Chapter 4

4.1 Square Roots and Cube Roots, pages 158 to 161

1. a) 49 **b)** -2500 **c)** 9
d) $\frac{16}{5}$ **e)** $\frac{3}{4}$ **f)** $\frac{9}{16}$

2. a) 8 **b)** -64 **c)** -125
d) 2 **e)** $\frac{1}{72}$ **f)** $\frac{8}{27}$

3. a) 7 **b)** 13 **c)** 10
d) 2 **e)** 2 **f)** $3x$

4. a) 1 **b)** 6 **c)** 20
d) 2 **e)** $\frac{3}{5}$ **f)** $4a$

5. a) both; $(1)(1) = 1$, $(1)(1)(1) = 1$
b) perfect cube; $(10)(10)(10) = 1000$
c) perfect square; $(9)(9) = 81$
d) perfect square; $(13)(13) = 169$
e) perfect cube; $(6)(6)(6) = 216$
f) perfect square; $(32)(32) = 1024$

6. a) perfect square **b)** perfect cube
c) perfect square **d)** perfect square
e) both **f)** both

7. Find all prime factors of the radicand. Group the prime factors into two equal groups. Calculate the value of one group.
a) 10 **b)** 2 **c)** 9 **d)** 3 **e)** 12 **f)** 24

8. a) 14 **b)** 16 **c)** 21 **d)** 15 **e)** 31 **f)** 17

9. 20 m

10. 7 ft

11. a) 40 **b)** 38 ft
c) Example: My answer is 2 ft less than my estimate.

12. 1 m by 1 m or 2 m by 2 m or 3 m by 3 m

13. a) 120 squares **b)** Designs may vary.
c) Example: The length of the diagonal of each square is the square root of the sum of two sides squared.

14. 36 in.

15. a) 17 in.
b) Example: It is a 17 by 17 by 17 cube, so 17 represents the cube root of the volume.

16. 1000 mm^3

17. a) 22.2 km **b)** 6.3 h

18. 26 cm

19. a) 2880 cm^2
b) 13 824 cm^3; 24 cm by 24 cm by 24 cm

20. a)

Number	0	1	2	3	4	5	6	7	8
Number Squared	0	1	4	9	16	25	36	49	64

b) vertical axis: number squared; horizontal axis: number
c) 0.2; 2
d) Find 5 on the horizontal axis, slide up to the curve, and left to the vertical axis.
e) Find 49 on the vertical axis, slide right to the curve, and down to the horizontal axis.
f) $4.2^2 = 17.64$ **g)** 39

21. a) Example: What is the square root of $\frac{4}{9}$?

b) Example: What is the cube root of $\frac{8}{27}$?

4.2 Integral Exponents, pages 169 to 173

1. a) A positive exponent would be used for calculating population in future years, n being the number of years past 2005. A negative exponent would be used to calculate the population in years before 2005.

b) A positive exponent would be used for calculating the amount of radioactive substance a number of periods, n, after the sample was measured. A negative exponent would be used to calculate the amount of radioactive substance a number of periods before the sample was measured.

c) A positive exponent would be used for calculating the number of bacteria a number of periods, n, after the initial number in the culture was counted. A negative exponent would be used to calculate the number of bacteria in the culture a number of periods before the count was done.

