Solutions for Beginning Algebra 13th Edition by Lial

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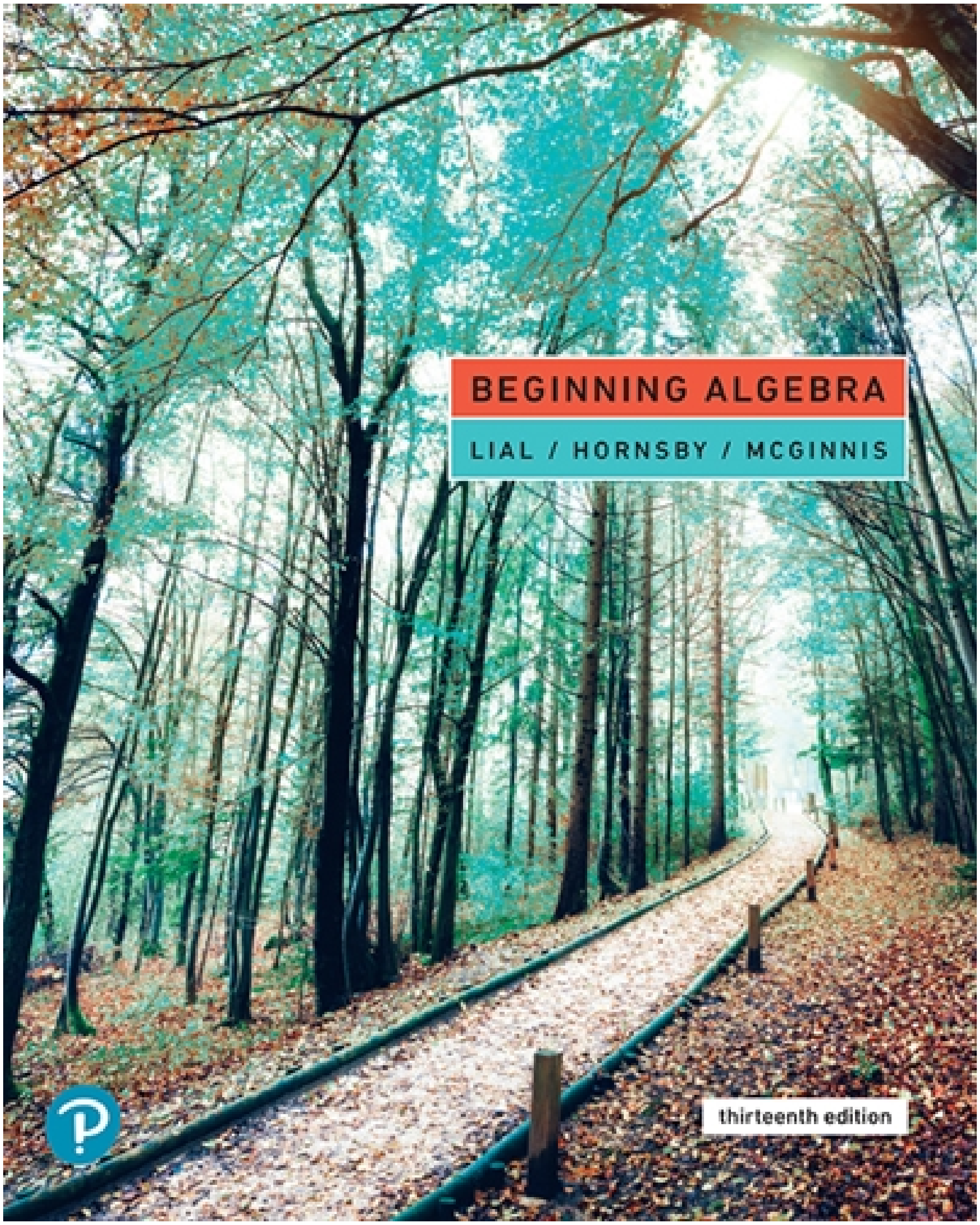


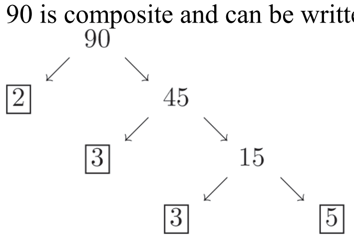
Solutions

Chapter R
Prealgebra Review

R.1 Fractions

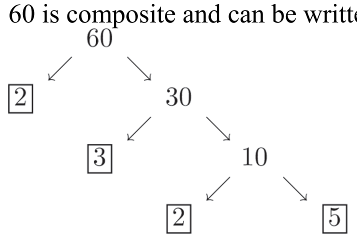
Classroom Examples, Now Try Exercises

1. 90 is composite and can be written as



Writing 90 as the product of primes gives us $90 = 2\cdot 3\cdot 3\cdot 5$.

