Chapter 3

3.1 Using Exponents to Describe Numbers, pages 97–98

4. a) $7^2 = 49$ **b)** $3^3 = 27$ **c)** $8^5 = 32\ 768$
d) $10^7 = 10\ 000\ 000$

5. a) 1^4; 1 is the base and 4 is the exponent
b) 2^5; 2 is the base and 5 is the exponent
c) 9^7; 9 is the base and 7 is the exponent
d) 13^1; 13 is the base and 1 is the exponent

6. a) 25 **b)** 27 **c)** 1024

7. a) 512 **b)** 64 **c)** 1

8.

Repeated Multiplication	Exponential Form	Value
a) $6 \times 6 \times 6$	6^3	216
b) $3 \times 3 \times 3 \times 3$	3^4	81
c) 7×7	7^2	49
d) 11×11	11^2	121
e) $5 \times 5 \times 5$	5^3	125

9. No, because $4^3 = 64$ and $3^4 = 81$

10. a) 81 **b)** -125 **c)** -128

11. a) -64 **b)** -1 **c)** 2187

12.

Repeated Multiplication	Exponential Form	Value
a) $(-3) \times (-3) \times (-3)$	$(-3)^3$	-27
b) $(-4) \times (-4)$	$(-4)^2$	16
c) $(-1) \times (-1) \times (-1)$	$(-1)^3$	-1
d) $(-7) \times (-7)$	$(-7)^2$	49
e) $(-10) \times (-10) \times (-10)$	$(-10)^3$	-1000

13. No, because $(-6)^4 = 1296$ and $-6^4 = -1296$

14. $3 \times 3 \times 3 = 3^3$

15. a)

Month	Body Length (cm)
Beginning	1
1	2
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1024

b) $2^5 = 32$ cm **c)** After 6 months.

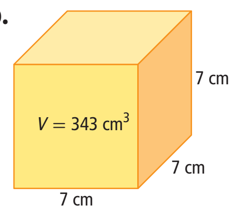
16. 1^{22}, 2^5, 7^2, 4^3, 3^4

17. $2^{15} = 32\ 768$

18. a) 3^2 **b)** $(-3)^2$

19. Example: Multiplication is repeated addition. For example, $3 \times 5 = 3 + 3 + 3 + 3 + 3$
$= 15$
Powers are a way to represent repeated multiplication. For example, $3^5 = 3 \times 3 \times 3 \times 3 \times 3$
$= 243$

20.



21. Example: 12×12, $2 \times 6 \times 2 \times 6$, $2 \times 2 \times 3 \times 2 \times 2 \times 3$

22.

Exponential Form	Value
5^3	125
5^4	625
5^5	3 125
5^6	15 625
5^7	78 125
5^8	390 625
5^9	1 953 125
5^{10}	9 765 625

a) An even exponent has 625 as its last three digits. An odd exponent has 125 as its last three digits. **b)** 625

23.

Exponential Form	Value
3^1	3
3^2	9
3^3	27
3^4	81
3^5	243
3^6	729
3^7	2 187
3^8	6 561
3^9	19 683
3^{10}	59 049
3^{11}	177 147
3^{12}	531 441

a) Example: The units digit follows a pattern of 3, 9, 7, 1
b) Example: I predict that the units digit will be a 7. The cycle is of length 4. So, with an exponent of 63, the cycle would go through 15 times, with a remainder of 3. That means that the units digit would be the third number in the cycle, which is a 7.

3.2 Exponent Laws, pages 106–107

5. a) $4^7 = 16\ 384$ **b)** $7^6 = 117\ 649$ **c)** $(-3)^7 = -2187$
6. a) $5^5 = 3125$ **b)** $(-6)^6 = 46\ 656$ **c)** $8^3 = 512$
7. a) $4^3 \times 4^4 = 4^7$ **b)** $2^5 \times 2^2 = 2^7$ **c)** $9^4 \times 9^7 = 9^{11}$
8. $3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 3^9$
9. a) $5^2 = 25$ **b)** $3^4 = 81$ **c)** $(-4)^4 = 256$
10. a) $7^3 = 343$ **b)** $(-8)^2 = 64$ **c)** $(-2)^1 = -2$
11. a) $\frac{6^4}{6^3} = 6^1$ **b)** $\frac{3^8}{3^2} = 3^6$ **c)** $\frac{5^7}{5^1} = 5^6$
12. $\frac{(-5)^7}{(-5)^2}$
13. $\frac{(6^2)^3}{6^3} = 6^3$
14. a) $3^8 = 6561$ **b)** $7^4 \times (-3)^4 = 194\ 481$
c) $\frac{5^4}{6^4} = \frac{625}{1296}$
15. a) $-4^6 = -4096$ **b)** $3^4 \times 4^4 = 20\ 736$ **c)** $\frac{4^3}{5^3} = \frac{64}{125}$
16. $[(2)^2]^4$
17.

