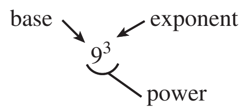
Chapter 4

Chapter Opener

Math in the Real World (p. 171)

15.1 quadrillion is written as 15,100,000,000,000,000.
So 1 quadillion is written as 1,000,000,000,000,000.
One quadrillion has 15 zeros.

Prerequisite Skills Quiz (p. 172)

1. 

2. $5\frac{1}{3} = \frac{5 \cdot 3 + 1}{3} = \frac{16}{3}$ **3.** $6\frac{2}{5} = \frac{6 \cdot 5 + 2}{5} = \frac{32}{5}$

4. $3\frac{7}{9} = \frac{3 \cdot 9 + 7}{9} = \frac{34}{9}$ **5.** $8\frac{5}{6} = \frac{8 \cdot 6 + 5}{6} = \frac{53}{6}$

6. $20 \times \frac{3}{5} = \frac{20}{1} \times \frac{3}{5} = \frac{\overset{4}{\cancel{20}} \times 3}{1 \times \underset{1}{\cancel{5}}} = 12$

7. $32 \times \frac{7}{8} = \frac{32}{1} \times \frac{7}{8} = \frac{\overset{4}{\cancel{32}} \times 7}{1 \times \underset{1}{\cancel{8}}} = 28$

8. $\frac{2}{3} \times 27 = \frac{2}{3} \times \frac{27}{1} = \frac{2 \times \overset{9}{\cancel{27}}}{\underset{1}{\cancel{3}} \times 1} = 18$

9. $\frac{9}{10} \times 50 = \frac{9}{10} \times \frac{50}{1} = \frac{9 \times \overset{5}{\cancel{50}}}{\underset{1}{\cancel{10}} \times 1} = 45$

10. 5 to the fourth power; $5^4 = 5 \cdot 5 \cdot 5 \cdot 5 = 625$

11. 12 cubed; $12^3 = 12 \cdot 12 \cdot 12 = 1728$

12. 1.3 cubed;
$(1.3)^3 = (1.3)(1.3)(1.3) = 2.197$

13. 0.2 squared; $(0.2)^2 = (0.2)(0.2) = 0.04$

Lesson 4.1

4.1 Concept Activity (p. 173)

Investigate

1–4.

	(2)	(3)	~~4~~	(5)	~~6~~
(7)	~~8~~	~~9~~	~~10~~	(11)	~~12~~
(13)	~~14~~	~~15~~	~~16~~	(17)	~~18~~
(19)	~~20~~	~~21~~	~~22~~	(23)	~~24~~
~~25~~	~~26~~	~~27~~	~~28~~	(29)	~~30~~
(31)	~~32~~	~~33~~	~~34~~	~~35~~	~~36~~
(37)	~~38~~	~~39~~	~~40~~	(41)	~~42~~
(43)	~~44~~	~~45~~	~~46~~	(47)	~~48~~
~~49~~	~~50~~	~~51~~	~~52~~	(53)	~~54~~
~~55~~	~~56~~	~~57~~	~~58~~	(59)	~~60~~

Draw Conclusions

1. The numbers that have been crossed out are *composite* numbers because they have more than two whole number factors. The numbers that have been circled are *prime* numbers because they only have two whole number factors, 1 and itself.

2. The numbers in the second column are crossed out because they are multiples of 2. The numbers in the third column are crossed out because they are multiples of 3. The numbers in the fourth column are crossed out because they are also multiples of 2.

3. Columns 2 (except for 2), 4, 6, 8, and 10 would be crossed out because they contain multiples of 2.

1	(2)	(3)	~~4~~	(5)	~~6~~	(7)	~~8~~	~~9~~	~~10~~
(11)	~~12~~	(13)	~~14~~	~~15~~	~~16~~	(17)	~~18~~	(19)	~~20~~
~~21~~	~~22~~	(23)	~~24~~	~~25~~	~~26~~	~~27~~	~~28~~	(29)	~~30~~
(31)	~~32~~	~~33~~	~~34~~	~~35~~	~~36~~	(37)	~~38~~	~~39~~	~~40~~
(41)	~~42~~	(43)	~~44~~	~~45~~	~~46~~	(47)	~~48~~	~~49~~	~~50~~
~~51~~	~~52~~	(53)	~~54~~	~~55~~	~~56~~	~~57~~	~~58~~	(59)	~~60~~

4.1 Checkpoint (pp. 174–176)

1. The factors of 30 are 1, 2, 3, 5, 6, 10, 15, and 30.

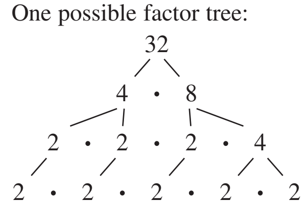
2. The factors of 31 are 1 and 31.

3. The factors of 45 are 1, 3, 5, 9, 15, and 45.

4. The factors of 87 are 1, 3, 29, and 87.

5. 32 is composite.

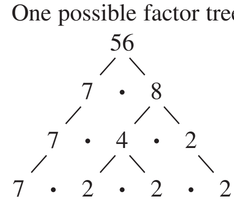
One possible factor tree:



The prime factorization of 32 is 2^5.

6. 56 is composite.

One possible factor tree:

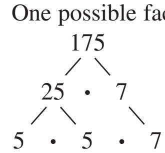


The prime factorization of 56 is $2^3 \cdot 7$.

7. 59 is prime. **8.** 83 is prime. **9.** 101 is prime.

10. 175 is composite.

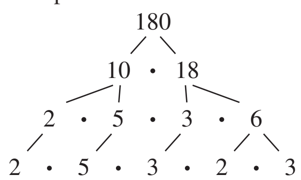
One possible factor tree:



The prime factorization of 175 is $5^2 \cdot 7$.

11. 180 is composite.

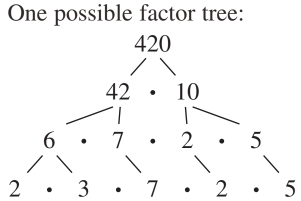
One possible factor tree:



The prime factorization of 180 is $2^2 \cdot 3^2 \cdot 5$.

12. 420 is composite.

One possible factor tree:



The prime factorization of 420 is $2^2 \cdot 3 \cdot 5 \cdot 7$.

13. $6ab = 2 \cdot 3 \cdot a \cdot b$

14. $15n^3 = 3 \cdot 5 \cdot n^3 = 3 \cdot 5 \cdot n \cdot n \cdot n$

15. $3x^3y^2 = 3 \cdot x^3 \cdot y^2 = 3 \cdot x \cdot x \cdot x \cdot y \cdot y$

16. $36s^4t = 2 \cdot 2 \cdot 3 \cdot 3 \cdot s^4 \cdot t = 2 \cdot 2 \cdot 3 \cdot 3 \cdot s \cdot s \cdot s \cdot s \cdot t$

4.1 Guided Practice (p. 176)

1. *Sample answer:* Write the number as the product of two whole number factors that are not equal to 1 or the number itself. Continue this process with any composite factors until only prime numbers remain. Write the original number as the product of the prime numbers that remain, using exponents for prime factors that repeat.

2. *Sample answer:* It has two whole number factors, 2 and 17, that are not equal to 1 or the number itself.

3. The factors of 16 are 1, 2, 4, 8, and 16.

4. The factors of 32 are 1, 2, 4, 8, 16, and 32.

5. The factors of 29 are 1 and 29.

6. The factors of 55 are 1, 5, 11, and 55.

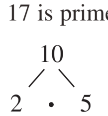
7. 9 is composite.

8. 15 is composite.

9. 17 is prime.

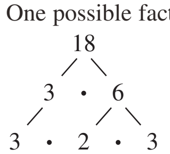
10. 23 is prime.

11.



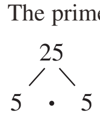
The prime factorization of 10 is $2 \cdot 5$.

12. One possible factor tree:



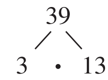
The prime factorization of 18 is $2 \cdot 3^2$.

13.



The prime factorization of 25 is 5^2.

14.



The prime factorization of 39 is $3 \cdot 13$.

15. *Sample answer*: The factor 4 is composite, and equals $2 \cdot 2$. The prime factorization of 60 is:

$60 = 2^2 \cdot 3 \cdot 5$

4.1 Practice and Problem Solving (pp. 177–178)

16. The factors of 8 are 1, 2, 4, and 8.

17. The factors of 53 are 1 and 53.

18. The factors of 12 are 1, 2, 3, 4, 6, and 12.

19. The factors of 33 are 1, 3, 11, and 33.

20. The factors of 36 are 1, 2, 3, 4, 6, 9, 12, 18, and 36.

21. The factors of 60 are 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, and 60.

22. The factors of 71 are 1 and 71.

23. The factors of 144 are 1, 2, 3, 4, 6, 8, 9, 12, 16, 18, 24, 36, 48, 72, and 144.

24. 7 is prime.

25. 16 is composite.

26. 21 is composite.

27. 19 is prime.

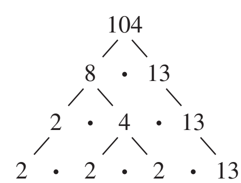
28. 121 is composite.

29. 51 is composite.

30. 84 is composite.

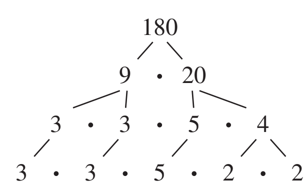
31. 141 is composite.

32.



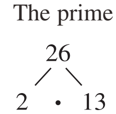
The prime factorization of 104 is $2^3 \cdot 13$.

33.



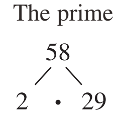
The prime factorization of 180 is $2^2 \cdot 3^2 \cdot 5$.

34.



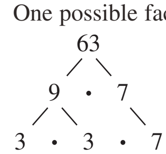
The prime factorization of 26 is $2 \cdot 13$.

35.



The prime factorization of 58 is $2 \cdot 29$.

36. One possible factor tree:



The prime factorization of 63 is $3^2 \cdot 7$.

37. 85

5 • 17

The prime factorization of 85 is 5 • 17.

38. One possible factor tree:

120

10 • 12

2 • 5 • 3 • 4

2 • 5 • 3 • 2 • 2

The prime factorization of 120 is 2^3 • 3 • 5.

39. One possible factor tree:

160

20 • 8

5 • 4 • 2 • 4

5 • 2 • 2 • 2 • 2 • 2

The prime factorization of 160 is 2^5 • 5.

40. One possible factor tree:

154

2 • 77

2 • 7 • 11

The prime factorization of 154 is 2 • 7 • 11.

41. One possible factor tree:

195

5 • 39

5 • 3 • 13

The prime factorization of 195 is 3 • 5 • 13.

42. 202

2 • 101

The prime factorization of 202 is 2 • 101.

43. One possible factor tree:

210

14 • 15

2 • 7 • 3 • 5

The prime factorization of 210 is 2 • 3 • 5 • 7.

44. 217

7 • 31

The prime factorization of 217 is 7 • 31.

45. 225

9 • 25

3 • 3 • 5 • 5

The prime factorization of 225 is $3^2 \cdot 5^2$.

46. Write 50 as a product of 2 numbers.

1 • 50 2 • 25 5 • 10

Possible displays:

1 row of 50 quarters	50 rows of 1 quarter
2 rows of 25 quarters	25 rows of 2 quarters
5 rows of 10 quarters	10 rows of 5 quarters

There are 6 possible displays.

47. *Sample answer:* $8x^3y^2$ is a monomial because it is the product of a number and a variable raised to a whole number power.

$8x^3y^2 + 1$ is not a monomial because it is the sum of two monomials.

48. $11cd = 11 \cdot c \cdot d$

49. $19m^3 = 19 \cdot m^3 = 19 \cdot m \cdot m \cdot m$

50. $3f^6 = 3 \cdot f^6 = 3 \cdot f \cdot f \cdot f \cdot f \cdot f \cdot f$

51. $21ab = 3 \cdot 7 \cdot a \cdot b$

52. $5xy^2 = 5 \cdot x \cdot y^2 = 5 \cdot x \cdot y \cdot y$

53. $35rs^5 = 5 \cdot 7 \cdot r \cdot s^5 = 5 \cdot 7 \cdot r \cdot s \cdot s \cdot s \cdot s \cdot s$

54. $2y^4z^3 = 2 \cdot y^4 \cdot z^3 = 2 \cdot y \cdot y \cdot y \cdot y \cdot z \cdot z \cdot z$

55. $40m^2n = 2 \cdot 2 \cdot 2 \cdot 5 \cdot m^2 \cdot n = 2 \cdot 2 \cdot 2 \cdot 5 \cdot m \cdot m \cdot n$

56. Write 69 as a product of 2 numbers.

1 • 69 3 • 23

Possible displays:

1 row of 69 fireflies	69 rows of 1 firefly
3 rows of 23 fireflies	23 rows of 3 fireflies

There are 4 possible displays.

57. All two-digit whole numbers with 5 as the ones' digit are multiples of 5 so 5 is a factor. Thus, these numbers have at least three factors and are composite.

58. One possible factor tree:

240

12 • 20

3 • 4 • 4 • 5

3 • 2 • 2 • 2 • 2 • 5

The prime factorization of 240 is 2^4 • 3 • 5.

Products of prime factors:

2 • 2 = 4	2 • 3 = 6
2 • 5 = 10	3 • 5 = 15
2 • 2 • 2 = 8	2 • 2 • 3 = 12
2 • 2 • 5 = 20	2 • 3 • 5 = 30
2 • 2 • 2 • 2 = 16	2 • 2 • 2 • 3 = 24
2 • 2 • 2 • 5 = 40	2 • 2 • 3 • 5 = 60
2 • 2 • 2 • 2 • 3 = 48	2 • 2 • 2 • 2 • 5 = 80
2 • 2 • 2 • 3 • 5 = 120	2 • 2 • 2 • 2 • 3 • 5 = 240

The factors of 240 are 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 30, 40, 48, 60, 80, 120, and 240.

59. 335

5 • 67

The prime factorization of 335 is 5 • 67.

Products of prime factors:

5 • 67 = 335

The factors of 335 are 1, 5, 67, and 335.

60. One possible factor tree:

500

20 • 25

4 • 5 • 5 • 5

2 • 2 • 5 • 5 • 5

The prime factorization of 500 is $2^2 \cdot 5^3$.

Products of prime factors:

2 • 2 = 4   2 • 5 = 10   5 • 5 = 25

2 • 2 • 5 = 20   2 • 5 • 5 = 50   5 • 5 • 5 = 125

2 • 2 • 5 • 5 = 100   2 • 5 • 5 • 5 = 250

2 • 2 • 5 • 5 • 5 = 500

The factors of 500 are 1, 2, 4, 5, 10, 20, 25, 50, 100, 125, 250, and 500.

61. 201

3 • 67

The prime factorization of 201 is 3 • 67.

Products of prime factors:

3 • 67 = 201

The factors of 201 are 1, 3, 67, and 201.

62. $6ab^2 = 2 \cdot 3 \cdot a \cdot b^2 = 2 \cdot 3 \cdot a \cdot b \cdot b$

Products of factors:

$2 \cdot 3 = 6$ $2 \cdot a = 2a$ $2 \cdot b = 2b$

$3 \cdot a = 3a$ $3 \cdot b = 3b$ $a \cdot b = ab$

$b \cdot b = b^2$

$2 \cdot 3 \cdot a = 6a$ $2 \cdot 3 \cdot b = 6b$ $2 \cdot a \cdot b = 2ab$

$2 \cdot b \cdot b = 2b^2$ $3 \cdot a \cdot b = 3ab$ $3 \cdot b \cdot b = 3b^2$

$a \cdot b \cdot b = ab^2$

$2 \cdot 3 \cdot a \cdot b = 6ab$ $2 \cdot 3 \cdot b \cdot b = 6b^2$

$3 \cdot a \cdot b \cdot b = 3ab^2$ $2 \cdot a \cdot b \cdot b = 2ab^2$

$2 \cdot 3 \cdot a \cdot b \cdot b = 6ab^2$

The factors of $6ab^2$ are 1, 2, 3, a, b, 6, $2a$, $2b$, $3a$, $3b$, ab, b^2, $6a$, $6b$, $2ab$, $2b^2$, $3ab$, $3b^2$, ab^2, $6ab$, $6b^2$, $3ab^2$, $2ab^2$, and $6ab^2$.

63. $52w = 2 \cdot 2 \cdot 13 \cdot w$

Products of factors:

$2 \cdot 2 = 4$ $2 \cdot 13 = 26$ $2 \cdot w = 2w$

$13 \cdot w = 13w$

$2 \cdot 2 \cdot 13 = 52$ $2 \cdot 2 \cdot w = 4w$

$2 \cdot 13 \cdot w = 26w$ $2 \cdot 2 \cdot 13 \cdot w = 52w$

The factors of $52w$ are 1, 2, 4, 13, 26, 52, w, $2w$, $4w$, $13w$, $26w$, and $52w$.

64. $2r^3s = 2 \cdot r^3 \cdot s = 2 \cdot r \cdot r \cdot r \cdot s$

Products of factors:

$2 \cdot r = 2r$ $2 \cdot s = 2s$ $r \cdot s = rs$

$r \cdot r = r^2$

$2 \cdot r \cdot r = 2r^2$ $2 \cdot r \cdot s = 2rs$ $r \cdot r \cdot r = r^3$

$r \cdot r \cdot s = r^2s$

$2 \cdot r \cdot r \cdot r = 2r^3$ $2 \cdot r \cdot r \cdot s = 2r^2s$

$r \cdot r \cdot r \cdot s = r^3s$ $2 \cdot r \cdot r \cdot r \cdot s = 2r^3s$

The factors of $2r^3s$ are 1, 2, r, s, $2r$, $2s$, rs, r^2, $2r^2$, $2rs$, r^3, r^2s, $2r^3$, $2r^2s$, r^3s, and $2r^3s$.

65. $7xyz = 7 \cdot x \cdot y \cdot z$

Products of factors:

$7 \cdot x = 7x$ $7 \cdot y = 7y$ $7 \cdot z = 7z$

$x \cdot y = xy$ $x \cdot z = xz$ $y \cdot z = yz$

$7 \cdot x \cdot y = 7xy$ $7 \cdot y \cdot z = 7yz$

$7 \cdot x \cdot z = 7xz$ $x \cdot y \cdot z = xyz$

$7 \cdot x \cdot y \cdot z = 7xyz$

The factors of $7xyz$ are 1, 7, x, y, z, $7x$, $7y$, $7z$, xy, xz, yz, $7xy$, $7yz$, $7xz$, xyz, and $7xyz$.

66. **a.** Write 102 as a product of 2 numbers.

1×102 2×51 3×34 6×17

Possible arrangements:

1 row of 102 photographs

102 rows of 1 photograph

2 rows of 51 photographs

51 rows of 2 photographs

3 rows of 34 photographs

34 rows of 3 photographs

6 rows of 17 photographs

17 rows of 6 photographs

There are 8 possible arrangements.

b. There are no rectangular arrangements that will have 15 photographs in any row or column.

—CONTINUED—

66. —CONTINUED—

c. Write 96 as a product of 2 numbers.

$1 \times 96 \quad 2 \times 48 \quad 3 \times 32 \quad 4 \times 24$

$6 \times 16 \quad 8 \times 12$

Possible arrangements:

8 rows of 12 photographs

12 rows of 8 photographs

There are now 2 possible arrangements.

67. Prime factorizations:

$4 = 2^2 \qquad 25 = 5^2$

$9 = 3^2 \qquad 36 = 2^2 \cdot 3^2$

$16 = 2^4 \qquad 64 = 2^6$

Conjecture: The exponents in the prime factorization of a perfect square are even integers.

68. The perfect number between 20 and 30 is $28 = 1 + 2 + 4 + 7 + 14$.

69. The factors of 18 are 1, 2, 3, 6, 9, and 18. So, if 18 is a factor of a number, then 1, 2, 3, 6, and 9 must also be factors of that number.

Example: 18 is a factor of 72, so 1, 2, 3, 6, and 9 should also be factors of 72.

The factors of 72 are **1**, **2**, **3**, 4, **6**, 8, **9**, 12, 18, 24, 36, and 72.

70. 64. *Sample answer:* The factors are 1, 2, 4, 8, 16, 32, and 64. I looked for a number that is a perfect square, because otherwise the number of factors is even. I also looked for a number that is not the square of a prime number, because such a number has only three factors.

4.1 Mixed Review (p. 178)

71.
$$a + 24 = 16$$
$$a + 24 - 24 = 16 - 24$$
$$a = -8$$
Check: $a + 24 = 16$
$$-8 + 24 \stackrel{?}{=} 16$$
$$16 = 16 \ \checkmark$$

72.
$$33 + b = 58$$
$$33 - 33 + b = 58 - 33$$
$$b = 25$$
Check: $33 + b = 58$
$$33 + 25 \stackrel{?}{=} 58$$
$$58 = 58 \ \checkmark$$

73.
$$c - 14 = 18$$
$$c - 14 + 14 = 18 + 14$$
$$c = 32$$
Check: $c - 14 = 18$
$$32 - 14 \stackrel{?}{=} 18$$
$$18 = 18 \ \checkmark$$

74.
$$d - 10 = 10$$
$$d - 10 + 10 = 10 + 10$$
$$d = 20$$
Check: $d - 10 = 10$
$$20 - 10 \stackrel{?}{=} 10$$
$$10 = 10 \ \checkmark$$

75.
$$6r = 48$$
$$\frac{6r}{6} = \frac{48}{6}$$
$$r = 8$$
Check: $6r = 48$
$$6(8) \stackrel{?}{=} 48$$
$$48 = 48 \ \checkmark$$

76.
$$-10s = 50$$
$$\frac{-10s}{-10} = \frac{50}{-10}$$
$$s = -5$$
Check: $-10s = 50$
$$-10(-5) \stackrel{?}{=} 50$$
$$50 = 50 \ \checkmark$$

77.
$$\frac{t}{9} = -7$$
$$9 \cdot \frac{t}{9} = 9 \cdot (-7)$$
$$t = -63$$
Check: $\frac{t}{9} = -7$
$$\frac{-63}{9} \stackrel{?}{=} -7$$
$$-7 = -7 \ \checkmark$$

78.
$$\frac{u}{-2} = -14$$
$$(-2)\left(\frac{u}{-2}\right) = (-2)(-14)$$
$$u = 28$$
Check: $\frac{u}{-2} = -14$
$$\frac{28}{-2} \stackrel{?}{=} -14$$
$$-14 = -14 \ \checkmark$$

79. Equation:
$$15 + n = 21 - n$$
$$15 + n + n = 21 - n + n$$
$$15 + 2n = 21$$
$$15 - 15 + 2n = 21 - 15$$
$$2n = 6$$
$$\frac{2n}{2} = \frac{6}{2}$$
$$n = 3$$

80. Equation:
$$2(3 + n) = 5 + n$$
$$6 + 2n = 5 + n$$
$$6 + 2n - n = 5 + n - n$$
$$6 + n = 5$$
$$6 - 6 + n = 5 - 6$$
$$n = -1$$

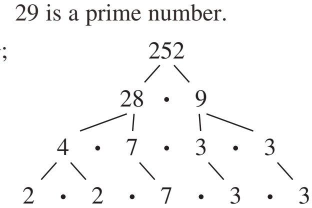
81. Equation:
$$8 + n = -3n$$
$$8 + n - n = -3n - n$$
$$8 = -4n$$
$$\frac{8}{-4} = \frac{-4n}{-4}$$
$$-2 = n$$

4.1 Standardized Test Practice (p. 178)

82. D; When $x = 4$; $7x + 1 = 7(4) + 1 = 28 + 1 = 29$

29 is a prime number.