N1. 60 is composite and can be written as



Writing 60 as the product of primes gives us $60 = 2\cdot 2\cdot 3\cdot 5$.

2. (a) $\frac{12}{20}=\frac{3\cdot 4}{5\cdot 4}=\frac{3}{5}\cdot\frac{4}{4}=\frac{3}{5}\cdot 1=\frac{3}{5}$

(b) $\frac{8}{48}=\frac{8}{6\cdot 8}=\frac{1}{6\cdot 1}=\frac{1}{6}$

(c) $\frac{90}{162}=\frac{5\cdot 18}{9\cdot 18}=\frac{5}{9}\cdot 1=\frac{5}{9}$

N2. (a) $\frac{30}{42}=\frac{5\cdot 6}{7\cdot 6}=\frac{5}{7}\cdot\frac{6}{6}=\frac{5}{7}\cdot 1=\frac{5}{7}$

(b) $\frac{10}{70}=\frac{10}{7\cdot 10}=\frac{1}{7\cdot 1}\cdot=\frac{1}{7}$

(c) $\frac{72}{120}=\frac{3\cdot 24}{5\cdot 24}=\frac{3}{5}\cdot 1=\frac{3}{5}$

3. The fraction bar represents division. Divide the numerator of the improper fraction by the denominator.

```
   3
10)37
   30
    7
```

Thus, $\frac{37}{10}=3\frac{7}{10}$.

N3. The fraction bar represents division. Divide the numerator of the improper fraction by the denominator.

```
  18
5)92
  5
  42
  40
   2
```

Thus, $\frac{92}{5}=18\frac{2}{5}$.

4. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$5\cdot 3=15$ and $15+4=19$
The denominator of the improper fraction is the same as the denominator in the mixed number.

Thus, $3\frac{4}{5}=\frac{19}{5}$.

N4. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$3\cdot 11=33$ and $33+2=35$
The denominator of the improper fraction is the same as the denominator in the mixed number.

Thus, $11\frac{2}{3}=\frac{35}{3}$.

5. (a) To multiply two fractions, multiply their numerators and then multiply their denominators. Then simplify and write the answer in lowest terms.

$$\frac{5}{9}\cdot\frac{18}{25}=\frac{5\cdot 18}{9\cdot 25}$$
$$=\frac{90}{225}$$
$$=\frac{2\cdot 45}{5\cdot 45}$$
$$=\frac{2}{5}$$

(b) To multiply two mixed numbers, first write them as improper fractions. Multiply their numerators and then multiply their denominators. Then simplify and write the answer as a mixed number in lowest terms.

$$3\frac{1}{3}\cdot 1\frac{3}{4}=\frac{10}{3}\cdot\frac{7}{4}=\frac{10\cdot 7}{3\cdot 4}=\frac{2\cdot 5\cdot 7}{3\cdot 2\cdot 2}=\frac{35}{6},\text{ or } 5\frac{5}{6}$$

N5. (a) To multiply two fractions, multiply their numerators and then multiply their denominators. Then simplify and write the answer in lowest terms.

$$\frac{4}{7}\cdot\frac{5}{8}=\frac{4\cdot 5}{7\cdot 8}=\frac{20}{56}=\frac{5\cdot 4}{14\cdot 4}=\frac{5}{14}$$

(b) To multiply two mixed numbers, first write them as improper fractions. Multiply their numerators and then multiply their denominators. Then simplify and write the answer as a mixed number in lowest terms.

$$3\frac{2}{5}\cdot 6\frac{2}{3}=\frac{17}{5}\cdot\frac{20}{3}=\frac{17\cdot 20}{5\cdot 3}=\frac{17\cdot 5\cdot 4}{5\cdot 3}=\frac{68}{3},\text{ or } 22\frac{2}{3}$$

6. (a) To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{9}{10}\div\frac{3}{5}=\frac{9}{10}\cdot\frac{5}{3}=\frac{3\cdot 3\cdot 5}{2\cdot 5\cdot 3}=\frac{3}{2},\text{ or } 1\frac{1}{2}$$