Expression	Repeated Multiplication	Powers
a) $[2 \times (-5)]^3$	$2 \times (-5) \times 2 \times (-5) \times 2 \times (-5)$	$2^3 \times (-5)^3$
b) $(9 \times 8)^2$	$9 \times 8 \times 9 \times 8$	$9^2 \times 8^2$
c) $\left(\frac{2}{3}\right)^4$	$\frac{2}{3} \times \frac{2}{3} \times \frac{2}{3} \times \frac{2}{3}$	$\frac{2^4}{3^4}$

18. a) 1; Example: $2^4 = 16$
$2^3 = 8$
$2^2 = 4$
$2^1 = 2$
$2^0 = 1$

b) $\frac{2^4}{2^4} = \frac{16}{16} = 1$ and $\frac{2^4}{2^4} = 2^{4-4} = 2^0$

Therefore, $2^0 = 1$.

19. a) $-4^0 = -1$ because $4^0 = 1$, so $-(1) = -1$ **b)** -1
20. a) $\frac{20^2}{50^2}$ **b)** $\left(\frac{2}{5}\right)^2$
21. a) 3^{11} **b)** $(-4)^3$
22. Example: Jenny multiplied the exponents in step 2. She should have added the exponents.
23. Example: $4^1 \times 4^4$, $4^2 \times 4^3$, $4^0 \times 4^5$
24. Example: Place 3 in the numerator and 5 in the denominator.
25. Example: **a)** $81^3 = 27^4$ **b)** $81^6 = 27^8$
26. a) 121 **b)** 33

3.3 Order of Operations, pages 111–113

5. a) 128 **b)** 63 **c)** −1250 **d)** −12
6. a) $4 \times 2^4 = 64$ **b)** $3 \times (-2)^3 = -24$
c) $7 \times 10^5 = 700\ 000$ **d)** $-1 \times 9^4 = -6561$
7. Example: **a)** $4 \times 3^2 = 36$ **b)** $-5 \times 4^3 = -320$
8. a) 18 **b)** 70 **c)** 535 **d)** 73
9. a) −11 **b)** 58 **c)** 1 **d)** 44
10. a) $3(2)^3 = 24$, and $2(3)^2 = 18$, so $3(2)^3$ is greater by 6.
b) $(3 \times 4)^2 = 144$, and $3^2 \times 4^2 = 144$, so the expressions are equal. **c)** $6^3 + 6^3 = 432$, and $(6 + 6)^3 = 1728$, so $(6 + 6)^3$ is greater by 1296.
11. In step 3, Justine should have multiplied 4 by 9. The correct answer is −27.
12. In step 1, Katarina should have squared 4 correctly to obtain 16. The correct answer is 76.
13. $9^3 - 7^3 = 386$ cm^3
14. a) 49 **b)** 2401 **c)** $7^1 + 7^2 + 7^3 + 7^4 = 2800$
15. $6^2 - 5^2 = 11$ cm^2
16. $10^2 - 8^2 = 36$ cm^2
17. 1 953 125
18. a) Question 2: \$12 500, question 3: \$50 000, question 4: \$200 000
b) 6 questions **c)** The 8th question.
d) $3125(4^0) + 3125(4^1) + 3125(4^2) + 3125(4^3) = 265\ 625$
19. a) 48 **b)** 3×2^4 **c)** Example: It represents the number of coaches who made the first six calls.
d) It represents the round number of the calls.
e) $3 \times 2^6 = 192$ **f)** $5 \times 2^3 = 40$
20. 2^{222}