83. G;



The prime factorization of 252 is $2^2 \cdot 3^2 \cdot 7$.

84. Write 54 as a product of 2 numbers.

1×54 2×27 3×18 6×9

Possible dimensions:

(1) 1 in. × 54 in. (2) 2 in. × 27 in.

(3) 3 in. × 18 in. (4) 6 in. × 9 in.

Perimeters: $P = 2\ell + 2w$

(1) $2(54) + 2(1) = 108 + 2 = 110$ in.

(2) $2(27) + 2(2) = 54 + 4 = 58$ in.

(3) $2(18) + 2(3) = 36 + 6 = 42$ in.

(4) $2(9) + 2(6) = 18 + 12 = 30$ in.

The dimensions of the rectangle with the greatest perimeter are 1 in. × 54 in.

Lesson 4.2

4.2 Checkpoint (pp. 179–180)

1. Factors of 12: 1, 2, 3, 4, (6), 12

Factors of 30: 1, 2, 3, 5, (6), 10, 15, 30

The GCF of 12 and 30 is 6.

2. Factors of 21: 1, 3, 7, (21)

Factors of 42: 1, 2, 3, 6, 7, 14, (21), 42

The GCF of of 21 and 42 is 21.

3. Factors of 16: 1, 2, 4, (8), 16

Factors of 32: 1, 2, 4, (8), 16, 32

Factors of 40: 1, 2, 4, 5, (8), 10, 20, 40

The GCF of 16, 32, and 40 is 8.

4. Factors of 27: 1, 3, (9), 27

Factors of 45: 1, 2, 5, (9), 15, 45

Factors of 90: 1, 2, 3, 5, 6, (9), 10, 15, 18, 30, 45, 90

The GCF of 27, 45, and 90 is 9.

5. $18 = 2 \cdot 3 \cdot 3$

$33 = 3 \cdot 11$

The GCF of 18 and 33 is 3.

Because the GCF is 3, 18 and 33 are not relatively prime.

6. $39 = 3 \cdot 13$

$50 = 2 \cdot 5 \cdot 5$

The GCF of 39 and 50 is 1.

Because the GCF is 1, 39 and 50 are relatively prime.

7. $110 = 2 \cdot 5 \cdot 11$

$77 = 7 \cdot 11$

The GCF of 110 and 77 is 11.

Because the GCF is 11, 110 and 77 are not relatively prime.

8. $21 = 3 \cdot 7$

$160 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 5$

The GCF of 21 and 160 is 1.

Because the GCF is 1, 21 and 160 are relatively prime.

9. *Sample answer:* They have no remaining common factors except 1, so they are relatively prime.

10. $6x = 2 \cdot 3 \cdot x$

$15x = 3 \cdot 5 \cdot x$

The GCF of $6x$ and $15x$ is $3x$.

11. $20x^2 = 2 \cdot 2 \cdot 5 \cdot x \cdot x$

$36x = 2 \cdot 2 \cdot 3 \cdot 3 \cdot x$

The GCF of $20x^2$ and $36x$ is $4x$.

12. $32y^2 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot y \cdot y$

$6x^2y = 2 \cdot 3 \cdot x \cdot x \cdot y$

The GCF of $32y^2$ and $6x^2y$ is $2y$.

13. $7xy^3 = 7 \cdot x \cdot y \cdot y \cdot y$

$28xy^2 = 2 \cdot 2 \cdot 7 \cdot x \cdot y \cdot y$

The GCF of $7xy^3$ and $28xy^2$ is $7xy^2$.

4.2 Guided Practice (p. 181)

1. *Sample answer:* A number is a common factor of two numbers if it is a whole number factor of both numbers.

2. $5 = 5$

$16 = 2^4$

The GCF of 5 and 16 is 1.

Because the GCF is 1, 5 and 16 are relatively prime.

$16 = 2^4$

$25 = 5^2$

The GCF of 16 and 25 is 1.

Because the GCF is 1, 16 and 25 are relatively prime.

3. $7 = 7$

$28 = 2 \cdot 2 \cdot 7$

The GCF of 7 and 28 is 7.

Because the GCF is 7, 7 and 28 are not relatively prime.

4. $34 = 2 \cdot 17$

$38 = 2 \cdot 19$

The GCF of 34 and 38 is 2.

Because the GCF is 2, 34 and 38 are not relatively prime.

5. $11 = 11$

$51 = 3 \cdot 17$

The GCF of 11 and 51 is 1.

Because the GCF is 1, 11 and 51 are relatively prime.

6. $32 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

$81 = 3 \cdot 3 \cdot 3 \cdot 3$

The GCF of 32 and 81 is 1.

Because the GCF is 1, 32 and 81 are relatively prime.

7. $18c = 2 \cdot 3 \cdot 3 \cdot c$

$4c = 2 \cdot 2 \cdot c$

The GCF of $18c$ and $4c$ is $2c$.

8. $r = r$

$r^4 = r \cdot r \cdot r \cdot r$

The GCF of r and r^4 is r.

9. $5m = 5 \cdot m$

$20m^3 = 2 \cdot 2 \cdot 5 \cdot m \cdot m \cdot m$

The GCF of $5m$ and $20m^3$ is $5m$.

10. $3x^2 = 3 \cdot x \cdot x$

$15x^3 = 3 \cdot 5 \cdot x \cdot x \cdot x$

The GCF of $3x^2$ and $15x^3$ is $3x^2$.

11. (1) $225 = 3 \cdot 3 \cdot 5 \cdot 5 = 3^2 \cdot 5^2$

$75 = 3 \cdot 5 \cdot 5 = 3 \cdot 5^2$

$120 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 5 = 2^3 \cdot 3 \cdot 5$

(2) The common prime factors are 3 and 5.

The GCF is $3 \cdot 5 = 15$.

(3) The GCF represents the greatest number of gift bags the owner can make, using 15 pastel crayons, 5 paintbrushes, and 8 tubes of oil paint in each bag.

4.2 Practice and Problem Solving (pp. 181–183)

12. Factors of 28: 1, 2, 4, 7, 14, 28

Factors of 42: 1, 2, 3, 6, 7, 14, 21, 42

The GCF of 28 and 42 is 14.

13. Factors of 21: 1, 3, 7, 21

Factors of 99: 1, 3, 9, 11, 33, 99

The GCF of 21 and 99 is 3.

14. Factors of 34: 1, 2, 17, 34

Factors of 85: 1, 5, 17, 85

The GCF of 34 and 85 is 17.

15. Factors of 12: 1, 2, 3, 4, 6, 12

Factors of 36: 1, 2, 3, 4, 6, 9, 12, 18, 36

The GCF of 12 and 36 is 12.

16. Factors of 32: 1, 2, 4, 8, 16, 32

Factors of 55: 1, 5, 11, 55

The GCF of 32 and 55 is 1.

17. Factors of 54: 1, 2, 3, 6, 9, 18, 27, 54

Factors of 89: 1, 89

The GCF of 54 and 89 is 1.

18. Factors of 76: 1, 2, 4, 19, 38, 76

Factors of 86: 1, 2, 43, 86

The GCF of 76 and 86 is 2.

19. Factors of 120: 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 30, 40, 60, 120

Factors of 960: 1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 16, 20, 24, 30, 32, 40, 48, 60, 64, 80, 96, 120, 160, 192, 240, 320, 480, 960

The GCF of 120 and 960 is 120.

20. $9 = 3 \cdot 3$

$26 = 2 \cdot 13$

The GCF of 9 and 26 is 1.

Because the GCF is 1, 9 and 26 are relatively prime.

21. $11 = 11$

$55 = 5 \cdot 11$

The GCF of 11 and 55 is 11.

Because the GCF is 11, 11 and 55 are not relatively prime.

22. $12 = 2 \cdot 2 \cdot 3$

$33 = 3 \cdot 11$

The GCF of 12 and 33 is 3.

Because the GCF is 3, 12 and 33 are not relatively prime.

23. $77 = 7 \cdot 11$

$51 = 3 \cdot 17$

The GCF of 77 and 51 is 1.

Because the GCF is 1, 77 and 51 are relatively prime.

24. $58 = 2 \cdot 29$

$60 = 2 \cdot 2 \cdot 3 \cdot 5$

The GCF of 58 and 60 is 2.

Because the GCF is 2, 58 and 60 are not relatively prime.

25. $121 = 11 \cdot 11$

$280 = 2 \cdot 2 \cdot 2 \cdot 5 \cdot 7$

The GCF of 121 and 280 is 1.

Because the GCF is 1, 121 and 280 are relatively prime.

26. $64 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

$144 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3$

The GCF of 64 and 144 is $2^4 = 16$.

Because the GCF is 16, 64 and 144 are not relatively prime.

27. $28 = 2 \cdot 2 \cdot 7$

$84 = 2 \cdot 2 \cdot 3 \cdot 7$

The GCF of 28 and 84 is $2 \cdot 2 \cdot 7 = 28$.

Because the GCF is 28, 28 and 84 are not relatively prime.

28. $16x = 2 \cdot 2 \cdot 2 \cdot 2 \cdot x$

$36x = 2 \cdot 2 \cdot 3 \cdot 3 \cdot x$

The GCF of $16x$ and $36x$ is $4x$.

29. $18m^2 = 2 \cdot 3 \cdot 3 \cdot m \cdot m$

$7m = 7 \cdot m$

The GCF of $18m^2$ and $7m$ is m.

30. $18k = 2 \cdot 3 \cdot 3 \cdot k$

$15k^3 = 3 \cdot 5 \cdot k \cdot k \cdot k$

The GCF of $18k$ and $15k^3$ is $3k$.

31. $2x = 2 \cdot x$

$8x^2 = 2 \cdot 2 \cdot 2 \cdot x \cdot x$

$6x^3 = 2 \cdot 3 \cdot x \cdot x \cdot x$

The GCF of $2x$, $8x^2$, and $6x^3$ is $2x$.

32. Vocalists: $32 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$
Drummers: $16 = 2 \cdot 2 \cdot 2 \cdot 2$
Guitarists: $24 = 2 \cdot 2 \cdot 2 \cdot 3$
Bassists: $16 = 2 \cdot 2 \cdot 2 \cdot 2$
The GCF is $2^3 = 8$. Therefore, 8 identical bands can be formed.
There will be $32 \div 8 = 4$ vocalists in each band.

33. Daisy: $63 = 3 \cdot 3 \cdot 7$
Lily: $56 = 2 \cdot 2 \cdot 2 \cdot 7$
Iris: $42 = 2 \cdot 3 \cdot 7$
Freesia: $21 = 3 \cdot 7$
The GCF is 7. Therefore, 7 identical bouquets can be made. Each bouquet will contain:
$63 \div 7 = 9$ daisies,
$56 \div 7 = 8$ lilies,
$42 \div 7 = 6$ irises, and
$21 \div 7 = 3$ freesias.

34. $115 = 5 \cdot 23$
$207 = 3 \cdot 3 \cdot 23$
Because the GCF is 23, 115 and 207 are not relatively prime.

35. $224 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 7$
$243 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$
Because the GCF is 1, 224 and 243 are relatively prime.

36. $152 = 2 \cdot 2 \cdot 2 \cdot 19$
$171 = 3 \cdot 3 \cdot 19$
Because the GCF is 19, 152 and 171 are not relatively prime.

37. $12m^2n^3 = 2 \cdot 2 \cdot 3 \cdot m \cdot m \cdot n \cdot n \cdot n$
$70m^3n = 2 \cdot 5 \cdot 7 \cdot m \cdot m \cdot m \cdot n$
The GCF of $12m^2n^3$ and $70m^3n$ is $2m^2n$.

38. $72a^3b^2 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot a \cdot a \cdot a \cdot b \cdot b$
$86a = 2 \cdot 43 \cdot a$
The GCF of $72a^3b^2$ and $86a$ is $2a$.

39. $44m^2n = 2 \cdot 2 \cdot 11 \cdot m \cdot m \cdot n$
$48mn^2 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot m \cdot n \cdot n$
The GCF of $44m^2n$ and $48mn^2$ is $4mn$.

40. $a^2b^3 = a \cdot a \cdot b \cdot b \cdot b$
$ab^3 = a \cdot b \cdot b \cdot b$
The GCF of a^2b^3 and ab^3 is ab^3.

41. $3x = 3 \cdot x$
$7xy^2 = 7 \cdot x \cdot y \cdot y$
The GCF of $3x$ and $7xy^2$ is x.

42. $4rs^2 = 2 \cdot 2 \cdot r \cdot s \cdot s$
$27st^3 = 3 \cdot 3 \cdot 3 \cdot s \cdot t \cdot t \cdot t$
The GCF of $4rs^2$ and $27st^3$ is s.

43. $18wx^2 = 2 \cdot 3 \cdot 3 \cdot w \cdot x \cdot x$
$45wx = 3 \cdot 3 \cdot 5 \cdot w \cdot x$
The GCF of $18wx^2$ and $45wx$ is $9wx$.

44. $12y^2 = 2 \cdot 2 \cdot 3 \cdot y \cdot y$
$15y^3 = 3 \cdot 5 \cdot y \cdot y \cdot y$
$5y = 5 \cdot y$
The GCF of $12y^2$, $15y^3$, and $5y$ is y.

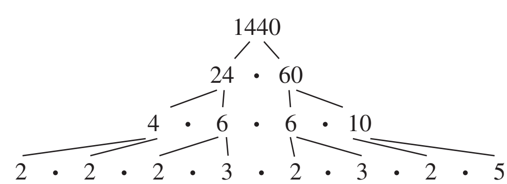
45. $rs^3 = r \cdot s \cdot s \cdot s$
$s^3t = s \cdot s \cdot s \cdot t$
$r^2st^2 = r \cdot r \cdot s \cdot t \cdot t$
The GCF of rs^3, s^3t, and r^2st^2 is s.

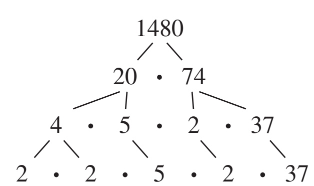
46. $42 = 2 \cdot 3 \cdot 7$
$72 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3$
The GCF is $2 \cdot 3 = 6$. Therefore, the greatest side length the tiles can have is 6 inches.

47. $45 = 3 \cdot 3 \cdot 5$
$75 = 3 \cdot 5 \cdot 5$
$60 = 2 \cdot 2 \cdot 3 \cdot 5$
The GCF is $3 \cdot 5 = 15$. Therefore, the greatest possible length each piece of lacing can be is 15 centimeters.

48. $30 = 2 \cdot 3 \cdot 5$
One possible value for n is 6 because $6 = 2 \cdot 3$ and the GCF of 6 and 30 is 6.
There are many other possible values instead of 6. Any number that is a multiple of 6, but not a multiple of 5 will also work. Some other examples are 18, 24, 36, 54, and 72.

49. a.





Earth: $1440 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 5$
Mars: $1480 = 2 \cdot 2 \cdot 2 \cdot 5 \cdot 37$
The GCF of 1440 and 1480 is $2 \cdot 2 \cdot 2 \cdot 5 = 40$. Therefore, the greatest number of minutes that could be in a space-hour is 40.

b. There would be $1440 \div 40 = 36$ space-hours on Earth. There would be $1480 \div 40 = 37$ space-hours on Mars.

c. $210 \cdot 36 = 7560$
The trip from Earth to Mars would take 7560 space-hours.

50. It is given that a is a factor of b. Also, a is the largest factor of itself, so there can be no larger factor of both a and b.

Sample answers:

Let $a = 5$ and $b = 20$.

$5 = 5$

$20 = 2 \cdot 2 \cdot 5$

The GCF is 5, or a.

Let $a = 7$ and $b = 28$.

$7 = 7$

$28 = 2 \cdot 2 \cdot 7$

The GCF is 7, or a.

Let $a = 12$ and $b = 60$.

$12 = 2 \cdot 2 \cdot 3$

$60 = 2 \cdot 2 \cdot 3 \cdot 5$

The GCF is $2 \cdot 2 \cdot 3 = 12$, or a.

51. If a and b are relatively prime numbers and b and c are relatively prime numbers, then a and c are sometimes relatively prime numbers.

Examples (a and b and b and c are relatively prime):

Let $a = 5$, $b = 49$, and $c = 12$.

$5 = 5$

$12 = 2 \cdot 2 \cdot 3$

The GCF of 5 and 12 is 1. So, a and c are relatively prime numbers.

Let $a = 2$, $b = 25$, and $c = 6$.

$2 = 2$

$6 = 2 \cdot 3$

The GCF of 2 and 6 is 2. So, a and c are not relatively prime numbers.

52. $2x, 6x^2, 18x^3, 54x^4, \ldots$

The next 2 monomials are $162x^5$ and $486x^6$.

$2x = 2 \cdot x$

$6x^2 = 2 \cdot 3 \cdot x \cdot x$

$18x^3 = 2 \cdot 3 \cdot 3 \cdot x \cdot x \cdot x$

$54x^4 = 2 \cdot 3 \cdot 3 \cdot 3 \cdot x \cdot x \cdot x \cdot x$

$\vdots$

The GCF of all the monomials is $2x$. Excluding the first term, the GCF is $6x^2$.

4.2 Mixed Review (p. 183)

53. $\frac{2}{9} + \frac{5}{9} = \frac{2+5}{9} = \frac{7}{9}$

54. $\frac{3}{7} + \frac{3}{7} = \frac{3+3}{7} = \frac{6}{7}$

55. $\frac{14}{15} - \frac{8}{15} = \frac{14-8}{15} = \frac{6}{15}$

56. $\frac{11}{20} - \frac{3}{20} = \frac{11-3}{20} = \frac{8}{20}$

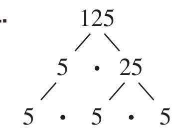
57. $60 \times \frac{3}{10} = \frac{60}{1} \times \frac{3}{10} = \frac{\overset{6}{\cancel{60}} \times 3}{1 \times \underset{1}{\cancel{10}}} = 18$

58. $28 \times \frac{1}{4} = \frac{28}{1} \times \frac{1}{4} = \frac{\overset{7}{\cancel{28}} \times 1}{1 \times \underset{1}{\cancel{4}}} = 7$

59. $\frac{5}{12} \times 36 = \frac{5}{12} \times \frac{36}{1} = \frac{5 \times \overset{3}{\cancel{36}}}{\underset{1}{\cancel{12}} \times 1} = 15$

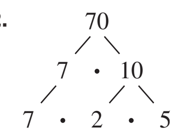
60. $\frac{3}{7} \times 49 = \frac{3}{7} \times \frac{49}{1} = \frac{3 \times \overset{7}{\cancel{49}}}{\underset{1}{\cancel{7}} \times 1} = 21$

61.



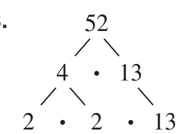
The prime factorization of 125 is 5^3.

62.



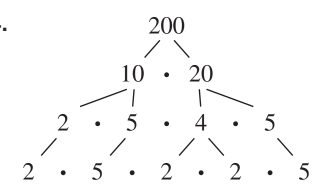
The prime factorization of 70 is $2 \cdot 5 \cdot 7$.

63.



The prime factorization of 52 is $2^2 \cdot 13$.

64.



The prime factorization of 200 is $2^3 \cdot 5^2$.

4.2 Standardized Test Practice (p. 183)

65. C; $63 = 3 \cdot 3 \cdot 7$

$91 = 7 \cdot 13$

The GCF of 63 and 91 is 7. Because the GCF is 7, 63 and 91 are not relatively prime.

66. Bandages: $48 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3$

Gauze: $15 = 3 \cdot 5$

Ointment: $6 = 2 \cdot 3$

Ice packs: $6 = 2 \cdot 3$

The GCF is 3. Therefore, you can make 3 identical first-aid kits.

Each first-aid kit will contain: $48 \div 3 = 16$ bandages, $15 \div 3 = 5$ squares of gauze, $6 \div 3 = 2$ tubes of ointment, and $6 \div 3 = 2$ ice packs.

Brain Game (p. 183)

First number	Second number	GCF
945	735	105
645	435	15
648	432	216
658	532	14

$945 = 3 \cdot 3 \cdot 3 \cdot 5 \cdot 7$
$735 = 3 \cdot 5 \cdot 7 \cdot 7$

The GCF of 945 and 735 is 105.

$645 = 3 \cdot 5 \cdot 43$
$435 = 3 \cdot 5 \cdot 29$

The GCF of 645 and 435 is 15.

$648 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3 \cdot 3$
$432 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$

The GCF of 648 and 432 is $2^3 \cdot 3^3 = 216$.

$658 = 2 \cdot 7 \cdot 47$
$532 = 2 \cdot 2 \cdot 7 \cdot 19$

The GCF of 658 and 532 is 14.