(b) Change both mixed numbers to improper fractions. Then multiply by the reciprocal of the second fraction.

$$2\frac{3}{4}\div 3\frac{1}{3}=\frac{11}{4}\div\frac{10}{3}=\frac{11}{4}\cdot\frac{3}{10}=\frac{33}{40}$$

N6. (a) To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{2}{7}\div\frac{8}{9}=\frac{2}{7}\cdot\frac{9}{8}=\frac{2\cdot 3\cdot 3}{7\cdot 2\cdot 4}=\frac{9}{28}$$

(b) To divide fractions, multiply by the reciprocal of the divisor.

$$3\frac{3}{4}\div 4\frac{2}{7}=\frac{15}{4}\div\frac{30}{7}=\frac{15}{4}\cdot\frac{7}{30}=\frac{15\cdot 7}{4\cdot 2\cdot 15}=\frac{7}{8}$$

7. To find the sum of two fractions having the same denominator, add the numerators and keep the same denominator.

$$\frac{1}{9}+\frac{5}{9}=\frac{1+5}{9}=\frac{6}{9}=\frac{2\cdot 3}{3\cdot 3}=\frac{2}{3}$$

N7. To find the sum of two fractions having the same denominator, add the numerators and keep the same denominator.

$$\frac{1}{8}+\frac{3}{8}=\frac{1+3}{8}=\frac{4}{8}=\frac{1\cdot 4}{2\cdot 4}=\frac{1}{2}$$

8. **(a)** Since $30=2\cdot 3\cdot 5$ and $45=3\cdot 3\cdot 5$, the least common denominator must have one factor of 2 (from 30), two factors of 3 (from 45), and one factor of 5 (from either 30 or 45), so it is $2\cdot 3\cdot 3\cdot 5=90$.
Write each fraction with a denominator of 90.

$$\frac{7}{30}=\frac{7}{30}\cdot\frac{3}{3}=\frac{21}{90} \text{ and } \frac{2}{45}=\frac{2}{45}\cdot\frac{2}{2}=\frac{4}{90}$$

Now add.

$$\frac{7}{30}+\frac{2}{45}=\frac{21}{90}+\frac{4}{90}=\frac{21+4}{90}=\frac{25}{90}$$

Write $\frac{25}{90}$ in lowest terms.

$$\frac{25}{90}=\frac{5\cdot 5}{18\cdot 5}=\frac{5}{18}$$

(b) Write each mixed number as an improper fraction.

$$4\frac{5}{6}+2\frac{1}{3}=\frac{29}{6}+\frac{7}{3}$$

The least common denominator is 6, so write each fraction with a denominator of 6.

$$\frac{29}{6} \text{ and } \frac{7}{3}=\frac{7}{3}\cdot\frac{2}{2}=\frac{14}{6}$$

Now add.

$$\frac{29}{6}+\frac{7}{3}=\frac{29}{6}+\frac{14}{6}=\frac{29+14}{6}=\frac{43}{6}, \text{ or } 7\frac{1}{6}$$

N8. **(a)** Since $12=2\cdot 2\cdot 3$ and $8=2\cdot 2\cdot 2$, the least common denominator must have three factors of 2 (from 8) and one factor of 3 (from 12), so it is $2\cdot 2\cdot 2\cdot 3=24$.
Write each fraction with a denominator of 24.

$$\frac{5}{12}=\frac{5}{12}\cdot\frac{2}{2}=\frac{10}{24} \text{ and } \frac{3}{8}=\frac{3}{8}\cdot\frac{3}{3}=\frac{9}{24}$$

Now add.

$$\frac{5}{12}+\frac{3}{8}=\frac{10}{24}+\frac{9}{24}=\frac{10+9}{24}=\frac{19}{24}$$

(b) Write each mixed number as an improper fraction.

$$3\frac{1}{4}+5\frac{5}{8}=\frac{13}{4}+\frac{45}{8}$$

The least common denominator is 8, so write each fraction with a denominator of 8.

$$\frac{45}{8} \text{ and } \frac{13}{4}=\frac{13}{4}\cdot\frac{2}{2}=\frac{26}{8}$$

Now add.

$$\frac{13}{4}+\frac{45}{8}=\frac{26}{8}+\frac{45}{8}=\frac{26+45}{8}=\frac{71}{8}, \text{ or } 8\frac{7}{8}$$

9. **(a)** Since $10=2\cdot 5$ and $4=2\cdot 2$, the least common denominator is $2\cdot 2\cdot 5=20$. Write each fraction with a denominator of 20.