2. a) $\frac{1}{b^3}$ **b)** $\frac{x}{y^4}$ **c)** $\frac{2}{x^2}$

d) $\frac{2x^2}{y}$ **e)** $\frac{-4}{x^5}$ **f)** $\frac{-2}{x^3y^4}$

3. Yes. A negative exponent in the numerator is a positive exponent in the denominator.

4. a) $\frac{1}{4^2}$ **b)** $\frac{1}{3^2}$ **c)** $\frac{1}{12^4}$

d) $\frac{1}{8^3}$ **e)** $\frac{1}{5^8}$ **f)** $\frac{3^6}{2^{15}}$

g) $\frac{4^2}{5^2}$ **h)** 3.2^6 **i)** $4(2^3)$

5. a) $\frac{t^6}{s^2}$ **b)** $\frac{1}{h^{10}}$ **c)** $8t^4$

d) $\frac{8}{x^{12}}$ **e)** $\frac{1}{n^{24}}$ **f)** x^6y^{24}

6. a) $2^6 = 64$ **b)** $\left(\frac{3}{2}\right)^9 = 38.4434$

c) $5^{-4} = 0.0016$ **d)** $(6^0)^{-3} = 1$

e) $8^8 = 16\ 777\ 216$ **f)** $\left(\frac{3}{4}\right)^6 = 0.1780$

7. a) 1250; 78 **b)** 80 000

8. \$593 979.4

9. 1000

10. a) i) 8000 **ii)** 256 000 **iii)** 500

b) the beginning of the time period

11. 1.298×10^{19} miles

12. 250 000 mm

13. a) 405 **b)** 328

14. 3.2×10^{24}

15. 4.1 volts

16. 2 weeks ago

17. a) the doubling approach **b)** \$40.96

18. 20 days

19. a) 14 164 **b)** 17 284

20. a) $\frac{2}{3}$ **b)** -4 **c)** -3 **d)** -2

21. 4

22. a) $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}, \frac{1}{32}, \frac{1}{64}$

b) \$32 000, \$16 000, \$8000, \$4000, \$2000, \$1000

c) \$1000 **d)** 9 agencies

23. a) 1200 **b)** 768 **c)** 491.5

24. a) 100 **b)** starting time

c) times before the starting time

25. Example: A power with a negative exponent moves from the numerator to the denominator, while a power with a positive exponent remains in the numerator. For example, $2^{-2} = \frac{1}{2^2}$, $2^2 = \frac{2^2}{1}$.

26. Example: In the half-life of a chemical substance, a negative exponent means the value decreases by a certain proportion over time.

27. a) 3^5 is larger. The greater the exponent, the greater the result will be if the base is the same.

b) The greater the base, the greater the result will be when the exponent is the same.

c) 6^{222}, 2^{666}, 5^{333}, 3^{555}, 4^{444}

4.3 Rational Exponents, pages 180 to 183

1. a) $x^{\frac{16}{3}}$ **b)** b^2 **c)** a^3

d) $k^{7.8}$ **e)** 2 **f)** $\frac{-2a^2}{3}$

g) $-8x^2$ **h)** $27x^3$ **i)** $5x$

2. a) $x^{\frac{7}{3}}$ **b)** $\frac{1}{3^3}$ **c)** $\frac{1}{m^{\frac{10}{3}}}$

d) $\frac{1}{3p^{\frac{5}{2}}}$ **e)** $\frac{1}{x^9y^6}$ **f)** $\frac{243x^5}{32y^{10}}$

3. a) 2 **b)** $\frac{5}{4}$ **c)** $\frac{1}{2}$

d) $\frac{1}{4}$ **e)** $\frac{1}{2}$ **f)** 3

4. a) 4 **b)** 2 **c)** -81

d) 3 **e)** $\frac{216}{125}$ **f)** $\frac{1}{6}$

5. a) 0.0370 **b)** 6208.3751

c) 0.6905 **d)** 0.25

e) 77.5305 **f)** 0.1768

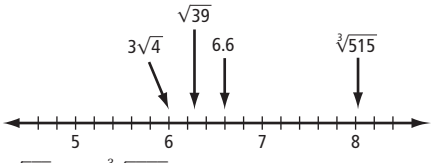
6. a) 402 **b)** 383 **c)** 207 **d)** 179