Lesson 4.3

4.3 Checkpoint (p. 185)

1. *Sample answer:* $\frac{5}{10} = \frac{5 \div 5}{10 \div 5} = \frac{1}{2}; \frac{5}{10} = \frac{5 \cdot 2}{10 \cdot 2} = \frac{10}{20}$
2. *Sample answer:* $\frac{6}{9} = \frac{6 \div 3}{9 \div 3} = \frac{2}{3}; \frac{6}{9} = \frac{6 \cdot 2}{9 \cdot 2} = \frac{12}{18}$
3. *Sample answer:* $\frac{12}{20} = \frac{12 \div 4}{20 \div 4} = \frac{3}{5}; \frac{12}{20} = \frac{12 \div 2}{20 \div 2} = \frac{6}{10}$
4. *Sample answer:* $\frac{18}{24} = \frac{18 \div 6}{24 \div 6} = \frac{3}{4}; \frac{18}{24} = \frac{18 \cdot 2}{24 \cdot 2} = \frac{36}{48}$
5. $4 = 2^2$ $\quad 14 = 2 \cdot 7$
   The GCF of 4 and 14 is 2.
   $\frac{4}{14} = \frac{4 \div 2}{14 \div 2} = \frac{2}{7}$
6. $8 = 2^3$ $\quad 36 = 2^2 \cdot 3^2$
   The GCF of 8 and 36 is 4.
   $\frac{8}{36} = \frac{8 \div 4}{36 \div 4} = \frac{2}{9}$
7. $27 = 3^3$ $\quad 42 = 2 \cdot 3 \cdot 7$
   The GCF of 27 and 42 is 3.
   $\frac{27}{42} = \frac{27 \div 3}{42 \div 3} = \frac{9}{14}$
8. $28 = 2^2 \cdot 7$ $\quad 49 = 7^2$
   The GCF of 28 and 49 is 7.
   $\frac{28}{49} = \frac{28 \div 7}{49 \div 7} = \frac{4}{7}$

4.3 Guided Practice (p. 186)

1. *Sample answer:* It means that the numerator and denominator have no whole number common factors other than 1.
2. *Sample answer:* To find fractions that are equivalent to $\frac{3}{7}$, multiply or divide the numerator and the denominator by the same nonzero number.
   $\frac{3}{7} = \frac{3 \cdot 2}{7 \cdot 2} = \frac{6}{14}$
3. *Sample answer:* $\frac{12}{16} = \frac{12 \cdot 2}{16 \cdot 2} = \frac{24}{32}; \frac{12}{16} = \frac{12 \div 4}{16 \div 4} = \frac{3}{4}$
4. *Sample answer:* $\frac{15}{18} = \frac{15 \div 3}{18 \div 3} = \frac{5}{6}; \frac{15}{18} = \frac{15 \cdot 2}{18 \cdot 2} = \frac{30}{36}$
5. *Sample answer:* $\frac{8}{14} = \frac{8 \div 2}{14 \div 2} = \frac{4}{7}; \frac{8}{14} = \frac{8 \cdot 2}{14 \cdot 2} = \frac{16}{28}$
6. *Sample answer:* $\frac{10}{25} = \frac{10 \div 5}{25 \div 5} = \frac{2}{5}; \frac{10}{25} = \frac{10 \cdot 2}{25 \cdot 2} = \frac{20}{50}$
7. $16 = 2^4$ $\quad 38 = 2 \cdot 19$
   The GCF of 16 and 38 is 2.
   $\frac{16}{38} = \frac{16 \div 2}{38 \div 2} = \frac{8}{19}$
8. $35 = 5 \cdot 7$ $\quad 40 = 2^3 \cdot 5$
   The GCF of 35 and 40 is 5.
   $\frac{35}{40} = \frac{35 \div 5}{40 \div 5} = \frac{7}{8}$
9. $\frac{21a^3}{11a} = \frac{3 \cdot 7 \cdot a \cdot a \cdot \overset{1}{\cancel{a}}}{11 \cdot \underset{1}{\cancel{a}}} = \frac{21a^2}{11}$
10. $\frac{6b}{24b^2} = \frac{\overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{3}} \cdot \overset{1}{\cancel{b}}}{\underset{1}{\cancel{2}} \cdot 2 \cdot 2 \cdot \underset{1}{\cancel{3}} \cdot \underset{1}{\cancel{b}} \cdot b} = \frac{1}{4b}$
11. (1) Total = 30 + 55 + 163 = 248
    (2) $\frac{\text{Films rated G}}{\text{Number of films}} = \frac{30}{248}$
    (3) $30 = 2 \cdot 3 \cdot 5$
    $248 = 2^3 \cdot 31$
    The GCF of 30 and 248 is 2.
    $\frac{30}{248} = \frac{30 \div 2}{248 \div 2} = \frac{15}{124}$

4.3 Practice and Problem Solving (pp. 187–188)

12. *Sample answer:* $\frac{6}{12} = \frac{6 \cdot 2}{12 \cdot 2} = \frac{12}{24}; \frac{6}{12} = \frac{6 \div 6}{12 \div 6} = \frac{1}{2}$
13. *Sample answer:* $\frac{5}{15} = \frac{5 \div 5}{15 \div 5} = \frac{1}{3}; \frac{5}{15} = \frac{5 \cdot 2}{15 \cdot 2} = \frac{10}{30}$
14. *Sample answer:* $\frac{14}{16} = \frac{14 \div 2}{16 \div 2} = \frac{7}{8}; \frac{14}{16} = \frac{14 \cdot 2}{16 \cdot 2} = \frac{28}{32}$
15. *Sample answer:* $\frac{18}{21} = \frac{18 \div 3}{21 \div 3} = \frac{6}{7}; \frac{18}{21} = \frac{18 \cdot 2}{21 \cdot 2} = \frac{36}{42}$
16. *Sample answer:* $\frac{16}{20} = \frac{16 \div 4}{20 \div 4} = \frac{4}{5}; \frac{16}{20} = \frac{16 \cdot 2}{20 \cdot 2} = \frac{32}{40}$

17. *Sample answer:* $\frac{3}{27} = \frac{3 \div 3}{27 \div 3} = \frac{1}{9}; \frac{3}{27} = \frac{3 \cdot 2}{27 \cdot 2} = \frac{6}{54}$

18. *Sample answer:* $\frac{7}{10} = \frac{7 \cdot 2}{10 \cdot 2} = \frac{14}{20}; \frac{7}{10} = \frac{7 \cdot 3}{10 \cdot 3} = \frac{21}{30}$

19. *Sample answer:* $\frac{5}{8} = \frac{5 \cdot 2}{8 \cdot 2} = \frac{10}{16}; \frac{5}{8} = \frac{5 \cdot 3}{8 \cdot 3} = \frac{15}{24}$

20. $32 = 2^5$ $\quad 36 = 2^2 \cdot 3^2$

The GCF of 32 and 36 is 4.

$\frac{32}{36} = \frac{32 \div 4}{36 \div 4} = \frac{8}{9}$

21. $25 = 5^2$ $\quad 35 = 5 \cdot 7$

The GCF of 25 and 35 is 5.

$\frac{25}{35} = \frac{25 \div 5}{35 \div 5} = \frac{5}{7}$

22. $46 = 2 \cdot 23$ $\quad 72 = 2^3 \cdot 3^2$

The GCF of 46 and 72 is 2.

$\frac{46}{72} = \frac{46 \div 2}{72 \div 2} = \frac{23}{36}$

23. $8 = 2^3$ $\quad 30 = 2 \cdot 3 \cdot 5$

The GCF of 8 and 30 is 2.

$\frac{8}{30} = \frac{8 \div 2}{30 \div 2} = \frac{4}{15}$

24. $54 = 2 \cdot 3^3$ $\quad 60 = 2^2 \cdot 3 \cdot 5$

The GCF of 54 and 60 is 6.

$\frac{54}{60} = \frac{54 \div 6}{60 \div 6} = \frac{9}{10}$

25. $36 = 2^2 \cdot 3^2$ $\quad 45 = 3^2 \cdot 5$

The GCF of 36 and 45 is 9.

$\frac{36}{45} = \frac{36 \div 9}{45 \div 9} = \frac{4}{5}$

26. $39 = 3 \cdot 13$ $\quad 42 = 2 \cdot 3 \cdot 7$

The GCF of 39 and 42 is 3.

$\frac{39}{42} = \frac{39 \div 3}{42 \div 3} = \frac{13}{14}$

27. $48 = 2^4 \cdot 3$ $\quad 76 = 2^2 \cdot 19$

The GCF of 48 and 76 is 4.

$\frac{48}{76} = \frac{48 \div 4}{76 \div 4} = \frac{12}{19}$

28. a. $\frac{\text{Number of bones in axial system}}{\text{Number of bones in the body}} = \frac{80}{80 + 126}$

$= \frac{80}{206}$

$= \frac{80 \div 2}{206 \div 2}$

$= \frac{40}{103}$

$\frac{40}{103}$ of the body's bones are in the axial system.

—CONTINUED—

28. —CONTINUED—

b. $\frac{\text{Number of bones in the appendicular system}}{\text{Number of bones in the body}}$

$= \frac{126}{80 + 126}$

$= \frac{126}{206}$

$= \frac{126 \div 2}{206 \div 2}$

$= \frac{63}{103}$

$\frac{63}{103}$ of the body's bones are in the appendicular system.

29. $\frac{6a}{6a^2} = \frac{\cancel{2}^1 \cdot \cancel{3}^1 \cdot \cancel{a}^1}{\cancel{2}_1 \cdot \cancel{3}_1 \cdot \cancel{a}_1 \cdot a} = \frac{1}{a}$

30. $\frac{4mn^3}{10n^2} = \frac{\cancel{2}^1 \cdot 2 \cdot m \cdot \cancel{n}^1 \cdot \cancel{n}^1 \cdot n}{\cancel{2}_1 \cdot 5 \cdot \cancel{n}_1 \cdot \cancel{n}_1} = \frac{2mn}{5}$

31. $\frac{27bcd}{12b} = \frac{\cancel{3}^1 \cdot 3 \cdot 3 \cdot \cancel{b}^1 \cdot c \cdot}{2 \cdot 2 \cdot \cancel{3}_1 \cdot \cancel{b}_1} = \frac{9cd}{4}$

32. $\frac{5s^2t^2}{40st} = \frac{\cancel{5}^1 \cdot \cancel{s}^1 \cdot s \cdot \cancel{t}^1 \cdot t}{2 \cdot 2 \cdot 2 \cdot \cancel{5}_1 \cdot \cancel{s}_1 \cdot \cancel{t}_1} = \frac{st}{8}$

33. $\frac{36w}{60w^2} = \frac{\cancel{2}^1 \cdot \cancel{2}^1 \cdot \cancel{3}^1 \cdot 3 \cdot \cancel{w}^1}{\cancel{2}_1 \cdot \cancel{2}_1 \cdot \cancel{3}_1 \cdot 5 \cdot \cancel{w}_1 \cdot w} = \frac{3}{5w}$

34. $\frac{42r^3}{56r^2} = \frac{\cancel{2}^1 \cdot 3 \cdot \cancel{7}^1 \cdot \cancel{r}^1 \cdot \cancel{r}^1 \cdot r}{\cancel{2}_1 \cdot 2 \cdot 2 \cdot \cancel{7}_1 \cdot \cancel{r}_1 \cdot \cancel{r}_1} = \frac{3r}{4}$

35. $\frac{77x^3}{6x} = \frac{7 \cdot 11 \cdot \cancel{x}^1 \cdot x \cdot x}{2 \cdot 3 \cdot \cancel{x}_1} = \frac{77x^2}{6}$

36. $\frac{49t^2}{7t^3} = \frac{\cancel{7}^1 \cdot 7 \cdot \cancel{t}^1 \cdot \cancel{t}^1}{\cancel{7}_1 \cdot \cancel{t}_1 \cdot \cancel{t}_1 \cdot t} = \frac{7}{t}$

37. a. $\frac{\text{Number of squares with pieces}}{\text{Total number of squares}} = \frac{12 + 12}{64}$

$= \frac{24}{64}$

$= \frac{24 \div 8}{64 \div 8}$

$= \frac{3}{8}$

$\frac{3}{8}$ of the squares hold pieces at the start of the game.

—CONTINUED—

37. —CONTINUED—

b. $\dfrac{\text{Number of squares with pieces}}{\text{Total number of squares}} = \dfrac{5+3}{64}$

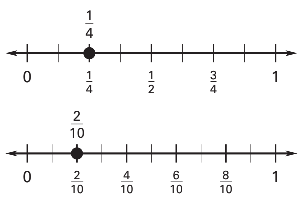
$= \dfrac{8}{64}$

$= \dfrac{8 \div 8}{64 \div 8}$

$= \dfrac{1}{8}$

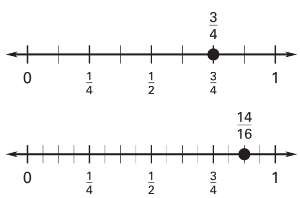
$\frac{1}{8}$ of the squares hold pieces.

38.



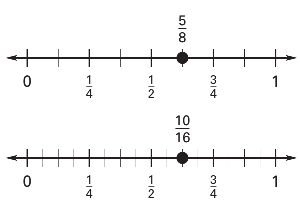
$\frac{1}{4}$ and $\frac{2}{10}$ are not equivalent fractions.

39.



$\frac{3}{4}$ and $\frac{14}{16}$ are not equivalent fractions.

40.



$\frac{5}{8}$ and $\frac{10}{16}$ are equivalent fractions.

41. $12 = 2^2 \cdot 3$ $\quad 15 = 3 \cdot 5$

The GCF of 12 and 15 is 3.

$\dfrac{12}{15} = \dfrac{12 \div 3}{15 \div 3} = \dfrac{4}{5}$

$26 = 2 \cdot 13$ $\quad 30 = 2 \cdot 3 \cdot 5$

The GCF of 26 and 30 is 2.

$\dfrac{26}{30} = \dfrac{26 \div 2}{30 \div 2} = \dfrac{13}{15}$

So, $\frac{12}{15}$ and $\frac{26}{30}$ are not equivalent fractions.

42. $18 = 2 \cdot 3^2$ $\quad 20 = 2^2 \cdot 5$

The GCF of 18 and 20 is 2.

$\dfrac{18}{20} = \dfrac{18 \div 2}{20 \div 2} = \dfrac{9}{10}$

$45 = 3^2 \cdot 5$ $\quad 50 = 2 \cdot 5^2$

The GCF of 45 and 50 is 5.

$\dfrac{45}{50} = \dfrac{45 \div 5}{50 \div 5} = \dfrac{9}{10}$

So, $\frac{18}{20}$ and $\frac{45}{50}$ are equivalent fractions.

43. $9 = 3^2$ $\quad 24 = 2^3 \cdot 3$

The GCF of 9 and 24 is 3.

$\dfrac{9}{24} = \dfrac{9 \div 3}{24 \div 3} = \dfrac{3}{8}$

$15 = 3 \cdot 5$ $\quad 48 = 2^4 \cdot 3$

The GCF of 15 and 48 is 3.

$\dfrac{15}{48} = \dfrac{15 \div 3}{48 \div 3} = \dfrac{5}{16}$

So, $\frac{9}{24}$ and $\frac{15}{48}$ are not equivalent fractions.

44. $63 = 3^2 \cdot 7$ $\quad 84 = 2^2 \cdot 3 \cdot 7$

The GCF of 63 and 84 is 21.

$\dfrac{63}{84} = \dfrac{63 \div 21}{84 \div 21} = \dfrac{3}{4}$

$45 = 3^2 \cdot 5$ $\quad 60 = 2^2 \cdot 3 \cdot 5$

The GCF of 45 and 60 is 15.

$\dfrac{45}{60} = \dfrac{45 \div 15}{60 \div 15} = \dfrac{3}{4}$

So, $\frac{63}{84}$ and $\frac{45}{60}$ are equivalent fractions

45. $49 = 7^2$ $\quad 63 = 3^2 \cdot 7$

The GCF of 49 and 63 is 7.

$\dfrac{49}{63} = \dfrac{49 \div 7}{63 \div 7} = \dfrac{7}{9}$

$21 = 3 \cdot 7$ $\quad 27 = 3^3$

The GCF of 21 and 27 is 3.

$\dfrac{21}{27} = \dfrac{21 \div 3}{27 \div 3} = \dfrac{7}{9}$

So, $\frac{49}{63}$ and $\frac{21}{27}$ are equivalent fractions.

46. $30 = 2 \cdot 3 \cdot 5$ $\quad 36 = 2^2 \cdot 3^2$

The GCF of 30 and 36 is 6.

$\dfrac{30}{36} = \dfrac{30 \div 6}{36 \div 6} = \dfrac{5}{6}$

$57 = 3 \cdot 19$ $\quad 72 = 2^3 \cdot 3^2$

The GCF of 57 and 72 is 3.

$\dfrac{57}{72} = \dfrac{57 \div 3}{72 \div 3} = \dfrac{19}{24}$

So, $\frac{30}{36}$ and $\frac{57}{72}$ are not equivalent fractions.

47. For the negative values one of the factors is -1.

$-12 = -1 \cdot 2^2 \cdot 3$ $\quad\quad 27 = 3^3$

The GCF of -12 and 27 is 3.

$$\frac{-12}{27} = \frac{-12 \div 3}{27 \div 3} = \frac{-4}{9}$$

$25 = 5^2$ $\quad\quad -35 = 1 \cdot 5 \cdot 7$

The GCF of 25 and -35 is 5.

$$\frac{25}{-35} = \frac{25 \div 5}{-35 \div 5} = \frac{5}{-7}$$

$-33 = -1 \cdot 3 \cdot 11$ $\quad\quad -55 = -1 \cdot 5 \cdot 11$

The GCF of -33 and -55 is -11.

$$\frac{-33}{-55} = \frac{-33 \div (-11)}{-55 \div (-11)} = \frac{3}{5}$$

48. a. $\dfrac{\text{Weeks spent as a butterfly}}{\text{Weeks in a regular monarch's life}} = \dfrac{5}{1 + 2 + 1 + 5}$

$= \dfrac{5}{9}$

$\frac{5}{9}$ of a regular monarch's life is spent as a butterfly.

b. $\dfrac{\text{Weeks spent as a butterfly}}{\text{Weeks in a migrating monarch's life}}$

$= \dfrac{30}{1 + 2 + 1 + 30}$

$= \dfrac{30}{34}$

$= \dfrac{30 \div 2}{34 \div 2}$

$= \dfrac{15}{17}$

$\frac{15}{17}$ of a migrating monarch's life is spent as a butterfly.

49. For $\frac{5}{6}$ and $\frac{x}{24}$ to be equivalent fractions, then

$$\frac{x}{24} = \frac{x \div 4}{24 \div 4} = \frac{5}{6}.$$

If $x \div 4 = 5$, then $x = 20$.

50. For $\frac{7}{9}$ and $\frac{28}{x}$ to be equivalent fractions, then

$$\frac{28}{x} = \frac{28 \div 4}{x \div 4} = \frac{7}{9}.$$

If $x \div 4 = 9$, then $x = 36$.

51. For $\frac{x}{12}$ and $\frac{80}{192}$ to be equivalent fractions, then

$$\frac{x}{12} = \frac{x \cdot 16}{12 \cdot 16} = \frac{80}{192}.$$

If $x \cdot 16 = 80$, then $x = 5$.

52. For $\frac{3}{8}$ and $\frac{2 + x}{32}$ to be equivalent fractions, then

$$\frac{2 + x}{32} = \frac{(2 + x) \div 4}{32 \div 4} = \frac{3}{8}.$$

If $(2 + x) \div 4 = 3$, then $x = 10$.

53. a. When $x = 2$ and $y = 3$;

$$\frac{8x^2y}{6x^2y^2} = \frac{8(2)^2(3)}{6(2)^2(3)^2} = \frac{8(4)(3)}{6(4)(9)} = \frac{32(3)}{24(9)} = \frac{96}{216}$$

$96 = 2^5 \cdot 3$ $\quad\quad 216 = 2^3 \cdot 3^3$

The GCF of 96 and 216 is 24.

$$\frac{96}{216} = \frac{96 \div 24}{216 \div 24} = \frac{4}{9}$$

b. $$\frac{8x^2y}{6x^2y} = \frac{\overset{1}{\cancel{2}} \cdot 2 \cdot 2 \cdot \overset{1}{\cancel{x}} \cdot \overset{1}{\cancel{x}} \cdot \overset{1}{\cancel{y}}}{\underset{1}{\cancel{2}} \cdot 3 \cdot \underset{1}{\cancel{x}} \cdot \underset{1}{\cancel{x}} \cdot \underset{1}{\cancel{y}} \cdot y} = \frac{4}{3y}$$

When $x = 2$ and $y = 3$; $\frac{4}{3y} = \frac{4}{3(3)} = \frac{4}{9}$

c. The results are the same. *Sample answer:* The method in part (b) requires less work because the multiplication is easier if simplifying is done first.

d. When $x = 3$ and $y = 4$;

$$\frac{8x^2y}{6x^2y^2} = \frac{8(3)^2(4)}{6(3)^2(4)^2} = \frac{8(9)(4)}{6(9)(16)} = \frac{72(4)}{54(16)} = \frac{288}{864}$$

$288 = 2^5 \cdot 3^2$ $\quad\quad 864 = 2^5 \cdot 3^3$

The GCF of 288 and 864 is 288.

$$\frac{288}{864} = \frac{288 \div 288}{864 \div 288} = \frac{1}{3}$$

$$\frac{8x^2y}{6x^2y^2} = \frac{\overset{1}{\cancel{2}} \cdot 2 \cdot 2 \cdot \overset{1}{\cancel{x}} \cdot \overset{1}{\cancel{x}} \cdot \overset{1}{\cancel{y}}}{\underset{1}{\cancel{2}} \cdot 3 \cdot \underset{1}{\cancel{x}} \cdot \underset{1}{\cancel{x}} \cdot \underset{1}{\cancel{y}} \cdot y} = \frac{4}{3y}$$

When $x = 3$ and $y = 4$;

$$\frac{4}{3y} = \frac{4}{3(4)} = \frac{4}{12} = \frac{4 \div 4}{12 \div 4} = \frac{1}{3}$$

The results are the same.

The method from part (b) is easier.

54. Adding the same nonzero number to the numerator and denominator of a fraction will only produce an equivalent fraction if the fraction is equal to 1.

4.3 Mixed Review (p. 188)

55. When $x = 4$ and $y = -9$;

$|x| + |y| = |4| + |-9| = 4 + 9 = 13$

56. When $y = -9$;

$|-19| + |y| = |-19| + |-9| = 19 + 9 = 28$

57. When $x = 4$;

$|x| + |-14| = |4| + |-14| = 4 + 14 = 18$

58. $n + p = p + n$ illustrates the commutative property of addition.

