
$=x^3+1$

17. $(2x-3)(x^2-3x+5)=(2x)(x^2)+(2x)(-3x)+(2x)(5)+(-3)(x^2)+(-3)(-3x)+(-3)(5)$
$=2x^3-6x^2+10x-3x^2+9x-15$
$=2x^3-9x^2+19x-15$

19. $(x+7)(x+3)=x^2+3x+7x+21=x^2+10x+21$

21. $(x-5)(x+3)=x^2+3x-5x-15=x^2-2x-15$

23. $(3x+5)(2x+1)=(3x)(2x)+3x(1)+5(2x)+5=6x^2+3x+10x+5=6x^2+13x+5$

25. $(2x-3)(5x+3)=(2x)(5x)+(2x)(3)+(-3)(5x)+(-3)(3)$
$=10x^2+6x-15x-9$
$=10x^2-9x-9$

27. $(5x^2-4)(3x^2-7)=(5x^2)(3x^2)+(5x^2)(-7)+(-4)(3x^2)+(-4)(-7)$
$=15x^4-35x^2-12x^2+28$
$=15x^4-47x^2+28$

29. $(x+3)(x-3)=x^2-3^2$
$=x^2-9$

31. $(3x+2)(3x-2)=(3x)^2-2^2$
$=9x^2-4$