7. a) $t^{1.7}$ **b)** $4x$

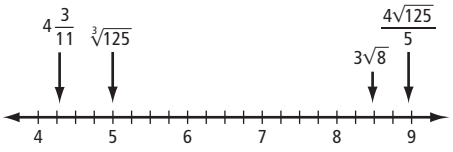
8. a) 3-year term deposit at 1.5%
b) $5.28
9. a) the starting population, in millions
b) 1 255 286 **c)** 1 138 950
10. a) 12; 24; 48; $6(2)^m$ **b)** 543
c) No, tank size and increased pollution of the tank would limit population growth.
11. a) $5111.33 **b)** $15 642.66
12. a) 7.6 times larger **b)** 8 times
13. a) $\frac{2}{5}$ **b)** $\frac{3}{4}$
14. a) 4 °C **b)** 1.3 °C
15. 5.80×10^{10} m
16. 7 folds
17. a) 14 mg/mL
b) Answers may range from 1.5 h to 1.75 h. Example: 1.66 h
18. Example: Rational exponents can be used to model the decrease in value of a car that you own. For example, consider a $10 000 car that decreases in value at a rate of 15% per year. You can model this situation using the equation $V = 10\,000(0.85)^n$, where V represents the value of the car and n is the number of years.
19. Example: A common error is multiplying the exponents instead of adding them when multiplying powers with the same base. You could rewrite the rational exponents in the margin and add them separately to help avoid multiplying them.

4.4 Irrational Numbers, pages 192 to 195

1. a) $(\sqrt{4})^3$ **b)** $\sqrt[5]{32}$ **c)** $\sqrt{64}$
d) $\sqrt[4]{\frac{1}{100}}$ **e)** $\sqrt[3]{\frac{y^4}{x^3}}$ **f)** $\sqrt{m^{3n}}$
2. a) $(12p)^{\frac{3}{2}}$ **b)** $5^{\frac{3}{5}}$ **c)** $x^{\frac{3}{4}}$
d) $\left(\frac{s^3}{t^5}\right)^{\frac{1}{3}}$ or $\frac{s}{t^{\frac{5}{3}}}$ **e)** $y^{\frac{5}{6}}$ **f)** $8^{\frac{1}{n}}$
3. a) 0.6 **b)** 3
c) 16.4924 **d)** 16.1662
e) 1.4071 **f)** 2.2678
4. a) $\sqrt{99}$ **b)** $\sqrt{98}$ **c)** $\sqrt{45}$
d) $\sqrt{28}$ **e)** $\sqrt{27}$ **f)** $\sqrt{600}$
5. a) $\sqrt[3]{56}$ **b)** $\sqrt[3]{81}$ **c)** $\sqrt[3]{5000}$
d) $\sqrt[3]{128}$ **e)** $\sqrt[4]{162}$ **f)** $\sqrt[4]{80}$
6. a) $2\sqrt{3}$ **b)** $5\sqrt{2}$ **c)** $4\sqrt{3}$
d) $6\sqrt{2}$ **e)** $3\sqrt{5}$ **f)** $10\sqrt{5}$
7. a) $2\sqrt[3]{3}$ **b)** $3\sqrt[3]{2}$ **c)** $3\sqrt[3]{9}$
d) $2\sqrt[3]{5}$ **e)** $2\sqrt[4]{2}$ **f)** $3\sqrt[4]{3}$
8. a) $\sqrt{0.25}$, $\frac{5}{8}$, $0.\overline{6}$, $\sqrt[3]{0.84}$; $\sqrt[3]{0.84}$ is an irrational number.
b) $\sqrt[4]{625}$, $\sqrt{225}$, $15\frac{4}{5}$, $3\sqrt{28}$; $3\sqrt{28}$ is an irrational number.
9. a)



$\sqrt{39}$ and $\sqrt[3]{515}$ are irrational numbers.
b)



$\frac{4\sqrt{125}}{5}$ and $3\sqrt{8}$ are irrational numbers.
10. 3.375 cm
11. 1.35 m
12. 40 mph
13. a) 37.08 cm **b)** 2224.8 cm^2
14. a) 85 min **b)** 35 800 km
15. 3.24 ft
16. $0.862 \approx \sqrt[3]{8P}$
$0.862 \approx 2\sqrt[3]{P}$
$0.431 \approx \sqrt[3]{P}$
$P \approx (0.431)^3$
$P \approx 0.08$
The store should offer an 8% discount.
17. 6.3 A
18. 2
19. a) $2^{\frac{1}{5}}$ **b)** $256^{\frac{1}{8}}$
20. Sometimes true. Not true when $x < 0$.
21. a) 8
b) Rational numbers: 1 by 1, 2 by 2, 3 by 3, 4 by 4. Irrational numbers: $\sqrt{2}$ by $\sqrt{2}$, $2\sqrt{2}$ by $2\sqrt{2}$, $\sqrt{5}$ by $\sqrt{5}$, $\sqrt{10}$ by $\sqrt{10}$
c) 1, 2, 4, 5, 8, 9, 10
22. The denominator is the root and the numerator is the power: $\sqrt[m]{x^n} = x^{\frac{n}{m}}$.