59. $1 \cdot \frac{5}{6} = \frac{5}{6}$ illustrates the identity property of multiplication.

60. $16 + 0 = 16$ illustrates the identity property of addition.

61. $2x = 2 \cdot x$
$8x^2 = 2 \cdot 2 \cdot 2 \cdot x \cdot x$
The GCF of $2x$ and $8x^2$ is $2x$.

62. $9m^2 = 3 \cdot 3 \cdot m \cdot m$
$27m^3 = 3 \cdot 3 \cdot 3 \cdot m \cdot m \cdot m$
The GCF of $9m^2$ and $27m^3$ is $9m^2$.

63. $10r = 2 \cdot 5 \cdot r$
$25r^4 = 5 \cdot 5 \cdot r \cdot r \cdot r \cdot r$
The GCF of $10r$ and $25r^4$ is $5r$.

4.3 Standardized Test Practice (p. 188)

64. D; $39 = 3 \cdot 13$ $\qquad 52 = 2^2 \cdot 13$
The GCF of 39 and 52 is 13.
$$\frac{39}{52} = \frac{39 \div 13}{52 \div 13} = \frac{3}{4}$$
$\frac{31}{42}$ does not simplify so $\frac{39}{52}$ and $\frac{31}{42}$ are not equivalent fractions.

65. F; $13 = 13$ $\qquad 65 = 5 \cdot 13$
The GCF of 13 and 65 is 13.
$$\frac{13}{65} = \frac{13 \div 13}{65 \div 13} = \frac{1}{5}$$

Lesson 4.4

4.4 Checkpoint (pp. 189–190)

1. Multiples of 16: 16, 32, (48), 64, . . .
   Multiples of 24: 24, (48), 72, . . .
   The LCM of 16 and 24 is 48.
2. Multiples of 20: 20, 40, 60, 80, (100), . . .
   Multiples of 25: 25, 50, 75, (100), 125, . . .
   The LCM of 20 and 25 is 100.
3. Multiples of 6: 6, 12, 18, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96, 102, 108, 114, (120), 126, . . .
   Multiples of 8: 8, 16, 24, 32, 40, 48, 56, 64, 72, 80, 88, 96, 104, 112, (120), 128, . . .
   Multiples of 20: 20, 40, 60, 80, 100, (120), . . .
   The LCM of 6, 8, and 20 is 120.
4. Multiples of 15: 15, 30, 45, 60, 75, 90, 105, 120, 135, (150), 165, . . .
   Multiples of 30: 30, 60, 90, 120, (150), . . .
   Multiples of 50: 50, 100, (150), . . .
   The LCM of 15, 30, and 50 is 150.
5. $15x^2 = 3 \cdot 5 \cdot x \cdot x$
   $27x = 3 \cdot 3 \cdot 3 \cdot x$
   $\text{LCM} = 3 \cdot x \cdot 3 \cdot 3 \cdot 5 \cdot x = 135x^2$
   The LCM of $15x^2$ and $27x$ is $135x^2$.
6. $6m^2 = 2 \cdot 3 \cdot m \cdot m$
   $10m^3 = 2 \cdot 5 \cdot m \cdot m \cdot m$
   $\text{LCM} = 2 \cdot m \cdot m \cdot 3 \cdot 5 \cdot m = 30m^3$
   The LCM of $6m^2$ and $10m^3$ is $30m^3$.
7. $14ab = 2 \cdot 7 \cdot a \cdot b$
   $21bc = 3 \cdot 7 \cdot b \cdot c$
   $\text{LCM} = 7 \cdot b \cdot 2 \cdot 3 \cdot a \cdot c = 42abc$
   The LCM of $14ab$ and $21bc$ is $42abc$.
8. $r^2 = r \cdot r$
   $5rst = 5 \cdot r \cdot s \cdot t$
   $\text{LCM} = r \cdot 5 \cdot r \cdot s \cdot t = 5r^2st$
   The LCM of r^2 and $5rst$ is $5r^2st$.
9. The LCM of 6 and 9 is 18. So, the LCD is 18.
   So, $\frac{5}{6} = \frac{5 \cdot 3}{6 \cdot 3} = \frac{15}{18}$ and $\frac{7}{9} = \frac{7 \cdot 2}{9 \cdot 2} = \frac{14}{18}$.
   $\frac{15}{18} > \frac{14}{18}$, so $\frac{5}{6} > \frac{7}{9}$.
10. The LCM of 8 and 20 is 40. So, the LCD is 40.
    So, $\frac{5}{8} = \frac{5 \cdot 5}{8 \cdot 5} = \frac{25}{40}$ and $\frac{13}{20} = \frac{13 \cdot 2}{20 \cdot 2} = \frac{26}{40}$.
    $\frac{25}{40} < \frac{26}{40}$, so $\frac{5}{8} < \frac{13}{20}$.
11. The LCM of 12 and 15 is 60. So, the LCD is 60.
    So, $\frac{7}{12} = \frac{7 \cdot 5}{12 \cdot 5} = \frac{35}{60}$ and $\frac{11}{15} = \frac{11 \cdot 4}{15 \cdot 4} = \frac{44}{60}$.
    $\frac{35}{60} < \frac{44}{60}$, so $\frac{7}{12} < \frac{11}{15}$.
12. The LCM of 16 and 10 is 80. So, the LCD is 80.
    So, $\frac{5}{16} = \frac{5 \cdot 5}{16 \cdot 5} = \frac{25}{80}$ and $\frac{3}{10} = \frac{3 \cdot 8}{10 \cdot 8} = \frac{24}{80}$.
    $\frac{25}{80} > \frac{24}{80}$, so $\frac{5}{16} > \frac{3}{10}$.

4.4 Guided Practice (p. 191)

1. *Sample answer:* The least common denominator of two or more factions is the least common multiple of the denominators of the fractions.
2. To compare $\frac{4}{7}$ and $\frac{7}{12}$, find the LCD of the fractions. The LCD is the LCM of 7 and 12, which is 84.
   Write equivalent fractions using the LCD, 84.
   $$\frac{4}{7} = \frac{4 \cdot 12}{7 \cdot 12} = \frac{48}{84} \qquad \frac{7}{12} = \frac{7 \cdot 7}{12 \cdot 7} = \frac{49}{84}$$
   Then compare the numerators.
   $\frac{48}{84} < \frac{49}{84}$, so $\frac{4}{7} < \frac{7}{12}$.
3. Multiples of 3: 3, 6, 9, (12), 15, . . .
   Multiples of 4: 4, 8, (12), 16, . . .
   The LCM of 3 and 4 is 12.
4. Multiples of 4: 4, (8), 12, 16, 20, . . .
   Multiples of 8: (8), 16, 24, 32, . . .
   The LCM of 4 and 8 is 8.

5. Multiples of 18: 18, 36, 54, 72, 90, . . .
Multiples of 24: 24, 48, 72, 96, . . .
The LCM of 18 and 24 is 72.

6. Multiples of 10: 10, 20, 30, 40, 50, 60, 70, 80, . . .
Multiples of 16: 16, 32, 48, 64, 80, 96, . . .
The LCM of 10 and 16 is 80.

7. $3s = 3 \cdot s$
$s^2 = s \cdot s$
$\text{LCM} = s \cdot 3 \cdot s = 3s^2$
The LCM of $3s$ and s^2 is $3s^2$.

8. $x^4 = x \cdot x \cdot x \cdot x$
$x^2 = x \cdot x$
$\text{LCM} = x \cdot x \cdot x \cdot x = x^4$
The LCM of x^4 and x^2 is x^4.

9. $15m^2 = 3 \cdot 5 \cdot m \cdot m$
$9m = 3 \cdot 3 \cdot m$
$\text{LCM} = 3 \cdot m \cdot 3 \cdot 5 \cdot m = 45m^2$
The LCM of $15m^2$ and $9m$ is $45m^2$.

10. $8b = 2 \cdot 2 \cdot 2 \cdot b$
$20b^2 = 2 \cdot 2 \cdot 5 \cdot b \cdot b$
$\text{LCM} = 2 \cdot 2 \cdot b \cdot 2 \cdot 5 \cdot b = 40b^2$
The LCM of $8b$ and $20b^2$ is $40b^2$.

11. The LCM of 4 and 8 is 8. So, the LCD is 8.
So, $\frac{3}{4} = \frac{3 \cdot 2}{4 \cdot 2} = \frac{6}{8}$.
$\frac{6}{8} > \frac{5}{8}$, so $\frac{3}{4} > \frac{5}{8}$.

12. The LCM of 3 and 16 is 48. So, the LCD is 48.
So, $\frac{2}{3} = \frac{2 \cdot 16}{3 \cdot 16} = \frac{32}{48}$ and $\frac{13}{16} = \frac{13 \cdot 3}{16 \cdot 3} = \frac{39}{48}$.
$\frac{32}{48} < \frac{39}{48}$, so $\frac{2}{3} < \frac{13}{16}$.

13. The LCM of 5 and 8 is 40. So, the LCD is 40.
So, $\frac{2}{5} = \frac{2 \cdot 8}{5 \cdot 8} = \frac{16}{40}$ and $\frac{3}{8} = \frac{3 \cdot 5}{8 \cdot 5} = \frac{15}{40}$.
$\frac{16}{40} > \frac{15}{40}$, so $\frac{2}{5} > \frac{3}{8}$.

14. The LCM of 4 and 10 is 20. So, the LCD is 20.
So, $\frac{3}{4} = \frac{3 \cdot 5}{4 \cdot 5} = \frac{15}{20}$ and $\frac{7}{10} = \frac{7 \cdot 2}{10 \cdot 2} = \frac{14}{20}$.
$\frac{15}{20} > \frac{14}{20}$, so $\frac{3}{4} > \frac{7}{10}$.

15. *Sample answer:* When you write the product to compute the LCM, you use the power of each prime factor with the greatest exponent that it has in the given numbers. The power of 2 is 4, not 5. Therefore,
$\text{LCM} = 2^4 \cdot 3 \cdot 5 = 240$

4.4 Practice and Problem Solving (pp. 192–193)

16. $9 = 3 \cdot 3$
$12 = 2 \cdot 2 \cdot 3$
$\text{LCM} = 3 \cdot 2 \cdot 2 \cdot 3 = 36$
The LCM of 9 and 12 is 36.

17. $3 = 3$
$8 = 2 \cdot 2 \cdot 2$
$\text{LCM} = 2 \cdot 2 \cdot 2 \cdot 3 = 24$
The LCM of 3 and 8 is 24.

18. $4 = 2 \cdot 2$
$16 = 2 \cdot 2 \cdot 2 \cdot 2$
$\text{LCM} = 2 \cdot 2 \cdot 2 \cdot 2 = 16$
The LCM of 4 and 16 is 16.

19. $10 = 2 \cdot 5$
$15 = 3 \cdot 5$
$\text{LCM} = 5 \cdot 2 \cdot 3 = 30$
The LCM of 10 and 15 is 30.

20. $21 = 3 \cdot 7$
$14 = 2 \cdot 7$
$\text{LCM} = 7 \cdot 2 \cdot 3 = 42$
The LCM of 21 and 14 is 42.

21. $30 = 2 \cdot 3 \cdot 5$
$36 = 2 \cdot 2 \cdot 3 \cdot 3$
$\text{LCM} = 2 \cdot 3 \cdot 2 \cdot 3 \cdot 5 = 180$
The LCM of 30 and 36 is 180.

22. $55 = 5 \cdot 11$
$15 = 3 \cdot 5$
$\text{LCM} = 5 \cdot 3 \cdot 11 = 165$
The LCM of 55 and 15 is 165.

23. $42 = 2 \cdot 3 \cdot 7$
$66 = 2 \cdot 3 \cdot 11$
$\text{LCM} = 2 \cdot 3 \cdot 7 \cdot 11 = 462$
The LCM of 42 and 62 is 462.

24. $3 = 3$
$6 = 2 \cdot 3$
$12 = 2 \cdot 2 \cdot 3$
$\text{LCM} = 2 \cdot 3 \cdot 2 = 12$
The LCM of 3, 6, and 12 is 12.

25. $8 = 2 \cdot 2 \cdot 2$
$11 = 11$
$36 = 2 \cdot 2 \cdot 3 \cdot 3$
$\text{LCM} = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 11 = 792$
The LCM of 8, 11, and 36 is 792.

26. $10 = 2 \cdot 5$
$12 = 2 \cdot 2 \cdot 3$
$14 = 2 \cdot 7$
LCM $= 2 \cdot 2 \cdot 3 \cdot 5 \cdot 7 = 420$
The LCM of 10, 12, and 14 is 420.

27. $16 = 2 \cdot 2 \cdot 2 \cdot 2$
$20 = 2 \cdot 2 \cdot 5$
$30 = 2 \cdot 3 \cdot 5$
LCM $= 2 \cdot 2 \cdot 5 \cdot 2 \cdot 2 \cdot 3 = 240$
The LCM of 16, 20, and 30 is 240.

28. $5a^2 = 5 \cdot a \cdot a$
$16a^3 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot a \cdot a \cdot a$
LCM $= a \cdot a \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 5 \cdot a = 80a^3$
The LCM of $5a^2$ and $16a^3$ is $80a^3$.

29. $21w = 3 \cdot 7 \cdot w$
$9w^2 = 3 \cdot 3 \cdot w \cdot w$
LCM $= 3 \cdot w \cdot 3 \cdot 7 \cdot w = 63w^2$
The LCM of $21w$ and $9w^2$ is $63w^2$.

30. $17b^2 = 17 \cdot b \cdot b$
$3b^3 = 3 \cdot b \cdot b \cdot b$
LCM $= b \cdot b \cdot 3 \cdot 17 \cdot b = 51b^3$
The LCM of $17b^2$ and $3b^3$ is $51b^3$.

31. $14x^4 = 2 \cdot 7 \cdot x \cdot x \cdot x \cdot x$
$21x^2 = 3 \cdot 7 \cdot x \cdot x$
LCM $= 7 \cdot x \cdot x \cdot 2 \cdot 3 \cdot x \cdot x = 42x^4$
The LCM of $14x^4$ and $21x^2$ is $42x^4$.

32. $60s^4 = 2 \cdot 2 \cdot 3 \cdot 5 \cdot s \cdot s \cdot s \cdot s$
$24s^3 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot s \cdot s \cdot s$
LCM $= 2 \cdot 2 \cdot 3 \cdot s \cdot s \cdot s \cdot 2 \cdot 5 \cdot s = 120s^4$
The LCM of $60s^4$ and $24s^3$ is $120s^4$.

33. $2n^3 = 2 \cdot n \cdot n \cdot n$
$8n^2 = 2 \cdot 2 \cdot 2 \cdot n \cdot n$
LCM $= 2 \cdot n \cdot n \cdot 2 \cdot 2 \cdot n = 8n^3$
The LCM of $2n^3$ and $8n^2$ is $8n^3$.

34. $25a = 5 \cdot 5 \cdot a$
$40a^2 = 2 \cdot 2 \cdot 2 \cdot 5 \cdot a \cdot a$
LCM $= 5 \cdot a \cdot 2 \cdot 2 \cdot 2 \cdot 5 \cdot a = 200a^2$
The LCM of $25a$ and $40a^2$ is $200a^2$.

35. $11s = 11 \cdot s$
$33s^2 = 3 \cdot 11 \cdot s \cdot s$
LCM $= 11 \cdot s \cdot 3 \cdot s = 33s^2$
The LCM of $11s$ and $33s^2$ is $33s^2$.

36. $6 = 2 \cdot 3$
$8 = 2 \cdot 2 \cdot 2$
LCM $= 2 \cdot 2 \cdot 2 \cdot 3 = 24$
Both patterns will have a green star 24 figures after the first figure.

37. No. *Sample answer:* You can multiply any common multiple that you can find by a whole number greater than 1 to find an even greater common multiple.

38. $3 = 3$
$7 = 7$
LCM $= 3 \cdot 7 = 21$
So, in 21 days you will lift weights and have karate on the same day.

39. The LCM of 4 and 7 is 28. So, the LCD is 28.
So, $\frac{1}{4} = \frac{1 \cdot 7}{4 \cdot 7} = \frac{7}{28}$ and $\frac{2}{7} = \frac{2 \cdot 4}{7 \cdot 4} = \frac{8}{28}$.
$\frac{7}{28} < \frac{8}{28}$, so $\frac{1}{4} < \frac{2}{7}$.

40. The LCM of 3 and 8 is 24. So, the LCD is 24.
So, $\frac{2}{3} = \frac{2 \cdot 8}{3 \cdot 8} = \frac{16}{24}$ and $\frac{5}{8} = \frac{5 \cdot 3}{8 \cdot 3} = \frac{15}{24}$.
$\frac{16}{24} > \frac{15}{24}$, so $\frac{2}{3} > \frac{5}{8}$.

41. The LCM of 10 and 15 is 30. So, the LCD is 30.
So, $\frac{7}{10} = \frac{7 \cdot 3}{10 \cdot 3} = \frac{21}{30}$ and $\frac{11}{15} = \frac{11 \cdot 2}{15 \cdot 2} = \frac{22}{30}$.
$\frac{21}{30} < \frac{22}{30}$, so $\frac{7}{10} < \frac{11}{15}$.

42. The LCM of 5 and 11 is 55. So, the LCD is 55.
So, $\frac{3}{5} = \frac{3 \cdot 11}{5 \cdot 11} = \frac{33}{55}$ and $\frac{6}{11} = \frac{6 \cdot 5}{11 \cdot 5} = \frac{30}{55}$.
$\frac{33}{55} > \frac{30}{55}$, so $\frac{3}{5} > \frac{6}{11}$.

43. The LCM of 12 and 15 is 60. So, the LCD is 60.
So, $\frac{5}{12} = \frac{5 \cdot 5}{12 \cdot 5} = \frac{25}{60}$ and $\frac{4}{15} = \frac{4 \cdot 4}{15 \cdot 4} = \frac{16}{60}$.
$\frac{25}{60} > \frac{16}{60}$, so $\frac{5}{12} > \frac{4}{15}$.

44. The LCM of 20 and 25 is 100. So, the LCD is 100.
So, $\frac{7}{20} = \frac{7 \cdot 5}{20 \cdot 5} = \frac{35}{100}$ and $\frac{9}{25} = \frac{9 \cdot 4}{25 \cdot 4} = \frac{36}{100}$.
$\frac{35}{100} < \frac{36}{100}$, so $\frac{7}{20} < \frac{9}{25}$.

45. The LCM of 18 and 21 is 126. So, the LCD is 126.
So, $\frac{5}{18} = \frac{5 \cdot 7}{18 \cdot 7} = \frac{35}{126}$ and $\frac{8}{21} = \frac{8 \cdot 6}{21 \cdot 6} = \frac{48}{126}$.
$\frac{35}{126} < \frac{48}{126}$, so $\frac{5}{18} < \frac{8}{21}$.

46. The LCM of 42 and 63 is 126. So, the LCD is 126.
So, $\frac{11}{42} = \frac{11 \cdot 3}{42 \cdot 3} = \frac{33}{126}$ and $\frac{20}{63} = \frac{20 \cdot 2}{63 \cdot 2} = \frac{40}{126}$.
$\frac{33}{126} < \frac{40}{126}$, so $\frac{11}{42} < \frac{20}{63}$.

47. $1\frac{1}{3} = \frac{1 \cdot 3 + 1}{3} = \frac{4}{3}$

The LCM of 6, 9, and 3 is 18. So, the LCD is 18.

$\frac{7}{6} = \frac{7 \cdot 3}{6 \cdot 3} = \frac{21}{18}$ $\quad \frac{11}{9} = \frac{11 \cdot 2}{9 \cdot 2} = \frac{22}{18}$

$\frac{4}{3} = \frac{4 \cdot 6}{3 \cdot 6} = \frac{24}{18}$

$\frac{21}{18} < \frac{22}{18} < \frac{24}{18}$, so $\frac{7}{6} < \frac{11}{9} < \frac{4}{3}$.

From least to greatest, the numbers are $\frac{7}{6}$, $\frac{11}{9}$, and $1\frac{1}{3}$.

48. $3\frac{1}{2} = \frac{3 \cdot 2 + 1}{2} = \frac{7}{2}$

The LCM of 4, 2, and 8 is 8. So, the LCD is 8.

$\frac{13}{4} = \frac{13 \cdot 2}{4 \cdot 2} = \frac{26}{8}$ $\quad \frac{7}{2} = \frac{7 \cdot 4}{2 \cdot 4} = \frac{28}{8}$

$\frac{27}{8}$

$\frac{26}{8} < \frac{27}{8} < \frac{28}{8}$, so $\frac{13}{4} < \frac{27}{8} < \frac{7}{2}$.

From least to greatest, the numbers are $\frac{13}{4}$, $\frac{27}{8}$, and $3\frac{1}{2}$.

49. The LCM of 15, 5, and 10 is 30. So, the LCD is 30.

$\frac{8}{15} = \frac{8 \cdot 2}{15 \cdot 2} = \frac{16}{30}$ $\quad \frac{1}{5} = \frac{1 \cdot 6}{5 \cdot 6} = \frac{6}{30}$

$\frac{3}{10} = \frac{3 \cdot 3}{10 \cdot 3} = \frac{9}{30}$

$\frac{6}{30} < \frac{9}{30} < \frac{16}{30}$, so $\frac{1}{5} < \frac{3}{10} < \frac{8}{15}$.

From least to greatest, the numbers are $\frac{1}{5}$, $\frac{3}{10}$, and $\frac{8}{15}$.

50. The LCM of 11, 33, and 22 is 66. So, the LCD is 66.

$\frac{5}{11} = \frac{5 \cdot 6}{11 \cdot 6} = \frac{30}{66}$ $\quad \frac{14}{33} = \frac{14 \cdot 2}{33 \cdot 2} = \frac{28}{66}$

$\frac{9}{22} = \frac{9 \cdot 3}{22 \cdot 3} = \frac{27}{66}$

$\frac{27}{66} < \frac{28}{66} < \frac{30}{66}$, so $\frac{9}{22} < \frac{14}{33} < \frac{5}{11}$.

From least to greatest, the numbers are $\frac{9}{22}$, $\frac{14}{33}$, and $\frac{5}{11}$.

51. The LCM of 4, 9, and 15 is 180. So, the LCD is 180.

$\frac{3}{4} = \frac{3 \cdot 45}{4 \cdot 45} = \frac{135}{180}$ $\quad \frac{4}{9} = \frac{4 \cdot 20}{9 \cdot 20} = \frac{80}{180}$

$\frac{7}{15} = \frac{7 \cdot 12}{15 \cdot 12} = \frac{84}{180}$

$\frac{80}{180} < \frac{84}{180} < \frac{135}{180}$, so $\frac{4}{9} < \frac{7}{15} < \frac{3}{4}$.