3.4 Using Exponents to Solve Problems, pages 118–119

3. 216 cm^3
4. Area of square: $14^2 = 196$ cm^2; Surface area of cube: $6(6)^2 = 216$ cm^2. The surface area of the cube is larger.
5. a) 60 **b)** 14 580 **c)** $20(3^n)$
6. a) 400 **b)** 1600 **c)** 819 200
7. a) Example: If an assumption that she needs 100 cm^2 of overlap is made, she would need 12 796 cm^2 of paper.
8. 9×10^{13} joules
9. a) It represents the number of questions.
b) It represents the possible answers for each question.
c) TTTT, TTTF, TTFT, TFTT, TTFF, TFTF, TFFT, FFFF, FFFT, FFTF, FTFF, FFTT, FTFT, FTTF, FTTT
d) $2^{10} = 1024$
10. $60^3 = 216\,000$
11. a) 37.5 m **b)** 180 m
c) Example:
C 0.75 × 60 × (2000 ÷ 1000) x^2 = 180.
12. a) The term "googol" was created by nine year old Milton Sirotta, the nephew of the American mathematician Edward Kasner who was investigating very large numbers at the time. The Latin word for "a lot" is "googis". Google™ possibly used that name to suggest the enormous amount of information their search engine could be used to investigate. **b)** 100 zeros. **c)** The time to write a googol as a whole number is the time it would take to write a 1 followed by 100 zeros, a total of 101 digits. If two digits could be written per second, it would take 101 ÷ 2 or about 51 s.
13. a) Same base, different exponent: $3^7 \div 3^5 = 3^{7-5}$
$= 3^2$
$= 9$

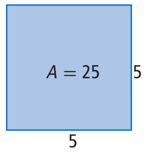
Rule: Divide the larger power by the smaller power and evaluate. This will indicate how many times as large the larger power is compared to the smaller power.

Different base, same exponent: $6^4 \div 5^4 = \left(\frac{6}{5}\right)^4$
$= \frac{1296}{625}$

Rule: Divide the larger power by the smaller power, express as a single power with a fractional base, then evaluate. This will indicate how many times as large the larger power is compared to the smaller power.
b) $32^4 = (2^5)^4$ $\quad 64^3 = (2^6)^3$ $\quad 2^{20} \div 2^{18} = 2^2$
$= 2^{20}$ $\quad = 2^{18}$ $\quad = 4$
So 32^4 is four times as large as 64^3.

Chapter 3 Review, pages 120–121

1. coefficient
2. exponential form
3. base
4. power
5. exponent
6. a) 2^3 **b)** $(-3)^4$
7. a) $4 \times 4 \times 4 \times 4 \times 4 \times 4$ **b)** $6 \times 6 \times 6 \times 6$
c) $(-5) \times (-5) \times (-5) \times (-5) \times (-5) \times (-5) \times (-5)$
d) $-(5 \times 5 \times 5 \times 5 \times 5 \times 5 \times 5)$
8. Area = 25 square units



9. $4 \times 4 \times 4 = 4^3$
$= 64$
$V = 64$ cm^3
10. -3^4, 9, 2^5, 7^2, 4^3
11. a) $3 \times 3 \times 5 \times 5 \times 5 \times 5$
b) $(-3) \times (-3) \times (-3) \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$
12. a) $2^3 \times 2^2 = 2^5$ **b)** $\frac{4^2 \times 4^4}{4^3} = 4^3$
13. a) $(-5) \times (-5) \times (-5) \times (-5) \times (-5) \times (-5) \times (-5) = (-5)^7$ **b)** $3^2 \times 3^2 \times 3^2 \times 3^2 = 3^8$
14. a) $6^3 \times 4^3$ **b)** $7^5 \times (-2)^5$
15. a) $\frac{4^2}{5^2}$ **b)** $\frac{2^4}{7^4}$
16. a) -16 **b)** 1 **c)** 243
17. Example: **a)** $(-2)^2 + (-2)^3 = -4$
b) $(2^3)^2 - 4 \times 6^0 = 60$
c) $(-3)^4 - (-3)^3 + (2 \times 4)^2 = 172$
18. a) 47 **b)** 9 **c)** 1 **d)** $1\frac{16}{25}$
19. In step 2, the error is that Ang added 81 + 7 when he should have multiplied 7 and 8.
20. 150 m^2
21. a) 80 **b)** 640
22. a) 4.9 m **b)** 19.6 m **c)** 176.4 m