Chapter 4 Review, pages 196 to 198

1. a) perfect square **b)** both
c) perfect cube **d)** perfect square
e) both **f)** perfect square
2. 144 = (2)(2)(2)(2)(3)(3); square root: (2)(2)(3) = 12
3. a) 11 **b)** 6 **c)** 20
4. 11 cm by 11 cm by 11 cm
5. $540

6. a) $\frac{1}{x^8}$ **b)** s^6

c) $(-2.6)^6$ **d)** $(4k)^5$

7. a) 81 **b)** 0.0370

c) 0.4823 **d)** $\frac{x^2}{1\ 048\ 576}$

8. a) 1.03 m **b)** 5 bounces

9. a) 15.625 g **b)** 8000 g

10. a) 1470; 1543; 1620; $1400(1.05)^n$

b) 3369 **c)** 1209

11. a) $\left(\frac{1}{x}\right)^{\frac{1}{3}}$ **b)** 4

c) $\frac{1}{8g^6}$ **d)** $8t^7$

12. a) $(3)(3) = 9$

b) Example: A negative exponent in the numerator is a positive exponent in the denominator.

13. a) 7.3004 **b)** 0.1111

c) 0.001 **d)** 45.2548

14. $27^{\frac{2}{3}} = 9$, not 18; $9x^{\frac{8}{3}}$

15. \$7785.51

16. 0.166 km

17. \$465 658.88

18. a) $\sqrt[5]{x^3}$ **b)** $\sqrt[3]{(27t^2)^2}$ **c)** $\sqrt{\frac{g^3}{18}}$

19. a) $(xp)^{\frac{5}{2}}$ **b)** $2^{\frac{5}{3}}$ **c)** $3\left(x^{\frac{4}{5}}\right)$

20. a) $\sqrt{108}$ **b)** $\sqrt{40}$

c) $\sqrt[3]{320}$ **d)** $\sqrt[3]{-16}$

21. a) $6\sqrt{5}$ **b)** $8\sqrt{3}$

c) $4\sqrt[3]{2}$ **d)** $2\sqrt[4]{3}$

22. a) Irrational numbers: $\frac{\pi}{3}$, $\sqrt{0.9}$, $\sqrt[5]{96}$;

Order: $\sqrt[5]{96}$, $\frac{\pi}{3}$, $\sqrt{0.9}$, $0.\overline{24}$

b) Irrational number: $18^{\frac{1}{2}}$;

Order: $6.\overline{2}$, $2\sqrt[3]{27}$, $\sqrt{36}$, $18^{\frac{1}{2}}$

24. a) 9.8 cm **b)** 452.4 cm^2

Chapter 4 Practice Test, pages 199 to 201

1. D

2. A

3. D

4. C

5. A

6. A

7. B

8. a) $(2)(2)(2) = 8$ while $(3)(3)(3) = 27$, so the cube root of 10.648 is closer to 2.

b) 2.2 m by 2.2 m by 2.2 m

9. Example: An irrational number cannot be made into a ratio or fraction, so it cannot be rational.

10. a) 13 cm by 13 cm **b)** 4.3 cm

11. Subtract the exponents in step 2; $\frac{1}{2}$

12. 31.25 g

13. 224.8 km

14. a) 1580 **b)** 1758

15. a) Convert the numbers to decimals and order on the number line.

b) Change all mixed radicals to entire radicals and compare.

c) $6\sqrt{3}$, $4\sqrt{12}$, $3\sqrt{27}$, $3\sqrt{48}$