From least to greatest, the numbers are $\frac{4}{9}$, $\frac{7}{15}$, and $\frac{3}{4}$.

52. The LCM of 6, 10, and 15 is 30. So, the LCD is 30.

$\frac{5}{6} = \frac{5 \cdot 5}{6 \cdot 5} = \frac{25}{30}$ $\quad \frac{7}{10} = \frac{7 \cdot 3}{10 \cdot 3} = \frac{21}{30}$

$\frac{11}{15} = \frac{11 \cdot 2}{15 \cdot 2} = \frac{22}{30}$

$\frac{21}{30} < \frac{22}{30} < \frac{25}{30}$, so $\frac{7}{10} < \frac{11}{15} < \frac{5}{6}$.

From least to greatest, the numbers are $\frac{7}{10}$, $\frac{11}{15}$, and $\frac{5}{6}$.

53. $2\frac{5}{12} = \frac{2 \cdot 12 + 5}{12} = \frac{29}{12}$

The LCM of 5, 12, and 18 is 180. So, the LCD is 180.

$\frac{12}{5} = \frac{12 \cdot 36}{5 \cdot 36} = \frac{432}{180}$ $\quad \frac{29}{12} = \frac{29 \cdot 15}{12 \cdot 15} = \frac{435}{180}$

$\frac{43}{18} = \frac{43 \cdot 10}{18 \cdot 10} = \frac{430}{180}$

$\frac{430}{180} < \frac{432}{180} < \frac{435}{180}$, so $\frac{43}{18} < \frac{12}{5} < \frac{29}{12}$.

From least to greatest, the numbers are $\frac{43}{18}$, $\frac{12}{5}$, and $2\frac{5}{12}$.

54. $1\frac{1}{3} = \frac{1 \cdot 3 + 1}{3} = \frac{4}{3}$, $1\frac{13}{33} = \frac{1 \cdot 33 + 13}{33} = \frac{46}{33}$

The LCM of 3, 7, and 33 is 231. So, the LCD is 231.

$\frac{4}{3} = \frac{4 \cdot 77}{3 \cdot 77} = \frac{308}{231}$ $\quad \frac{10}{7} = \frac{10 \cdot 33}{7 \cdot 33} = \frac{330}{231}$

$\frac{46}{33} = \frac{46 \cdot 7}{33 \cdot 7} = \frac{322}{231}$

$\frac{308}{231} < \frac{322}{231} < \frac{330}{231}$, so $\frac{4}{3} < \frac{46}{33} < \frac{10}{7}$.

From least to greatest, the numbers are $1\frac{1}{3}$, $1\frac{13}{33}$, and $\frac{10}{7}$.

55. 25. *Sample answer:* $12 = 2 \cdot 2 \cdot 3$

$\text{LCM} = 300 = 2 \cdot 2 \cdot 3 \cdot 5 \cdot 5$

In order for the LCM to include the two factors of 5, the second number must be a multiple of $5 \cdot 5 = 25$. Thus, the least number that meets all the requirements is 25.

56. $24de^2 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot d \cdot e \cdot e$

$36d^3e = 2 \cdot 2 \cdot 3 \cdot 3 \cdot d \cdot d \cdot d \cdot e$

$\text{LCM} = 2 \cdot 2 \cdot 3 \cdot d \cdot e \cdot 2 \cdot 3 \cdot e \cdot d \cdot d = 72d^3e^2$

The LCM of $24de^2$ and $36d^3e$ is $72d^3e^2$.

57. $x^3y = x \cdot x \cdot x \cdot y$

$15xy^5 = 3 \cdot 5 \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y$

$\text{LCM} = x \cdot y \cdot 3 \cdot 5 \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y = 15x^3y^5$

The LCM of x^3y and $15xy^5$ is $15x^3y^5$.

58. $10a^2b^2 = 2 \cdot 5 \cdot a \cdot a \cdot b \cdot b$

$20ab = 2 \cdot 2 \cdot 5 \cdot a \cdot b$

$\text{LCM} = 2 \cdot 5 \cdot a \cdot b \cdot 2 \cdot a \cdot b = 20a^2b^2$

The LCM of $10a^2b^2$ and $20ab$ is $20a^2b^2$.

59. $45gh^3 = 3 \cdot 3 \cdot 5 \cdot g \cdot h \cdot h \cdot h$

$33g^4h = 3 \cdot 11 \cdot g \cdot g \cdot g \cdot g \cdot h$

$\text{LCM} = 3 \cdot g \cdot h \cdot 3 \cdot 5 \cdot 11 \cdot g \cdot g \cdot g \cdot h \cdot h = 495g^4h^3$

The LCM of $45gh^3$ and $33g^4h$ is $495g^4h^3$.

60. $xyz^3 = x \cdot y \cdot z \cdot z \cdot z$

$x^2yz^2 = x \cdot x \cdot y \cdot z \cdot z$

LCM $= x \cdot y \cdot z \cdot z \cdot x \cdot z = x^2yz^3$

The LCM of xyz^3 and x^2yz^2 is x^2yz^3.

61. $26ab^2 = 2 \cdot 13 \cdot a \cdot b \cdot b$

$28ac^3 = 2 \cdot 2 \cdot 7 \cdot a \cdot c \cdot c \cdot c$

LCM $= 2 \cdot a \cdot 2 \cdot 7 \cdot 13 \cdot b \cdot b \cdot c \cdot c \cdot c = 364ab^2c^3$

The LCM of $26ab^2$ and $28ac^3$ is $364ab^2c^3$.

62. $11rst = 11 \cdot r \cdot s \cdot t$

$15r^3t^2 = 3 \cdot 5 \cdot r \cdot r \cdot r \cdot t \cdot t$

LCM $= r \cdot t \cdot 3 \cdot 5 \cdot 11 \cdot r \cdot r \cdot s \cdot t = 165r^3st^2$

The LCM of $11rst$ and $15r^3t^2$ is $165r^3st^2$.

63. $30df^2 = 2 \cdot 3 \cdot 5 \cdot d \cdot f \cdot f$

$40d^3ef = 2 \cdot 2 \cdot 2 \cdot 5 \cdot d \cdot d \cdot d \cdot e \cdot f$

LCM $= 2 \cdot 5 \cdot d \cdot f \cdot 2 \cdot 2 \cdot 3 \cdot d \cdot d \cdot e \cdot f = 120d^3ef^2$

64. 1800–1900: $\frac{\text{Vice Presidents who became President}}{\text{Number of Vice Presidents}} = \frac{6}{23}$

1901–2000: $\frac{\text{Vice Presidents who became President}}{\text{Number of Vice Presidents}} = \frac{7}{21}$

The LCM of 21 and 23 is 483. So, the LCD is 483.

$\frac{6}{23} = \frac{6 \cdot 21}{23 \cdot 21} = \frac{126}{483}$ $\quad \frac{7}{21} = \frac{7 \cdot 23}{21 \cdot 23} = \frac{161}{483}$

$\frac{126}{483} < \frac{161}{483}$, so $\frac{6}{23} < \frac{7}{21}$.

During 1901–2000, a greater fraction of Vice Presidents became Presidents.

65. The LCM of 3 and 4 is 12. So, the LCD is 12.

$\frac{x}{3} = \frac{x \cdot 4}{3 \cdot 4} = \frac{4x}{12}$ $\quad \frac{x}{4} = \frac{x \cdot 3}{4 \cdot 3} = \frac{3x}{12}$

66. The LCM of $6y$ and $8x$ is $24xy$. So, the LCD is $24xy$.

$\frac{x}{6y} = \frac{x \cdot 4x}{6y \cdot 4x} = \frac{4x^2}{24xy}$ $\quad \frac{y}{8x} = \frac{y \cdot 3y}{8x \cdot 3y} = \frac{3y^2}{24xy}$

67. The LCM of $4y^2$ and $5xy$ is $20xy^2$. So, the LCD is $20xy^2$.

$\frac{3x}{4y^2} = \frac{3x \cdot 5x}{4y^2 \cdot 5x} = \frac{15x^2}{20xy^2}$

$\frac{2}{5xy} = \frac{2 \cdot 4y}{5xy \cdot 4y} = \frac{8y}{20xy^2}$

68. The LCM of $2yz$ and $4xz$ is $4xyz$. So, the LCD is $4xyz$.

$\frac{3x}{2yz} = \frac{3x \cdot 2x}{2yz \cdot 2x} = \frac{6x^2}{4xyz}$ $\quad \frac{5y}{4xz} = \frac{5y \cdot y}{4xz \cdot y} = \frac{5y^2}{4xyz}$

69. *Sample answer:* The LCM of 6, b, and 7 is $42b$. So, the LCD is $42b$.

$\frac{1}{6} = \frac{1 \cdot 7b}{6 \cdot 7b} = \frac{7b}{42b}$ $\quad \frac{a}{b} = \frac{a \cdot 42}{b \cdot 42} = \frac{42a}{42b}$

$\frac{2}{7} = \frac{2 \cdot 6b}{7 \cdot 6b} = \frac{12b}{42b}$

If $\frac{1}{6} < \frac{a}{b}$ and $\frac{a}{b} < \frac{2}{7}$, then $\frac{7b}{42b} < \frac{42a}{42b} < \frac{12b}{42b}$.

—CONTINUED—

69. —CONTINUED—

Let $42a = 10b$.

$\frac{42a}{42b} = \frac{10b}{42b} = \frac{\overset{1}{\cancel{2}} \cdot 5 \cdot \overset{1}{\cancel{b}}}{\underset{1}{\cancel{2}} \cdot 3 \cdot 7 \cdot \underset{1}{\cancel{b}}} = \frac{5}{21}$

So, $\frac{a}{b} = \frac{5}{21}$.

70.

Given numbers	Prime factorizations	LCM	GCF	LCM • GCF	*a* • *b*
$a = 6$, $b = 18$	$6 = 2 \cdot 3$ $18 = 2 \cdot 3^2$	18	6	108	108
$a = 15$, $b = 35$	$15 = 3 \cdot 5$ $35 = 5 \cdot 7$	105	5	525	525
$a = 6$, $b = 20$	$6 = 2 \cdot 3$ $20 = 2^2 \cdot 5$	60	2	120	120
$a = 12$, $b = 60$	$12 = 2^2 \cdot 3$ $60 = 2^2 \cdot 3 \cdot 5$	60	12	720	720

The product of the LCM and the GCF is equal to the product of a and b.

4.4 Mixed Review (p. 193)

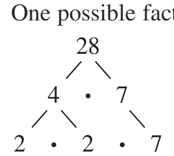
71. When $n = 5$; $n^2 = 5^2 = 5 \cdot 5 = 25$

72. When $n = 5$; $n^3 = 5^3 = 5 \cdot 5 \cdot 5 = 125$

73. When $n = 5$; $n^4 = 5^4 = 5 \cdot 5 \cdot 5 \cdot 5 = 625$

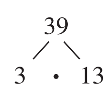
74. When $n = 5$; $n^5 = 5^5 = 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 = 3125$

75. One possible factor tree:



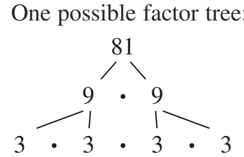
The prime factorization of 28 is $2^2 \cdot 7$.

76.



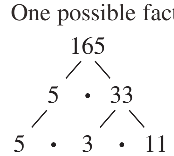
The prime factorization of 39 is $3 \cdot 13$.

77. One possible factor tree:



The prime factorization of 81 is 3^4.

78. One possible factor tree:



The prime factorization of 165 is $3 \cdot 5 \cdot 11$.

79. Peanut butter: $64 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

Chocolate chip: $80 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 5$

Sugar: $56 = 2 \cdot 2 \cdot 2 \cdot 7$

The GCF is $2^3 = 8$. Therefore, you can make 8 identical gift boxes.

4.4 Standardized Test Practice (p. 193)

80. D; $27w^4z = 3 \cdot 3 \cdot 3 \cdot w \cdot w \cdot w \cdot w \cdot z$

$75w^2z^2 = 3 \cdot 5 \cdot 5 \cdot w \cdot w \cdot z \cdot z$

$\text{LCM} = 3 \cdot w \cdot w \cdot z \cdot 3 \cdot 3 \cdot 5 \cdot 5 \cdot w \cdot w \cdot z$

$= 675w^4z^2$

The LCM of $27w^4z$ and $75w^2z^2$ is $675w^4z^2$.

81. H; The LCM of 20, 8, and 12 is 120. So, the LCD is 120.

$\frac{7}{20} = \frac{7 \cdot 6}{20 \cdot 6} = \frac{42}{120}$ $\frac{3}{8} = \frac{3 \cdot 15}{8 \cdot 15} = \frac{45}{120}$

$\frac{5}{12} = \frac{5 \cdot 10}{12 \cdot 10} = \frac{50}{120}$

$\frac{42}{120} < \frac{45}{120} < \frac{50}{120}$, so $\frac{7}{20} < \frac{3}{8} < \frac{5}{12}$.

From least to greatest, the numbers are $\frac{7}{20}$, $\frac{3}{8}$, and $\frac{5}{12}$.

Mid-Chapter Quiz (p. 194)

1. 46 is composite.

$$46 \to 2 \cdot 23$$

The prime factorization of 46 is $2 \cdot 23$.

2. 57 is composite.

$$57 \to 3 \cdot 19$$

The prime factorization of 57 is $3 \cdot 19$.

3. 61 is prime.

4. 89 is prime.

5. $25m^3 = 5 \cdot 5 \cdot m^3 = 5 \cdot 5 \cdot m \cdot m \cdot m$

6. $14n^4 = 2 \cdot 7 \cdot n^4 = 2 \cdot 7 \cdot n \cdot n \cdot n \cdot n$

7. $19a^2b = 19 \cdot a^2 \cdot b = 19 \cdot a \cdot a \cdot b$

8. $64f^2g^2 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot f^2 \cdot g^2$

$= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot f \cdot f \cdot g \cdot g$

9. $9 = 3 \cdot 3$

$16 = 2 \cdot 2 \cdot 2 \cdot 2$

The GCF of 9 and 16 is 1.

Because the GCF is 1, 9 and 16 are relatively prime.

10. $12 = 2 \cdot 2 \cdot 3$

$51 = 3 \cdot 17$

The GCF of 12 and 51 is 3.

Because the GCF is 3, 12 and 51 are not relatively prime.

11. $18 = 2 \cdot 3 \cdot 3$

$49 = 7 \cdot 7$

The GCF of 18 and 49 is 1.

Because the GCF is 1, 18 and 49 are relatively prime.

12. $56 = 2 \cdot 2 \cdot 2 \cdot 7$

$75 = 3 \cdot 5 \cdot 5$

The GCF of 56 and 75 is 1.

Because the GCF is 1, 56 and 75 are relatively prime.

13. Eight-year-olds: $24 = 2 \cdot 2 \cdot 2 \cdot 3$

Nine-year-olds: $96 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 3$

Ten-year-olds: $60 = 2 \cdot 2 \cdot 3 \cdot 5$

The GCF is $2 \cdot 2 \cdot 3 = 12$. Therefore, 12 teams can be formed. There will be $60 \div 12 = 5$ ten-year-olds on each team.

14. $18 = 2 \cdot 3^2$ $48 = 2^4 \cdot 3$

The GCF of 18 and 48 is 6.

$\frac{18}{48} = \frac{18 \div 6}{48 \div 6} = \frac{3}{8}$

15. $42 = 2 \cdot 3 \cdot 7$ $81 = 3^4$

The GCF of 42 and 81 is 3.

$\frac{42}{81} = \frac{42 \div 3}{81 \div 3} = \frac{14}{27}$

16. $\frac{32a}{8a^2} = \frac{\overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot 2 \cdot 2 \cdot \overset{1}{\cancel{a}}}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{a}} \cdot a} = \frac{4}{a}$

17. $\frac{15b}{39b^4} = \frac{\overset{1}{\cancel{3}} \cdot 5 \cdot \overset{1}{\cancel{b}}}{\underset{1}{\cancel{3}} \cdot 13 \cdot \underset{1}{\cancel{b}} \cdot b \cdot b \cdot b} = \frac{5}{13b^3}$

18. $4 = 2 \cdot 2$

$11 = 11$

$\text{LCM} = 2 \cdot 2 \cdot 11 = 44$

The LCM of 4 and 11 is 44.

19. $10 = 2 \cdot 5$

$24 = 2 \cdot 2 \cdot 2 \cdot 3$

$\text{LCM} = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 5 = 120$

The LCM of 10 and 24 is 120.

20. $15 = 3 \cdot 5$

$45 = 3 \cdot 3 \cdot 5$

$\text{LCM} = 3 \cdot 5 \cdot 3 = 45$

The LCM of 15 and 45 is 45.

21. $30 = 2 \cdot 3 \cdot 5$

$54 = 2 \cdot 3 \cdot 3 \cdot 3$

$\text{LCM} = 2 \cdot 3 \cdot 3 \cdot 3 \cdot 5 = 270$

The LCM of 30 and 54 is 270.

22. The LCM of 8 and 9 is 72. So, the LCD is 72.

$\frac{3}{8} = \frac{3 \cdot 9}{8 \cdot 9} = \frac{27}{72}$ $\frac{4}{9} = \frac{4 \cdot 8}{9 \cdot 8} = \frac{32}{72}$

$\frac{27}{72} < \frac{32}{72}$, so $\frac{3}{8} < \frac{4}{9}$.

$\frac{4}{9} > \frac{3}{8}$

23. The LCM of 10 and 25 is 50. So, the LCD is 50.

$\frac{7}{10} = \frac{7 \cdot 5}{10 \cdot 5} = \frac{35}{50}$ $\frac{18}{25} = \frac{18 \cdot 2}{25 \cdot 2} = \frac{36}{50}$

$\frac{35}{50} < \frac{36}{50}$, so $\frac{7}{10} < \frac{18}{25}$.

$\frac{18}{25} > \frac{7}{10}$

24. The LCM of 12 and 20 is 60. So, the LCD is 60.

$\frac{5}{12} = \frac{5 \cdot 5}{12 \cdot 5} = \frac{25}{60}$ $\frac{9}{20} = \frac{9 \cdot 3}{20 \cdot 3} = \frac{27}{60}$

$\frac{25}{60} < \frac{27}{60}$, so $\frac{5}{12} < \frac{9}{20}$.

$\frac{9}{20} > \frac{5}{12}$

25. The LCM of 18 and 24 is 72.

$\frac{11}{18} = \frac{11 \cdot 4}{18 \cdot 4} = \frac{44}{72}$ $\frac{13}{24} = \frac{13 \cdot 3}{24 \cdot 3} = \frac{39}{72}$

$\frac{44}{72} > \frac{39}{72}$, so $\frac{11}{18} > \frac{13}{24}$.

$\frac{11}{18} > \frac{13}{24}$

Brain Game (p. 194)

Sample answer: $\frac{42}{70}, \frac{15}{25}, \frac{24}{40}, \frac{69}{115}, \frac{33}{?}$

The LCM of 25 and x is $25x$. So, the LCD is $25x$.

$\frac{15}{25} = \frac{15 \cdot x}{25 \cdot x} = \frac{15x}{25x}$ $\frac{33}{x} = \frac{33 \cdot 25}{x \cdot 25} = \frac{825}{25x}$

$\frac{15x}{25x} = \frac{825}{25x}$

So, $15x = 825$.

Use mental math to solve $x = 55$.

So, ? = 55 and the last fraction is $\frac{33}{55}$.

Lesson 4.5

4.5 Concept Activity (p. 195)

Investigate

Product			
Expression	**Expression written as repeated multiplication**	**Number of factors**	**Product as a power**
$2^4 \cdot 2^3$	$(2 \cdot 2 \cdot 2 \cdot 2) \cdot (2 \cdot 2 \cdot 2)$	7	2^7
$3^1 \cdot 3^4$	$(3) \cdot (3 \cdot 3 \cdot 3 \cdot 3)$	5	3^5
$5^2 \cdot 5^4$	$(5 \cdot 5) \cdot (5 \cdot 5 \cdot 5 \cdot 5)$	6	5^6

Quotients		
Expression	**Expression written as repeated multiplication**	**Simplified expression**
$\frac{2^8}{2^3}$	$\frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot \cancel{2} \cdot \cancel{2} \cdot \cancel{2}}{\cancel{2} \cdot \cancel{2} \cdot \cancel{2}}$	$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$
$\frac{3^5}{3^3}$	$\frac{3 \cdot 3 \cdot \cancel{3} \cdot \cancel{3} \cdot \cancel{3}}{\cancel{3} \cdot \cancel{3} \cdot \cancel{3}}$	$3 \cdot 3$
$\frac{5^7}{5^6}$	$\frac{5 \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5}}{\cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5}}$	5

Quotients		
Expression	**Number of factors**	**Quotients as a power**
$\frac{2^8}{2^3}$	5	2^5
$\frac{3^5}{3^3}$	2	3^2
$\frac{5^7}{5^6}$	1	5^1

Draw Conclusions

1. The exponents in the last column are the sums of the exponents in the corresponding rows of the first columns.

2. $10^7 \cdot 10^4 = 10^{7+4} = 10^{11}$

3. The exponents in the last column are the differences of the exponents in the corresponding rows of the first columns.

4. $\frac{6^9}{6^7} = 6^{9-7} = 6^2$

4.5 Checkpoint (pp. 196–198)

1. $2^3 \cdot 2^2 = 2^{3+2} = 2^5$

2. $8^7 \cdot 8^5 = 8^{7+5} = 8^{12}$

3. $(0.5) \cdot (0.5)^2 = (0.5)^{1+2} = (0.5)^3$

4. $4^6 \cdot 4^4 \cdot 4^3 = 4^{6+4+3} = 4^{13}$

5. $b^7 \cdot b^2 = b^{7+2} = b^9$

6. $a \cdot a^5 \cdot a^2 = a^{1+5+2} = a^8$

7. $0.2n^{11} \cdot 6n^8 = 0.2 \cdot 6 \cdot n^{11} \cdot n^8$
$= 0.2 \cdot 6 \cdot n^{11+8}$
$= 0.2 \cdot 6 \cdot n^{19}$
$= 1.2n^{19}$

8. $2m^4 \cdot 7m^5 = 2 \cdot 7 \cdot m^4 \cdot m^5$
$= 2 \cdot 7 \cdot m^{4+5}$
$= 2 \cdot 7 \cdot m^9$
$= 14m^9$

9. $\frac{(0.6)^9}{(0.6)^4} = (0.6)^{9-4} = (0.6)^5$

10. $\frac{10^{11}}{10^7} = 10^{11-7} = 10^4$

11. $\frac{z^8}{z^3} = z^{8-3} = z^5$

12. $\frac{12n^5}{8n^2} = \frac{12n^{5-2}}{8} = \frac{12n^3}{8} = \frac{3n^3}{2}$

13. $\frac{a^4 \cdot 10a^3}{a^2} = \frac{10a^{4+3}}{a^2} = \frac{10a^7}{a^2} = 10a^{7-2} = 10a^5$

14. $\frac{13b^4 \cdot b^4}{b} = \frac{13b^{4+4}}{b} = \frac{13b^8}{b} = 13b^{8-1} = 13b^7$

15. $\frac{x \cdot 7x^5}{10x^4} = \frac{7x^{5+1}}{10x^4} = \frac{7x^6}{10x^4} = \frac{7x^{6-4}}{10} = \frac{7x^2}{10}$

16. $\frac{12y^2 \cdot y^8}{16y^5} = \frac{12y^{2+8}}{16y^5}$
$= \frac{12y^{10}}{16y^5}$
$= \frac{12y^{10-5}}{16}$
$= \frac{12y^5}{16}$
$= \frac{3y^5}{4}$

4.5 Guided Practice (p. 198)

1. To multiply two powers with the same base, *add* their exponents.

2. *Sample answer:* $\frac{14d^9}{16d^5}$

3. $4^2 \cdot 4^9 = 4^{2+9} = 4^{11}$

4. $5^3 \cdot 5^8 = 5^{3+8} = 5^{11}$

5. $6^7 \cdot 6 = 6^{7+1} = 6^8$

6. $(0.3)^5 \cdot (0.3)^4 = (0.3)^{5+4} = (0.3)^9$

7. $\frac{2^{12}}{2^7} = 2^{12-7} = 2^5$

8. $\frac{(0.5)^{14}}{(0.5)^2} = (0.5)^{14-2} = (0.5)^{12}$

9. $\frac{3^5}{3^2} = 3^{5-2} = 3^3$

10. $\frac{10^9}{10^7} = 10^{9-7} = 10^2$

11. $m^4 \cdot m^3 = m^{4+3} = m^7$

12. $2x^7 \cdot 5x^2 = 2 \cdot 5 \cdot x^7 \cdot x^2$
$= 2 \cdot 5 \cdot x^{7+2}$
$= 2 \cdot 5 \cdot x^9$
$= 10x^9$

13. $\frac{x^{10}}{x^4} = x^{10-4} = x^6$

14. $\frac{1.5y^7}{0.5y^3} = \frac{1.5y^{7-3}}{0.5} = \frac{1.5y^4}{0.5} = 3y^4$

15. The coefficients of each expression should have been multiplied.
$2x^5 \cdot 2x^4 = 2 \cdot 2 \cdot x^5 \cdot x^4$
$= 2 \cdot 2 \cdot x^{5+4}$
$= 2 \cdot 2 \cdot x^9$
$= 4x^9$

4.5 Practice and Problem Solving (pp. 199–200)

16. $10^6 \cdot 10^7 = 10^{6+7} = 10^{13}$

17. $9^2 + 9^3 = 9^{2+3} = 9^5$

18. $11^4 \cdot 11^4 = 11^{4+4} = 11^8$

19. $8 \cdot 8^5 \cdot 8^2 = 8^{1+5+2} = 8^8$

20. $\frac{6^3}{6^2} = 6^{3-2} = 6^1 = 6$

21. $\frac{(0.8)^{12}}{(0.8)^6} = (0.8)^{12-6} = (0.8)^6$

22. $\frac{7^{20}}{7^4} = 7^{20-4} = 7^{16}$

23. $\frac{9^{11}}{9} = 9^{11-1} = 9^{10}$

24. $a^4 \cdot a^8 = a^{4+8} = a^{12}$

25. $b^9 \cdot b^6 = b^{9+6} = b^{15}$

26. $3w^3 \cdot w^2 = 3w^{3+2} = 3w^5$

27. $z^7 \cdot 0.5z^4 = 0.5 \cdot z^7 \cdot z^4 = 0.5z^{7+4} = 0.5z^{11}$

28. $3n^4 \cdot 6n^9 = 3 \cdot 6 \cdot n^4 \cdot n^9$
$= 3 \cdot 6 \cdot n^{4+9}$
$= 3 \cdot 6 \cdot n^{13}$
$= 18n^{13}$

29. $4r^5 \cdot 2r = 4 \cdot 2 \cdot r^5 \cdot r^1$
$= 4 \cdot 2 \cdot r^{5+1}$
$= 4 \cdot 2 \cdot r^6$
$= 8r^6$

30. $x^2 \cdot x^2 \cdot x = x^{2+2+1} = x^5$

31. $z^5 \cdot z^2 \cdot z^7 = z^{5+2+7} = z^{14}$

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

33. $\frac{0.7y^8}{y^5} = 0.7y^{8-5} = 0.7y^3$

34. $\frac{24m^{11}}{18m^3} = \frac{24m^{11-3}}{18} = \frac{24m^8}{18} = \frac{4m^8}{3}$

35. $\frac{28s^{15}}{42s^{12}} = \frac{28s^{15-12}}{42} = \frac{28s^3}{42} = \frac{2s^3}{3}$

36. Mass of the Great Pyramid = Number of blocks • Average mass per block
$= 2^{21} \cdot 2^{11}$
$= 2^{21+11}$
$= 2^{32}$

The total mass of the Great Pyramid is about 2^{32} kilograms.

37. $3^8 = 3^6 \cdot 3^2 = 3^{6+2} = 3^8$

38. $2^7 > 2 \cdot 2^5 = 2^{1+5} = 2^6$

39. $6^5 > 6^2 \cdot 6^2 = 6^{2+2} = 6^4$

40. a. $\dfrac{\text{Number of bytes in a megabyte}}{\text{Number of bytes in a kilobyte}} = \dfrac{10^6}{10^3}$

$= 10^{6-3}$

$= 10^3$

There are 10^3 kilobytes in a megabyte.

b. $\dfrac{\text{Number of bytes in a petabyte}}{\text{Number of bytes in a gigabyte}} = \dfrac{10^{15}}{10^9}$

$= 10^{15-9}$

$= 10^6$

There are 10^6 gigabytes in a petabyte.

c. $\dfrac{\text{Number of bytes in a petabyte}}{\text{Number of bytes in a megabyte}} = \dfrac{10^{15}}{10^6}$

$= 10^{15-6}$

$= 10^9$

There are 10^9 megabytes in a petabyte.

41. The product of powers property cannot be used to simplify $a^7 \cdot b^7$ because the powers do not have the same base.

42. $\dfrac{a^?}{a^3} = a^{?-3} = a^5$; ? = 8

43. $y^5 \cdot y^? = y^{5+?} = y^7$; ? = 2

44. $b^? \cdot b^6 = b^{?+6} = b^7$; ? = 1

45. $\dfrac{z^7}{z^?} = z^{7-?} = z^4$; ? = 3

46. $x^2 \cdot y^4 \cdot x^3 = x^2 \cdot x^3 \cdot y^4 = x^{2+3} \cdot y^4 = x^5y^4$

47. $4m^4(n^7m) = 4m^4 \cdot n^7 \cdot m$

$= 4m^4 \cdot m \cdot n^7$

$= 4m^{4+1} \cdot n^7$

$= 4m^5n^7$

48. $(p^3q^2)(p^4q^2) = p^3q^2 \cdot p^4q^2$

$= p^3 \cdot p^4 \cdot q^2 \cdot q^2$

$= p^{3+4} \cdot q^{2+2}$

$= p^7q^4$

49. $4ab(0.5a^2b^3) = 4ab \cdot 0.5a^2b^3$

$= 4 \cdot 0.5 \cdot a \cdot a^2 \cdot b \cdot b^3$

$= 4 \cdot 0.5 \cdot a^{1+2} \cdot b^{1+3}$

$= 4 \cdot 0.5 \cdot a^3 \cdot b^4$

$= 2a^3b^4$

50. $\dfrac{14a^3b^4}{4ab} = \dfrac{14a^{3-1} \cdot b^{4-1}}{4} = \dfrac{14a^2b^3}{4} = \dfrac{7a^2b^3}{2}$

51. $\dfrac{63m^5n^6}{27mn} = \dfrac{63m^{5-1} \cdot n^{6-1}}{27} = \dfrac{63m^4n^5}{27} = \dfrac{7m^4n^5}{3}$

52. $\dfrac{24w^4z^9}{15w^2z^3} = \dfrac{24w^{4-2} \cdot z^{9-3}}{15} = \dfrac{24w^2z^6}{15} = \dfrac{8w^2z^6}{5}$

53. $\dfrac{28c^{10}d^{13}}{24c^6d^8} = \dfrac{28c^{10-6} \cdot d^{13-8}}{24} = \dfrac{28c^4d^5}{24} = \dfrac{7c^4d^5}{6}$

54. $\dfrac{2x^6 \cdot 4x^3}{24x^5} = \dfrac{2 \cdot 4 \cdot x^6 \cdot x^3}{24x^5}$

$= \dfrac{8x^{6+3}}{24x^5}$

$= \dfrac{8x^9}{24x^5}$

$= \dfrac{8x^{9-5}}{24}$

$= \dfrac{8x^4}{24}$

$= \dfrac{x^4}{3}$

55. $\dfrac{3a \cdot 4a^4}{28a^2} = \dfrac{3 \cdot 4 \cdot a \cdot a^4}{28a^2}$

$= \dfrac{12a^{1+4}}{28a^2}$

$= \dfrac{12a^5}{28a^2}$

$= \dfrac{12a^{5-2}}{28}$

$= \dfrac{12a^3}{28}$

$= \dfrac{3a^3}{7}$

56. $\dfrac{6z^9 \cdot 8z^3}{27z^2} = \dfrac{6 \cdot 8 \cdot z^9 \cdot z^3}{27z^3}$

$= \dfrac{48z^{9+3}}{27z^2}$

$= \dfrac{48z^{12}}{27z^2}$

$= \dfrac{48z^{12-2}}{27}$

$= \dfrac{48z^{10}}{27}$

$= \dfrac{16z^{10}}{9}$

57. $\dfrac{0.2w^6 \cdot 3.6w^8}{1.8w^4} = \dfrac{0.2 \cdot 3.6 \cdot w^6 \cdot w^8}{1.8w^4}$

$= \dfrac{0.72w^{6+8}}{1.8w^4}$

$= \dfrac{0.72w^{14}}{1.8w^4}$

$= \dfrac{0.72w^{14-4}}{1.8}$

$= \dfrac{0.72w^{10}}{1.8}$

$= 0.4w^{10}$

58. Number of stars in the universe = Number of stars per galaxy • Number of galaxies

$= 100 \cdot 10^9 \cdot 100 \cdot 10^9$

$= 100 \cdot 100 \cdot 10^9 \cdot 10^9$

$= 100 \cdot 100 \cdot 10^{9+9}$

$= 100 \cdot 100 \cdot 10^{18}$

$= 10{,}000 \cdot 10^{18}$

$= 10^4 \cdot 10^{18}$

$= 10^{4+18}$

$= 10^{22}$

There are about 10^{22} stars in the universe.

59. a. $\dfrac{5^m}{5^n} = 5^{m-n}$

b. *Sample answer:* Let $m = 4$ and $n = 3$.
$5^{4-3} = 5^1 = 5$

c. Yes. *Sample answer:* Any pair of integers m and n such that m is 1 more than n will result in a true equation.

60. $-3n^4 \cdot 6n^3 = -3 \cdot 6 \cdot n^{4+3} = -18n^7$

61. $-5a^7 \cdot (-4a^2) = -5 \cdot (-4) \cdot a^{7+2} = 20a^9$

62. $\dfrac{15x^6}{-3x^2} = \dfrac{15x^{6-2}}{-3} = -5x^4$

63. $\dfrac{-42c^8}{-6c^3} = \dfrac{-42c^{8-3}}{-6} = 7c^5$

64. $\dfrac{a^{m+n}}{a^n} = a^{m+n-n} = a^m$

65. 2. *Sample answer:* $3^{4n} \cdot 3^{n+4} = 3^{4n+n+4}$

$= 3^{5n+4}$

$= 3^{14}$

Use mental math to solve $5n + 4 = 14$. So, $n = 2$.

4.5 Mixed Review (p. 200)

66. $-14 + 98 = 84$ **67.** $26 + (-19) = 7$

68. $-89 - 23 = -89 + (-23) = -112$

69. $78 - (-34) = 78 + 34 = 112$

70. $44x^3 = 2 \cdot 2 \cdot 11 \cdot x \cdot x \cdot x$

$24x^2 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot x \cdot x$

The GCF of $44x^3$ and $24x^2$ is $4x^2$.

71. $21xy = 3 \cdot 7 \cdot x \cdot y$

$25x^2 = 5 \cdot 5 \cdot x \cdot x$

The GCF of $21xy$ and $25x^2$ is x.

72. $42x^3y = 2 \cdot 3 \cdot 7 \cdot x \cdot x \cdot x \cdot y$

$70xy^2 = 2 \cdot 5 \cdot 7 \cdot x \cdot y \cdot y$

The GCF of $42x^3y$ and $70xy^2$ is $14xy$.

73. $100x^3 = 2 \cdot 2 \cdot 5 \cdot 5 \cdot x \cdot x \cdot x$

$75y^3 = 3 \cdot 5 \cdot 5 \cdot y \cdot y \cdot y$

The GCF of $100x^3$ and $75y^3$ is 25.

74. $6x^2 = 2 \cdot 3 \cdot x \cdot x$

$12xy^3 = 2 \cdot 2 \cdot 3 \cdot x \cdot y \cdot y \cdot y$

LCM $= 2 \cdot 3 \cdot x \cdot 2 \cdot x \cdot y \cdot y \cdot y = 12x^2y^3$

The LCM of $6x^2$ and $12xy^3$ is $12x^2y^3$.

75. $3y = 3 \cdot y$

$5x^2y^2 = 5 \cdot x \cdot x \cdot y \cdot y$

LCM $= y \cdot 3 \cdot 5 \cdot x \cdot x \cdot y = 15x^2y^2$

The LCM of $3y$ and $5x^2y^2$ is $15x^2y^2$.

76. $4x^3 = 2 \cdot 2 \cdot x \cdot x \cdot x$

$7xy^2 = 7 \cdot x \cdot y \cdot y$

LCM $= x \cdot 2 \cdot 2 \cdot 7 \cdot x \cdot x \cdot y \cdot y = 28x^3y^2$

The LCM of $4x^3$ and $7xy^2$ is $28x^3y^2$.

77. $9x^2y^3 = 3 \cdot 3 \cdot x \cdot x \cdot y \cdot y \cdot y$

$8xy = 2 \cdot 2 \cdot 2 \cdot x \cdot y$

LCM $= x \cdot y \cdot 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot x \cdot y \cdot y = 72x^2y^3$

The LCM of $9x^2y^3$ and $8xy$ is $72x^2y^3$.

4.5 Standardized Test Practice (p. 200)

78. D; $\dfrac{24m^{18}}{36m^6} = \dfrac{24m^{18-6}}{36} = \dfrac{24m^{12}}{36} = \dfrac{2m^{12}}{3}$

79. I; $36x^3 \cdot 9x^2 = 36 \cdot 9 \cdot x^3 \cdot x^2$

$= 36 \cdot 9 \cdot x^{3+2}$

$= 36 \cdot 9 \cdot x^5$

$= 324x^5$

Brain Game (p. 200)

The pattern the digits in the ones' place for the first 4 powers of 3 are (in order) 3, 9, 7, 1, and these digits repeat in this same order for succeeding powers of 3.

The digit in the ones' place for 3^{100} is 1.

Lesson 4.6

4.6 Checkpoint (pp. 201–202)

1. $5^{-2} = \dfrac{1}{5^2}$ **2.** $1{,}000{,}000^0 = 1$

3. $3y^{-2} = \dfrac{3}{y^2}$ **4.** $a^{-7}b^3 = \dfrac{b^3}{a^7}$

5. $\dfrac{1}{25} = \dfrac{1}{5^2} = 5^{-2}$ **6.** $\dfrac{1}{1000} = \dfrac{1}{10^3} = 10^{-3}$

7. $\dfrac{2}{a^8} = 2a^{-8}$ **8.** $\dfrac{x^7}{z^2} = x^7z^{-2}$

9. $3^{-7} \cdot 3^{11} = 3^{-7+11} = 3^4$

10. $(0.5)^{-8} \cdot 0.5^{-7} = (0.5)^{-8+(-7)} = (0.5)^{-15}$

11. $m^{-3} \cdot m^{-1} = m^{-3+(-1)} = m^{-4} = \dfrac{1}{m^4}$

12. $a^{-2} \cdot a^{10} = a^{-2+10} = a^8$

13. $\dfrac{(0.2)^{-3}}{(0.2)^4} = (0.2)^{-3-4} = (0.2)^{-7} = \dfrac{1}{(0.2)^7}$

14. $\frac{7^2}{7^{-8}} = 7^{2-(-8)} = 7^{2+8} = 7^{10}$

15. $\frac{5k^3}{k^{-9}} = 5k^{3-(-9)} = 5k^{3+9} = 5k^{12}$

16. $\frac{b^{-4}}{b^{-6}} = b^{-4-(-6)} = b^{-4+6} = b^2$

4.6 Guided Practice (p. 203)

1. $7^{-2} = \frac{1}{7^2}$

2. No; if a is nonzero, the value of a^0 does not depend on a because any nonzero number to the zero power is 1.

3. $5^{-3} = \frac{1}{5^3}$

4. $3^{-5} = \frac{1}{3^5}$

5. $4a^{-6} = \frac{4}{a^6}$

6. $b^{-3}c^0 = b^{-3} \cdot 1 = \frac{1}{b^3}$

7. $\frac{1}{27} = \frac{1}{3^3} = 3^{-3}$

8. $\frac{1}{10^8} = 10^{-8}$

9. $\frac{4}{x^3} = 4x^{-3}$

10. $\frac{11}{c^5} = 11c^{-5}$

11. $6^{-4} \cdot 6^7 = 6^{-4+7} = 6^3$

12. $3^{-2} \cdot 3^{-8} = 3^{-2+(-8)} = 3^{-10} = \frac{1}{3^{10}}$

13. $x^{11} \cdot x^{-3} = x^{11+(-3)} = x^8$

14. $z^{-5} \cdot z^{-1} = z^{-5+(-1)} = z^{-6} = \frac{1}{z^6}$

15. (1) $\frac{\text{Duration of a millisecond}}{\text{Duration of a nanosecond}} = \frac{10^{-3}}{10^{-9}}$

(2) $\frac{10^{-3}}{10^{-9}} = 10^{-3-(-9)} = 10^{-3+9} = 10^6$

There are 10^6 nanoseconds in a millisecond.

4.6 Practice and Problem Solving (pp. 204–205)

16. $13^{-6} = \frac{1}{13^6}$

17. $121^0 = 1$

18. $8^{-9} = \frac{1}{8^9}$

19. $20^{-4} = \frac{1}{20^4}$

20. $xy^0 = x \cdot 1 = x$

21. $18f^{-1} = \frac{18}{f^1} = \frac{18}{f}$

22. $0.6g^{-5} = \frac{0.6}{g^5}$

23. $c^3d^{-1} = \frac{c^3}{d^1} = \frac{c^3}{d}$

24. $\frac{1}{25} = \frac{1}{5^2} = 5^{-2}$

25. $\frac{1}{19} = \frac{1}{19^1} = 19^{-1}$

26. $\frac{1}{10{,}000} = \frac{1}{10^4} = 10^{-4}$

27. $\frac{1}{64} = \frac{1}{2^6} = 2^{-6}$

28. $\frac{8}{c^5} = 8c^{-5}$

29. $\frac{4}{d} = \frac{4}{d^1} = 4d^{-1}$

30. $\frac{4y}{x^3} = 4x^{-3}y$

31. $\frac{9a^2}{b^6} = 9a^2b^{-6}$

32. $3^4 \cdot 3^{-7} = 3^{4+(-7)} = 3^{-3} = \frac{1}{3^3}$

33. $5 \cdot 5^{-5} = 5^{1+(-5)} = 5^{-4} = \frac{1}{5^4}$

34. $10^{-2} \cdot 10^{-8} = 10^{-2+(-8)} = 10^{-10} = \frac{1}{10^{10}}$

35. $13^0 \cdot 13^6 = 1 \cdot 13^6 = 13^6$

36. $2s^{-5} \cdot s^3 = 2s^{-5+3} = 2s^{-2} = \frac{2}{s^2}$

37. $5t^{-3} \cdot 3t^{-8} = 5 \cdot 3 \cdot t^{-3} \cdot t^{-8}$

$= 15t^{-3+(-8)}$

$= 15t^{-11}$

$= \frac{15}{t^{11}}$

38. $0.4a^0 \cdot 0.7a^{-4} = 0.4 \cdot a^0 \cdot 0.7 \cdot a^{-4} = 0.8a^{-4} = \frac{0.28}{a^4}$

39. $b^{-5} \cdot b^{-9} = b^{-5+(-9)} = b^{-14} = \frac{1}{b^{14}}$

40. $\frac{1}{100{,}000{,}000{,}000} = \frac{1}{10^{11}} = 10^{-11}$

41. *Sample answer:* $6^{-2} = \frac{1}{6^2} = \frac{1}{36}$

$6^2 = 36$

The two numbers are different because 6^{-2} is a fraction when simplified, and 6^2 is a whole number.

42. *Sample answer:* $a^{-n} = \frac{1}{a^n}$ does not apply to $a = 0$ because $\frac{1}{0}$ is undefined.

43. $\frac{2^5}{2^8} = 2^{5-8} = 2^{5+(-8)} = 2^{-3} = \frac{1}{2^3}$

44. $\frac{(0.4)^{-2}}{(0.4)^6} = (0.4)^{-2-6} = (0.4)^{-8} = \frac{1}{(0.4)^8}$

45. $\frac{16^{-9}}{16^{-8}} = 16^{-9-(-8)} = 16^{-9+8} = 16^{-1} = \frac{1}{16}$

46. $\frac{15^3}{15^{-4}} = 15^{3-(-4)} = 15^{3+4} = 15^7$

47. $\frac{1.7a^3}{a^7} = 1.7a^{3-7} = 1.7a^{-4} = \frac{1.7}{a^4}$

48. $\frac{15b^{-5}}{3b^4} = \frac{15b^{-5-4}}{3} = \frac{15b^{-9}}{3} = \frac{15}{3b^9} = \frac{5}{b^9}$

49. $\frac{26w^{-4}}{13w^{-12}} = \frac{26w^{-4-(-12)}}{13} = \frac{26w^{-4+12}}{13} = \frac{26w^8}{13} = 2w^8$

50. $\frac{11g^2}{g^{-4}} = 11g^{2-(-4)} = 11g^{2+4} = 11g^6$

51. $(4.5)^{-3} \approx 0.011$

52. $(8.1)^{-2} \approx 0.015$

53. $(3.2)^{-4} \approx 0.010$

54. $(7.5)^{-3} \approx 0.002$

55. a. $\frac{1}{1{,}000{,}000{,}000} = \frac{1}{10^9} = 10^{-9}\text{ m}^2$

b. Total area of all crystals = Area of each crystal • Number of crystals

$= 10^{-9} \cdot 10^4$

$= 10^{-9+4}$

$= 10^{-5}$

The total area of all the crystals on a brittle star is 10^{-5} square meter.

56. $\frac{a^6b^4}{a^3b^7} = a^{6-3} \cdot b^{4-7} = a^{6-3} \cdot b^{4+(-7)} = a^3b^{-3} = \frac{a^3}{b^3}$

57. $\frac{c^2d^{11}}{c^8d^5} = c^{2-8} \cdot d^{11-5}$

$= c^{2+(-8)} \cdot d^{11-5}$

$= c^{-6}d^6$

$= \frac{d^6}{c^6}$

58. $\frac{m^8n^4}{m^2n^9} = m^{8-2} \cdot n^{4-9}$

$= m^{8-2} \cdot n^{4+(-9)}$

$= m^6n^{-5}$

$= \frac{m^6}{n^5}$

59. $\frac{x^2y}{x^{10}y^7} = x^{2-10} \cdot y^{1-7}$

$= x^{2+(-10)} \cdot y^{1+(-7)}$

$= x^{-8}y^{-6}$

$= \frac{1}{x^8y^6}$

60. a. Volume of ink needed per square inch = Volume of an ink droplet • Number of droplets

$= 10 \cdot 10^6$

$= 10^{1+6}$

$= 10^7$

10^7 picoliters of ink are needed to completely cover a square inch of paper.

b. $\frac{\text{Number of picoliters}}{\text{Number of picoliters in a liter}} = \frac{10^7}{10^{12}}$

$= 10^{7-12}$

$= 10^{7+(-12)}$

$= 10^{-5}$

The volume of ink needed to completely cover a square inch of paper is 10^{-5} liter.

c. When $\ell = 11$ and $w = 8.5$; $A = \ell w = 11(8.5) = 93.5$

$93.5 \approx 100 = 10^2$

The area of a 8.5 inch by 11 inch piece of paper is about 10^2 square inches.

Volume of ink needed per paper = Volume of ink per square inch • Number of square inches

$= 10^{-5} \cdot 10^2$

$= 10^{-5+2}$

$= 10^{-3}$

10^{-3} liter of ink are needed to completely cover an entire piece of paper.

—CONTINUED—

60. —CONTINUED—

d. There are 10^{-3} liter in 1 millimeter.

So, 1 millimeter of ink is needed per page.

Number of pages $= \frac{\text{Number of milliliters}}{\text{Number of milliliters per page}}$

$= \frac{60}{1}$

$= 60$

The cartridge could print about 60 pages.

61. a. $\frac{a^n}{a^n} = a^{n-n} = a^0$

b. $\frac{a^n}{a^n} = \frac{a_1 \cdot a_2 \cdot a_3 \cdot \ldots \cdot a_n}{a_1 \cdot a_2 \cdot a_3 \cdot \ldots \cdot a_n}$

$= \frac{\overset{1}{\cancel{a_1}} \cdot \overset{1}{\cancel{a_2}} \cdot \overset{1}{\cancel{a_3}} \cdot \ldots \cdot \overset{1}{\cancel{a_n}}}{\underset{1}{\cancel{a_1}} \cdot \underset{1}{\cancel{a_2}} \cdot \underset{1}{\cancel{a_3}} \cdot \ldots \cdot \underset{1}{\cancel{a_n}}}$

$= 1$

You have developed the definition of zero exponents, $a^0 = 1$.

c. $\frac{a^0}{a^n} = a^{0-n} = a^{-n}$

d. $\frac{a^0}{a^n} = \frac{1}{a^n}$

You have developed the definition of negative exponents, $a^{-n} = \frac{1}{a^n}$.

4.6 Mixed Review (p. 205)

62. Equation: $9 + x = 17$

Question: 9 plus what number equals 17?

Solution: 8

Check: $9 + 8 = 17$ ✓

63. Equation: $8 - x = 3$

Question: 8 minus what number equals 3?

Solution: 5

Check: $8 - 5 = 3$ ✓

64. Equation: $-3x = 36$

Question: −3 times what number equals 36?

Solution: −12

Check: $-3(-12) = 36$ ✓

65. Equation: $\frac{x}{-8} = 6$

Question: What number divided by −8 equals 6?

Solution: −48

Check: $\frac{-48}{-8} = 6$ ✓

66. Let h represent the heights for which you can ride the bumper cars.

$h \geq 46$

67. $3^2 \cdot 3^2 = 3^{2+2} = 3^4$

68. $5^4 \cdot 5 = 5^{4+1} = 5^5$

69. $\dfrac{2^9}{2^4} = 2^{9-4} = 2^5$

70. $\dfrac{10^8}{10^5} = 10^{8-5} = 10^3$

4.6 Standardized Test Practice (p. 205)

71. B; $x^2 \cdot x^{-6} = x^{2+(-6)} = x^{-4}$

$x^{-2} \cdot x^6 = x^{-2+6} = x^4$

72. H; $\dfrac{24a^6}{3b^2} = \dfrac{24a^6b^{-2}}{3} = 8a^6b^{-2}$

Lesson 4.7

4.7 Checkpoint (p. 207)

1. $4100 = 4.1 \times 1000 = 4.1 \times 10^3$

2. $0.000067 = 6.7 \times 0.00001 = 6.7 \times 10^{-5}$

3. $34{,}600{,}000 = 3.46 \times 10{,}000{,}000 = 3.46 \times 10^7$

4. $0.0000145 = 1.45 \times 0.00001 = 1.45 \times 10^{-5}$

5. $7.1 \times 10^4 = 7.1 \times 10{,}000 = 71{,}000$

6. $1.93 \times 10^{-3} = 1.93 \times 0.001 = 0.00193$

7. $3.641 \times 10^{-6} = 3.641 \times 0.000001 = 0.000003641$

8. $5.59 \times 10^8 = 5.59 \times 100{,}000{,}000 = 559{,}000{,}000$

9. $49{,}000 = 4.9 \times 10^4$

From least to greatest, the numbers are 3.3×10^4, 49,000, and 2.4×10^5.

10. $635{,}000 = 6.35 \times 10^5$

From least to greatest, the numbers are 4.08×10^5, 635,000, and 8.16×10^6.

11. $0.00017 = 1.7 \times 10^{-4}$

From least to greatest, the numbers are 0.00017, 1.9×10^{-4}, and 2.8×10^{-3}.

12. $0.00056 = 5.6 \times 10^{-4}$

From least to greatest, the numbers are 0.00056, 7.8×10^{-3}, and 7.9×10^{-3}.

4.7 Guided Practice (p. 208)

1. *Sample answer:* 4.7×10^{-4}

2. 12.5×10^7 is not written in scientific notation because in the form $c \times 10^n$, c is not between 1 and 10.

3. $9{,}180{,}000 = 9.18 \times 1{,}000{,}000 = 9.18 \times 10^6$

4. $0.000062 = 6.2 \times 0.00001 = 6.2 \times 10^{-5}$

5. $723{,}000 = 7.23 \times 100{,}000 = 7.23 \times 10^5$

6. $0.00000002 = 2 \times 0.00000001 = 2 \times 10^{-8}$

7. $2.78 \times 10^7 = 2.78 \times 10{,}000{,}000 = 27{,}800{,}000$

8. $5.67 \times 10^{-3} = 5.67 \times 0.001 = 0.00567$

9. $4.15 \times 10^{-5} = 4.15 \times 0.00001 = 0.0000415$

10. $1.96 \times 10^5 = 1.96 \times 100{,}000 = 196{,}000$

11. $0.00005 = 5 \times 0.00001 = 5 \times 10^{-5}$ m

12. The powers of 10 should have been compared first since they are not the same.

Because $10^4 > 10^3$, $6.4 \times 10^4 > 6.5 \times 10^3$.

4.7 Practice and Problem Solving (pp. 209–210)

13. $46{,}200{,}000 = 4.62 \times 10{,}000{,}000 = 4.62 \times 10^7$

14. $9{,}750{,}000 = 9.75 \times 1{,}000{,}000 = 9.75 \times 10^6$

15. $1700 = 1.7 \times 1000 = 1.7 \times 10^3$

16. $8{,}910{,}000{,}000 = 8.91 \times 1{,}000{,}000{,}000 = 8.91 \times 10^9$

17. $104{,}000 = 1.04 \times 100{,}000 = 1.04 \times 10^5$

18. $0.00000062 = 6.2 \times 0.0000001 = 6.2 \times 10^{-7}$

19. $0.000023 = 2.3 \times 0.00001 = 2.3 \times 10^{-5}$

20. $0.00095 = 9.5 \times 0.0001 = 9.5 \times 10^{-4}$

21. $0.0000106 = 1.06 \times 0.00001 = 1.06 \times 10^{-5}$

22. $4.18 \times 10^4 = 4.18 \times 10{,}000 = 41{,}800$

23. $5.617 \times 10^6 = 5.617 \times 1{,}000{,}000 = 5{,}617{,}000$

24. $7.894 \times 10^8 = 7.894 \times 100{,}000{,}000 = 789{,}400{,}000$

25. $3.8 \times 10^{-9} = 3.8 \times 0.000000001 = 0.0000000038$

26. $9.83 \times 10^{-2} = 9.83 \times 0.01 = 0.0983$

27. $6 \times 10^{-7} = 6 \times 0.0000001 = 0.0000006$

28. $1.03 \times 10^{-5} = 1.03 \times 0.00001 = 0.0000103$

29. $2.28 \times 10^9 = 2.28 \times 1{,}000{,}000{,}000 = 2{,}280{,}000{,}000$

30. $8.391 \times 10^4 = 8.391 \times 10{,}000 = 83{,}910$

31. $3{,}721{,}000{,}000 = 3.721 \times 1{,}000{,}000{,}000$

$= 3.721 \times 10^9$ people

32. $239{,}000{,}000{,}000{,}000{,}000$

$= 2.39 \times 100{,}000{,}000{,}000{,}000{,}000$

$= 2.39 \times 10^{17}$ m

33. $0.000000000334 = 3.34 \times 0.0000000001$

$= 3.34 \times 10^{-10}$ sec

34. $5.71 \times 10^{-4} = 5.71 \times 0.0001 = 0.000571$ cm

35. $3.0 \times 10^{-5} = 3.0 \times 0.00001 = 0.00003$ m

36. $1.336 \times 10^3 = 1.336 \times 1000 = 1336$ mi/h

37. *Sample answer:* The friend did not compare powers of 10. Because $4 \times 10^3 = 4000$ and $2 \times 10^2 = 200$, 4×10^3 is actually 20 times greater than 2×10^2.

38. When a number between 0 and 1 is written in scientific notation, the exponent is negative. When a number greater than 1 is written in scientific notation, the exponent is positive.

39. $0.00042 = 4.2 \times 0.0001 = 4.2 \times 10^{-4}$ m

$0.00028 = 2.8 \times 0.0001 = 2.8 \times 10^{-4}$ m

$2{,}000{,}000 = 2 \times 1{,}000{,}000 = 2 \times 10^6$ dust mites

40. $321{,}000 = 3.21 \times 100{,}000 = 3.21 \times 10^5$

$3.21 \times 10^3 < 321{,}000$

41. $91{,}600 = 9.16 \times 10{,}000 = 9.16 \times 10^4$

$91{,}600 < 9.61 \times 10^4$

42. $2.3 \times 10^{-6} < 1.3 \times 10^{-2}$

43. $0.00875 = 8.75 \times 0.001 = 8.75 \times 10^{-3}$

$0.00875 > 8.75 \times 10^{-4}$

44. $(2.5 \times 10^4)(3 \times 10^2) = (2.5 \times 3)(10^4 \times 10^2)$
$= 7.5 \times (10^4 \times 10^2)$
$= 7.5 \times 10^{4+2}$
$= 7.5 \times 10^6$

45. $(6 \times 10^7)(9 \times 10^5) = (6 \times 9) \times (10^7 \times 10^5)$
$= 54 \times (10^7 \times 10^5)$
$= 54 \times 10^{7+5}$
$= 54 \times 10^{12}$
$= 5.4 \times 10^1 \times 10^{12}$
$= 5.4 \times 10^{1+12}$
$= 5.4 \times 10^{13}$

46. $(5 \times 10^{-3})(7.5 \times 10^8) = (5 \times 7.5) \times (10^{-3} \times 10^8)$
$= 37.5 \times (10^{-3} \times 10^8)$
$= 37.5 \times 10^{-3+8}$
$= 37.5 \times 10^5$
$= 3.75 \times 10^1 \times 10^5$
$= 3.75 \times 10^{1+5}$
$= 3.75 \times 10^6$

47. $(8.5 \times 10^{-2})(7 \times 10^{-7}) = (8.5 \times 7) \times (10^{-2} \times 10^{-7})$
$= 59.5 \times (10^{-2} \times 10^{-7})$
$= 59.5 \times 10^{-2+(-7)}$
$= 59.5 \times 10^{-9}$
$= 5.95 \times 10^1 \times 10^{-9}$
$= 5.95 \times 10^{1+(-9)}$
$= 5.95 \times 10^{-8}$

48. $3500 = 3.5 \times 10^3$

From least to greatest, the numbers are 3500, 2.6×10^4, and 9.2×10^4.

49. $8700 = 8.7 \times 10^3$

From least to greatest, the numbers are 1.97×10^3, 8700, and 3.98×10^4.

50. $0.0013 = 1.3 \times 10^{-3}$

From least to greatest, the numbers are 9.1×10^{-4}, 0.0013, and 5.2×10^{-2}.

51. $0.00009 = 9 \times 10^{-5}$

From least to greatest, the numbers are 8.4×10^{-6}, 0.00009, and 7.61×10^{-3}.

52. a. Pit: $0.000003 = 3 \times 0.000001 = 3 \times 10^{-6}$ m

Land: $0.0000022 = 2.2 \times 0.000001 = 2.2 \times 10^{-6}$ m

Combined length:

$0.000003 + 0.0000022 = 0.0000052$
$= 5.2 \times 0.000001$
$= 5.2 \times 10^{-6}$ m

—CONTINUED—

52. —CONTINUED—

b. $2{,}000{,}000{,}000 = 2 \times 1{,}000{,}000{,}000 = 2 \times 10^9$

Length of pits and lands = Number of pits • Length of pit + Number of lands • Length of lands

$= (2 \times 10^9)(3 \times 10^{-6}) + (2 \times 10^9)(2.2 \times 10^{-6})$
$= (2 \cdot 3) \times (10^9 \cdot 10^{-6}) + (2 \cdot 2.2) \times (10^9 \cdot 10^{-6})$
$= 6 \times (10^9 \cdot 10^{-6}) + 4.4 \times (10^9 \cdot 10^{-6})$
$= (6 \times 10^{9+(-6)}) + (4.4 \times 10^{9+(-6)})$
$= (6 \times 10^3) + (4.4 \times 10^3)$
$= 10.4 \times 10^3$
$= 1.04 \times 10^1 \times 10^3$
$= 1.04 \times 10^{1+3}$
$= 1.04 \times 10^4$ m

53. a. Plankton ingested per second = Cubic meters of water • Plankton per cubic meter

$= 2.3 \cdot 9000$
$= 20{,}700$
$= 2.07 \times 10{,}000$
$= 2.07 \times 10^4$

A right whale ingests 2.07×10^4 plankton each second.

b. Because a whale ingests 2.07×10^4 plankton per second and there are 3600 seconds per hour, then in one hour the whale ingests

$(2.07 \times 10^4) \cdot 3600 = (2.07 \times 10^4) \cdot (3.6 \times 10^3)$
$= (2.07 \cdot 3.6) \times (10^4 \times 10^3)$
$= 7.452 \times (10^4 \times 10^3)$
$= 7.452 \times 10^{4+3}$
$= 7.452 \times 10^7$

about 7.452×10^7 plankton.

c. The whale ingests 7.542×10^7 plankton per hour. Multiply by 15 to find how much plankton it ingests in 15 hours.

$(7.452 \times 10^7) \times 15 = (7.452 \cdot 15) \times 10^7$
$= 111.78 \times 10^7$
$= 1.1178 \times 10^2 \times 10^7$
$= 1.1178 \times 10^{7+2}$
$= 1.1178 \times 10^9$

The whale ingests about 1.12×10^9 plankton each day.

d. Calories in a single plankton $= \dfrac{\text{Calories consumed per day}}{\text{Plankton consumed per day}}$

$= \dfrac{500{,}000}{1.12 \times 10^9}$
≈ 0.000447
$= 4.47 \times 0.0001$
$= 4.47 \times 10^{-4}$

A single plankton contains about 4.47×10^{-4} calories.

54. a.

n	$n \times 10^{n+1}$	$(n+1) \times 10^n$
1	1×10^2	2×10^1
2	2×10^3	3×10^2
3	3×10^4	4×10^3
4	4×10^5	5×10^4

b. Always. Sample answer: For any value of n, the exponent in the value of $n \times 10^{n+1}$ is *always* greater than the value of $(n+1) \times 10^n$. This is because when you compare numbers in scientific notation, the number with the greater power of 10 is greater and $n + 1 > n$ when $n = 1, 2, 3,$ and 4.

4.7 Mixed Review (p. 210)

55. The integers, from least to greatest, are −17, −16, 11, and 13.

56. The integers, from least to greatest, are −27, −23, 24, and 25.

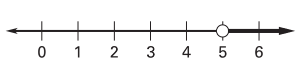
57. The integers, from least to greatest, are −119, −114, −98, and 99.

58.
$$x + 3.6 = -10.8$$
$$x + 3.6 - 3.6 = -10.8 - 3.6$$
$$x = -14.4$$

59.
$$y - 9.5 = 11.2$$
$$y - 9.5 + 9.5 = 11.2 + 9.5$$
$$y = 20.7$$

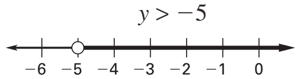
60.
$$2.5m = -5.1$$
$$\frac{2.5m}{2.5} = \frac{-5.1}{2.5}$$
$$m = -2.04$$

61.
$$3x - 7 > 8$$
$$3x - 7 + 7 > 8 + 7$$
$$3x > 15$$
$$\frac{3x}{3} > \frac{15}{3}$$
$$x > 5$$



Let $x = 7$; $3x - 7 > 8$
$$3(7) - 7 \overset{?}{>} 8$$
$$21 - 7 \overset{?}{>} 8$$
$$14 > 8 \checkmark$$

62.
$$-4y + 16 < 36$$
$$-4y + 16 - 16 < 36 - 16$$
$$-4y < 20$$
$$\frac{-4y}{-4} > \frac{20}{-4}$$
$$y > -5$$



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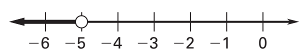
62. —CONTINUED—

Let $y = -3$; $-4y + 16 < 36$
$$-4(-3) + 16 \overset{?}{<} 36$$
$$12 + 16 \overset{?}{<} 36$$
$$28 < 36 \checkmark$$

63.
$$2 - 5x > 27$$
$$2 - 2 - 5x > 27 - 2$$
$$-5x > 25$$
$$\frac{-5x}{-5} < \frac{25}{-5}$$
$$x < -5$$



Let $x = 7$; $2 - 5x > 27$
$$2 - 5(-7) \overset{?}{>} 27$$
$$2 - (-35) \overset{?}{>} 27$$
$$2 + 35 \overset{?}{>} 27$$
$$37 > 27 \checkmark$$

4.7 Standardized Test Practice (p. 210)

64. Fiji: $844{,}000 = 8.44 \times 10^5$

Russia: $142{,}300{,}000 = 1.423 \times 10^8$

a. China has the greatest population.

b. Iceland has the least population.

c.
$$\frac{\text{Population of China}}{\text{Population of Iceland}} = \frac{1.273 \times 10^9}{2.78 \times 10^5}$$
$$\approx 0.458 \times 10^{9-5}$$
$$= 0.458 \times 10^4$$
$$= 0.458 \times 10{,}000$$
$$= 4580$$

The population of China is about 5000 times greater than the population of Iceland.

4.7 Technology Activity (p. 211)

1. $(6.13 \times 10^{17}) \times (8.92 \times 10^{-11}) = 5.46796 \times 10^7$

2. $(4.09 \times 10^{-9}) \div (5.31 \times 10^{23}) = 7.702448211 \times 10^{-33}$

3. Mass of Tau Boo exoplanet = Mass of Earth • Times greater than Earth
$$= (6 \times 10^{24}) \times (2.5 \times 10^3)$$
$$= 1.5 \times 10^{28}$$

The mass of the Tau Boo exoplanet is 1.5×10^{28} kilograms.

Chapter 4 Review (pp. 212–215)

1. *Sample answer:* An example of a prime number is 23 and an example of a composite number is 120.

2. Two nonzero whole numbers are relatively prime if their greatest common factor is 1.

3. *Sample answer:* $\frac{2}{3}$ and $\frac{10}{15}$ are equivalent because equivalent fractions are created by multiplying or dividing the numerator and denominator by the same nonzero number.

$$\frac{2}{3} = \frac{2 \cdot 5}{3 \cdot 5} = \frac{10}{15}$$

4. 0.32×10^{-4} is not written in scientific notation because in the form $c \times 10^n$, c is not between 1 and 10.

5. One possible factor tree:

75
3 • 25
3 • 5 • 5

The prime factorization of 75 is $3 \cdot 5^2$.

6. One possible factor tree:

104
4 • 26
2 • 2 • 2 • 13

The prime factorization of 104 is $2^3 \cdot 13$.

7. 129
3 • 43

The prime factorization of 129 is $3 \cdot 43$.

8. One possible factor tree:

138
6 • 23
2 • 3 • 23

The prime factorization of 138 is $2 \cdot 3 \cdot 23$.

9. $36a^4b^3 = 2 \cdot 2 \cdot 3 \cdot 3 \cdot a^4 \cdot b^3$
$= 2 \cdot 2 \cdot 3 \cdot 3 \cdot a \cdot a \cdot a \cdot a \cdot b \cdot b \cdot b$

10. $98x^3y^2 = 2 \cdot 7 \cdot 7 \cdot x^3 \cdot y^2 = 2 \cdot 7 \cdot 7 \cdot x \cdot x \cdot x \cdot y \cdot y$

11. $72w^6z = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot w^6 \cdot z$
$= 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot w \cdot w \cdot w \cdot w \cdot w \cdot w \cdot z$

12. $15r^2s^2 = 3 \cdot 5 \cdot r^2 \cdot s^2 = 3 \cdot 5 \cdot r \cdot r \cdot s \cdot s$

13. $26 = \boxed{2} \cdot 13$
$74 = \boxed{2} \cdot 37$

The common prime factor is 2. The GCF is 2.

14. $32 = \boxed{2} \cdot \boxed{2} \cdot \boxed{2} \cdot \boxed{2} \cdot \boxed{2}$
$64 = \boxed{2} \cdot \boxed{2} \cdot \boxed{2} \cdot \boxed{2} \cdot \boxed{2} \cdot 2$

The common prime factors are 2, 2, 2, 2, and 2. The GCF is the product $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$.

15. $12 = \boxed{2} \cdot \boxed{2} \cdot 3$
$40 = \boxed{2} \cdot \boxed{2} \cdot 2 \cdot 5$
$68 = \boxed{2} \cdot \boxed{2} \cdot 17$

The common prime factors are 2 and 2. The GCF is the product $2 \cdot 2 = 4$.

16. $15 = \boxed{3} \cdot 5$
$42 = 2 \cdot \boxed{3} \cdot 7$
$63 = 3 \cdot \boxed{3} \cdot 7$

The common prime factor is 3. The GCF is 3.

17. $4 = 2^2$ $\quad$ $18 = 2 \cdot 3^2$

The GCF of 4 and 18 is 2.

$$\frac{4}{18} = \frac{4 \div 2}{18 \div 2} = \frac{2}{9}$$

18. $12 = 2^2 \cdot 3$ $\quad$ $21 = 3 \cdot 7$

The GCF of 12 and 21 is 3.

$$\frac{12}{21} = \frac{12 \div 3}{21 \div 3} = \frac{4}{7}$$

19. $17 = 17$ $\quad$ $68 = 2^2 \cdot 17$

The GCF of 17 and 68 is 17.

$$\frac{17}{68} = \frac{17 \div 17}{68 \div 17} = \frac{1}{4}$$

20. $30 = 2 \cdot 3 \cdot 5$ $\quad$ $72 = 2^3 \cdot 3^2$

The GCF of 30 and 72 is $2 \cdot 3 = 6$.

$$\frac{30}{72} = \frac{30 \div 6}{72 \div 6} = \frac{5}{12}$$

21. $$\frac{6ab}{4b^2} = \frac{\overset{1}{\cancel{2}} \cdot 3 \cdot a \cdot \overset{1}{\cancel{b}}}{\underset{1}{\cancel{2}} \cdot 2 \cdot b \cdot \underset{1}{\cancel{b}}} = \frac{3a}{2b}$$

22. $$\frac{5cd}{2d} = \frac{5 \cdot c \cdot \overset{1}{\cancel{d}}}{2 \cdot \underset{1}{\cancel{d}}} = \frac{5c}{2}$$

23. $$\frac{8xy}{2x^2y} = \frac{\overset{1}{\cancel{2}} \cdot 2 \cdot 2 \cdot \overset{1}{\cancel{x}} \cdot \overset{1}{\cancel{y}}}{\underset{1}{\cancel{2}} \cdot x \cdot \underset{1}{\cancel{x}} \cdot \underset{1}{\cancel{y}}} = \frac{4}{x}$$

24. $$\frac{22m^2n}{11mn^2} = \frac{2 \cdot \overset{1}{\cancel{11}} \cdot \overset{1}{\cancel{m}} \cdot m \cdot \overset{1}{\cancel{n}}}{\underset{1}{\cancel{11}} \cdot \underset{1}{\cancel{m}} \cdot n \cdot \underset{1}{\cancel{n}}} = \frac{2m}{n}$$

25. $12 = \boxed{2} \cdot \boxed{2} \cdot 3$
$40 = \boxed{2} \cdot \boxed{2} \cdot 2 \cdot 5$

LCM $= 2 \cdot 2 \cdot 2 \cdot 3 \cdot 5 = 120$, so the LCD $= 120$.

$$\frac{1}{12} = \frac{1 \cdot 10}{12 \cdot 10} = \frac{10}{120} \qquad \frac{3}{40} = \frac{3 \cdot 3}{40 \cdot 3} = \frac{9}{120}$$

$\frac{10}{120} > \frac{9}{120}$, so $\frac{1}{12} > \frac{3}{40}$.

26. $15 = \boxed{3} \cdot 5$
$27 = \boxed{3} \cdot 3 \cdot 3$

LCM $= 3 \cdot 3 \cdot 3 \cdot 5 = 135$, so the LCD $= 135$.

$$\frac{4}{15} = \frac{4 \cdot 9}{15 \cdot 9} = \frac{36}{135} \qquad \frac{7}{27} = \frac{7 \cdot 5}{27 \cdot 5} = \frac{35}{135}$$

$\frac{36}{135} > \frac{35}{135}$, so $\frac{4}{15} > \frac{7}{27}$.

27. $30 = 2 \cdot 3 \cdot 5$

$36 = 2 \cdot 2 \cdot 3 \cdot 3$

LCM = $2 \cdot 3 \cdot 2 \cdot 3 \cdot 5 = 180$, so the LCD = 180.

$\frac{7}{30} = \frac{7 \cdot 6}{30 \cdot 6} = \frac{42}{180}$ $\quad$ $\frac{11}{36} = \frac{11 \cdot 5}{36 \cdot 5} = \frac{55}{180}$

$\frac{42}{180} < \frac{55}{180}$, so $\frac{7}{30} < \frac{11}{36}$.

28. $45 = 3 \cdot 3 \cdot 5$

$60 = 2 \cdot 2 \cdot 3 \cdot 5$

LCM = $3 \cdot 5 \cdot 2 \cdot 2 \cdot 3 = 180$, so the LCD = 180.

$\frac{4}{45} = \frac{4 \cdot 4}{45 \cdot 4} = \frac{16}{180}$ $\quad$ $\frac{13}{60} = \frac{13 \cdot 3}{60 \cdot 3} = \frac{39}{180}$

$\frac{16}{180} < \frac{39}{180}$, so $\frac{4}{45} < \frac{13}{60}$.

29. Your team: $\frac{14}{20}$

Friend's team: $\frac{18}{24}$

$20 = 2 \cdot 2 \cdot 5$

$24 = 2 \cdot 2 \cdot 2 \cdot 3$

LCM = $2 \cdot 2 \cdot 2 \cdot 3 \cdot 5 = 120$, so the LCD = 120.

$\frac{14}{20} = \frac{14 \cdot 6}{20 \cdot 6} = \frac{84}{120}$ $\quad$ $\frac{18}{24} = \frac{18 \cdot 5}{24 \cdot 5} = \frac{90}{120}$

$\frac{84}{120} < \frac{90}{120}$, so $\frac{14}{20} < \frac{18}{24}$.

So, your friend's team won a greater fraction of its games.

30. $2^{11} \cdot 2^3 = 2^{11+3} = 2^{14}$

31. $(0.3)^5 \cdot (0.3)^7 = (0.3)^{5+7} = (0.3)^{12}$

32. $7^8 \cdot 7^9 = 7^{8+9} = 7^{17}$

33. $10^4 \cdot 10^4 = 10^{4+4} = 10^8$

34. $1.6b^4 \cdot b^2 = 1.6 \cdot \left(b^4 \cdot b^2\right) = 1.6 \cdot b^{4+2} = 1.6b^6$

35. $c^9 \cdot 8c^2 = 8 \cdot \left(c^9 \cdot c^2\right) = 8 \cdot c^{9+2} = 8c^{11}$

36. $5x \cdot 4x^9 = (5 \cdot 4) \cdot \left(x^1 \cdot x^9\right)$

$= (5 \cdot 4) \cdot x^{1+9}$

$= (5 \cdot 4) \cdot x^{10}$

$= 20x^{10}$

37. $y^4 \cdot y^3 \cdot y^2 = y^{4+3+2} = y^9$

38. $12^{-4} = \frac{1}{12^4}$

39. $6^0 = 1$

40. $7c^{-3} = \frac{7}{c^3}$

41. $15d^{-9} = \frac{15}{d^9}$

42. $0.000000745 = 7.45 \times 0.0000001 = 7.45 \times 10^{-7}$

43. $67{,}000{,}000 = 6.7 \times 10{,}000{,}000 = 6.7 \times 10^7$

44. $0.000000881 = 8.81 \times 0.0000001 = 8.81 \times 10^{-7}$

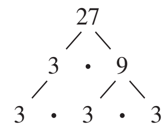
45. $4{,}280{,}000{,}000 = 4.28 \times 1{,}000{,}000{,}000 = 4.28 \times 10^9$

46. $4.8 \times 10^{-5} > 4.8 \times 10^{-8}$

47. $1.08 \times 10^6 < 1.09 \times 10^7$

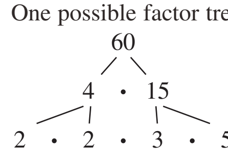
Chapter 4 Test (p. 216)

1. One possible factor tree:



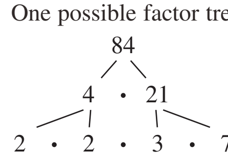
The prime factorization of 27 is 3^3.

2. One possible factor tree:



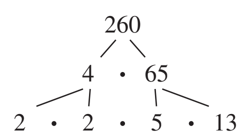
The prime factorization of 60 is $2^2 \cdot 3 \cdot 5$.

3. One possible factor tree:



The prime factorization of 84 is $2^2 \cdot 3 \cdot 7$.

4. One possible factor tree:



The prime factorization of 260 is $2^2 \cdot 5 \cdot 13$.

5. $25 = 5 \cdot 5$

$75 = 3 \cdot 5 \cdot 5$

The GCF of 25 and 75 is $5 \cdot 5 = 25$.

Because the GCF is 25, 25 and 75 are not relatively prime.

6. $30 = 2 \cdot 3 \cdot 5$

$49 = 7 \cdot 7$

The GCF of 30 and 49 is 1.

Because the GCF is 1, 30 and 49 are relatively prime.

7. $32 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

$90 = 2 \cdot 3 \cdot 3 \cdot 5$

The GCF of 32 and 90 is 2.

Because the GCF is 2, 32 and 90 are not relatively prime.

8. $42 = 2 \cdot 3 \cdot 7$

$108 = 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$

The GCF of 42 and 108 is $2 \cdot 3 = 6$.

Because the GCF is 6, 42 and 108 are not relatively prime.

9. $27 = 3^3$ $\quad$ $90 = 2 \cdot 3^2 \cdot 5$

The GCF of 27 and 90 is $3^2 = 9$.

$\frac{27}{90} = \frac{27 \div 9}{90 \div 9} = \frac{3}{10}$

10. $46 = 2 \cdot 23$ $60 = 2^2 \cdot 3 \cdot 5$

The GCF of 46 and 60 is 2.

$\frac{46}{60} = \frac{46 \div 2}{60 \div 2} = \frac{23}{30}$

11. $\frac{8xy}{16y} = \frac{\overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot \overset{1}{\cancel{2}} \cdot x \cdot \overset{1}{\cancel{y}}}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{2}} \cdot 2 \cdot \underset{1}{\cancel{y}}} = \frac{x}{2}$

12. $\frac{12a^2}{2ab} = \frac{\overset{1}{\cancel{2}} \cdot 2 \cdot 3 \cdot \overset{1}{\cancel{a}} \cdot a}{\underset{1}{\cancel{2}} \cdot \underset{1}{\cancel{a}} \cdot b} = \frac{6a}{b}$

13. $5 = 5$

$15 = 3 \cdot 5$

LCM = $5 \cdot 3 = 15$, so the LCD = 15.

$\frac{3}{5} = \frac{3 \cdot 3}{5 \cdot 3} = \frac{9}{15}$ $\frac{8}{15}$

$\frac{9}{15} > \frac{8}{15}$, so $\frac{3}{5} > \frac{8}{15}$.

14. $12 = 2 \cdot 2 \cdot 3$

$20 = 2 \cdot 2 \cdot 5$

LCM = $2 \cdot 2 \cdot 3 \cdot 5 = 60$, so the LCD = 60.

$\frac{11}{12} = \frac{11 \cdot 5}{12 \cdot 5} = \frac{55}{60}$ $\frac{11}{20} = \frac{11 \cdot 3}{20 \cdot 3} = \frac{33}{60}$

$\frac{55}{60} > \frac{33}{60}$, so $\frac{11}{12} > \frac{11}{20}$.

15. $35 = 5 \cdot 7$

$45 = 3 \cdot 3 \cdot 5$

LCM = $5 \cdot 3 \cdot 3 \cdot 7 = 315$, so the LCD = 315.

$\frac{3}{35} = \frac{3 \cdot 9}{35 \cdot 9} = \frac{27}{315}$ $\frac{7}{45} = \frac{7 \cdot 7}{45 \cdot 7} = \frac{49}{315}$

$\frac{27}{315} < \frac{49}{315}$, so $\frac{3}{35} < \frac{7}{45}$.

16. $50 = 2 \cdot 5 \cdot 5$

$100 = 2 \cdot 2 \cdot 5 \cdot 5$

LCM = $2 \cdot 5 \cdot 5 \cdot 2 = 100$, so the LCD = 100.

$\frac{29}{50} = \frac{29 \cdot 2}{50 \cdot 2} = \frac{58}{100}$ $\frac{61}{100}$

$\frac{58}{100} < \frac{61}{100}$, so $\frac{29}{50} < \frac{61}{100}$.

17. a. *Game 1:* $\frac{12}{42}$

$12 = 2 \cdot 2 \cdot 3$

$42 = 2 \cdot 3 \cdot 7$

The GCF of 12 and 42 is $2 \cdot 3 = 6$.

$\frac{12}{42} = \frac{12 \div 6}{42 \div 6} = \frac{2}{7}$

—CONTINUED—

17. —CONTINUED—

Game 2: $\frac{19}{57}$

$19 = 19$

$57 = 3 \cdot 19$

The GCF of 19 and 57 is 19.

$\frac{19}{57} = \frac{19 \div 19}{57 \div 19} = \frac{1}{3}$

Game 3: $\frac{15}{65}$

$15 = 3 \cdot 5$

$65 = 5 \cdot 13$

The GCF of 15 and 65 is 5.

$\frac{15}{65} = \frac{15 \div 5}{65 \div 5} = \frac{3}{13}$

Game 4: $\frac{4}{52}$

$4 = 2 \cdot 2$

$52 = 2 \cdot 2 \cdot 13$

The GCF of 4 and 52 is $2 \cdot 2 = 4$.

$\frac{4}{52} = \frac{4 \div 4}{52 \div 4} = \frac{1}{13}$

Game 5: $\frac{16}{60}$

$16 = 2 \cdot 2 \cdot 2 \cdot 2$

$60 = 2 \cdot 2 \cdot 3 \cdot 5$

The GCF of 16 and 60 is $2 \cdot 2 = 4$.

$\frac{16}{60} = \frac{16 \div 4}{60 \div 4} = \frac{4}{15}$

b. $7 = 7$

$3 = 3$

$13 = 13$

$13 = 13$

$15 = 3 \cdot 5$

LCM = $3 \cdot 13 \cdot 5 \cdot 7 = 1365$, so the LCD = 1365.

$\frac{2}{7} = \frac{2 \cdot 195}{7 \cdot 195} = \frac{390}{1365}$ $\frac{1}{3} = \frac{1 \cdot 455}{3 \cdot 455} = \frac{455}{1365}$

$\frac{3}{13} = \frac{3 \cdot 105}{13 \cdot 105} = \frac{315}{1365}$ $\frac{1}{13} = \frac{1 \cdot 105}{13 \cdot 105} = \frac{105}{1365}$

$\frac{4}{15} = \frac{4 \cdot 91}{15 \cdot 91} = \frac{364}{1365}$

$\frac{105}{1365} < \frac{315}{1365} < \frac{364}{1365} < \frac{390}{1365} < \frac{455}{1365}$, so

$\frac{1}{13} < \frac{3}{13} < \frac{4}{15} < \frac{2}{7} < \frac{1}{3}$.

You scored the greatest fraction of points in game 2.

18. $13^6 \cdot 13^4 = 13^{6+4} = 13^{10}$

19. $4m^7 \cdot 5m^6 = (4 \cdot 5) \cdot (m^7 \cdot m^6)$

$= (4 \cdot 5) \cdot m^{7+6}$

$= (4 \cdot 5) \cdot m^{13}$

$= 20m^{13}$

20. $\frac{7^6}{7^9} = 7^{6-9} = 7^{-3}$

21. $\frac{4w^{15}}{24w^3} = \frac{4w^{15-3}}{24} = \frac{4w^{12}}{24} = \frac{w^{12}}{6}$

22. $15^{-4} = \frac{1}{15^4}$

23. $16h^{-7} = \frac{16}{h^7}$

24. $12x^0 = 12 \cdot 1 = 12$

25. $m^{-4}n^5 = \frac{n^5}{m^4}$

26. $5{,}100{,}000{,}000 = 5.1 \times 1{,}000{,}000{,}000 = 5.1 \times 10^9$

27. $6{,}450{,}000{,}000{,}000 = 6.45 \times 1{,}000{,}000{,}000{,}000$

$= 6.45 \times 10^{12}$

28. $0.00000000897 = 8.97 \times 0.000000001 = 8.97 \times 10^{-9}$

29. $0.00000093 = 9.3 \times 0.0000001 = 9.3 \times 10^{-7}$

30. $9.0 \times 10^{17} < 5.2 \times 10^{18}$

31. $7.31 \times 10^{-2} > 7.31 \times 10^{-3}$

32. $1.25 \times 10^{-9} > 1.05 \times 10^{-9}$

33. $8.12 \times 10^5 > 8.18 \times 10^4$

Chapter 4 Standardized Test (p. 217)

1. D

2. H; One possible factor tree:

168

8 • 21

2 • 4 • 3 • 7

2 • 2 • 2 • 3 • 7

The prime factorization of 168 is $2^3 \cdot 3 \cdot 7$.

3. B; $14x^2 = 2 \cdot 7 \cdot x \cdot x$

$38x^3 = 2 \cdot 19 \cdot x \cdot x \cdot x$

The GCF of $14x^2$ and $38x^3$ is $2x^2$.

4. F; $25 = 5 \cdot 5$

$36 = 2 \cdot 2 \cdot 3 \cdot 3$

The GCF of 25 and 36 is 1.

Because the GCF is 1, 25 and 36 are relatively prime.

5. D; $54 = 2 \cdot 3 \cdot 3 \cdot 3$

$72 = 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3$

The GCF of 54 and 72 is $2 \cdot 3 \cdot 3 = 18$.

$\frac{54}{72} = \frac{54 \div 18}{72 \div 18} = \frac{3}{4}$

6. H; $\frac{15b^9}{25b^3} = \frac{15b^{9-3}}{25} = \frac{15b^6}{25} = \frac{3b^6}{5}$

7. B; $4^{-4} = \frac{1}{4^4} = \frac{1}{256}$

8. F; $3^{-4}x^0 = 3^{-4} \cdot 1 = \frac{1}{3^4} = \frac{1}{81}$

9. B; $8x^4 \cdot 5x^3 = (8 \cdot 5) \cdot (x^4 \cdot x^3)$

$= (8 \cdot 5) \cdot x^{4+3}$

$= (8 \cdot 5) \cdot x^7$

$= 40x^7$

10. I

11. $30 = 2 \cdot 3 \cdot 5$

$36 = 2 \cdot 2 \cdot 3 \cdot 3$

The GCF of 30 and 36 is $2 \cdot 3 = 6$.

$\frac{30}{36} = \frac{30 \div 6}{36 \div 6} = \frac{5}{6}$

12. $16 = 2 \cdot 2 \cdot 2 \cdot 2$

$80 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 5$

$\text{LCM} = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 5 = 80$

The LCM of 16 and 80 is 80.

13. Compare fractions using LCD

$42 = 2 \cdot 3 \cdot 7$

$7 = 7$

42 is a multiple of 7, and 7 is a prime number, so the LCD of the two number is 42.

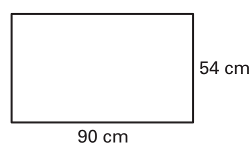
$\frac{5}{7} = \frac{5 \cdot 6}{7 \cdot 6} = \frac{30}{42} > \frac{23}{42}$

So, your friend has completed a larger portion of the novel.

14. $0.000018 = 1.8 \times 10^{-5}$

From least to greatest, the lengths are 2.5×10^{-6} m, 7.5×10^{-6} m, and 0.000018 m.

15. a.



$54 = 2 \cdot 3 \cdot 3 \cdot 3$

$90 = 2 \cdot 3 \cdot 3 \cdot 5$

Possible side lengths: 2 cm, 3 cm, $2 \cdot 3 = 6$ cm, $3 \cdot 3 = 9$ cm, and $2 \cdot 3 \cdot 3 = 18$ cm.

b. The largest side length is the GCF of 54 and 90, which is $2 \cdot 3 \cdot 3 = 18$. So, the largest side length is 18 centimeters.

c. Area of the board:
$A = \ell w = 90 \cdot 54 = 4860$ square centimeters

Area of each square:
$A = s^2 = 18^2 = 324$ square centimeters

$\frac{\text{Area of the board}}{\text{Area of each square}} = \frac{4860}{324} = 15$

You will have 15 square pieces.