$$\frac{3}{10}=\frac{3}{10}\cdot\frac{2}{2}=\frac{6}{20} \text{ and } \frac{1}{4}=\frac{1}{4}\cdot\frac{5}{5}=\frac{5}{20}$$

Now subtract.

$$\frac{3}{10}-\frac{1}{4}=\frac{6}{20}-\frac{5}{20}=\frac{1}{20}$$

(b) Write each mixed number as an improper fraction.

$$3\frac{3}{8}-1\frac{1}{2}=\frac{27}{8}-\frac{3}{2}$$

The least common denominator is 8. Write each fraction with a denominator of 8. $\frac{27}{8}$ remains unchanged, and $\frac{3}{2}=\frac{3}{2}\cdot\frac{4}{4}=\frac{12}{8}$.

Now subtract.

$$\frac{27}{8}-\frac{3}{2}=\frac{27}{8}-\frac{12}{8}=\frac{27-12}{8}=\frac{15}{8}, \text{ or } 1\frac{7}{8}$$

N9. **(a)** Since $11=11$ and $9=3\cdot 3$, the least common denominator is $3\cdot 3\cdot 11=99$. Write each fraction with a denominator of 99.

$$\frac{5}{11}=\frac{5}{11}\cdot\frac{9}{9}=\frac{45}{99} \text{ and } \frac{2}{9}=\frac{2}{9}\cdot\frac{11}{11}=\frac{22}{99}$$

Now subtract.

$$\frac{5}{11}-\frac{2}{9}=\frac{45}{99}-\frac{22}{99}=\frac{23}{99}$$

(b) Write each mixed number as an improper fraction.

$4\frac{1}{3}-2\frac{5}{6}=\frac{13}{3}-\frac{17}{6}$

The least common denominator is 6. Write each fraction with a denominator of 6. $\frac{17}{6}$ remains unchanged, and $\frac{13}{3}=\frac{13}{3}\cdot\frac{2}{2}=\frac{26}{6}$.

Now subtract.

$\frac{13}{3}-\frac{17}{6}=\frac{26}{6}-\frac{17}{6}=\frac{26-17}{6}=\frac{9}{6}$

Now reduce.

$\frac{9}{6}=\frac{3\cdot 3}{2\cdot 3}=\frac{3}{2}$, or $1\frac{1}{2}$

10. To find out how many yards of fabric Jen should buy, add the lengths needed for each piece to obtain the total length. The common denominator is 12.

$1\frac{1}{4}+1\frac{2}{3}+2\frac{1}{2}=1\frac{3}{12}+1\frac{8}{12}+2\frac{6}{12}=4\frac{17}{12}$

Because $\frac{17}{12}=1\frac{5}{12}$, we have

$4\frac{17}{12}=4+1\frac{5}{12}=5\frac{5}{12}$. Jen should buy $5\frac{5}{12}$ yd of fabric.

N10. To find out how long each piece must be, divide the total length by the number of pieces.

$10\frac{1}{2}\div 4=\frac{21}{2}\div\frac{4}{1}=\frac{21}{2}\cdot\frac{1}{4}=\frac{21}{8}$, or $2\frac{5}{8}$

Each piece should be $2\frac{5}{8}$ feet long.

11. **(a)** In the circle graph, the sector for Other is the second largest, so Other had the second largest share of Internet users, $\frac{23}{100}$.

(b) The total number of Internet users, 3900 million, can be rounded to 4000 million (or 4 billion). Multiply $\frac{1}{10}$ by 4000.

$\frac{1}{10}\cdot 4000=400$ million

(c) Multiply the fraction from the graph for Africa by the actual number of users.

$\frac{1}{10}\cdot 3900=390$ million

N11. **(a)** In the circle graph, the sector for Africa is the smallest, so Africa had the least number of Internet users.

(b) The total number of Internet users, 3900 million, can be rounded to 4000 million (or 4 billion). Multiply $\frac{1}{2}$ by 4000.

$\frac{1}{2}\cdot 4000=2000$ million, or 2 billion

(c) Multiply the fraction from the graph for Asia by the actual number of users.

$\frac{1}{2}\cdot 3900=1950$ million, or 1.95 billion

Exercises

1. True; the number above the fraction bar is called the numerator and the number below the fraction bar is called the denominator.

2. True; 5 divides the 31 six times with a remainder of one, so $\frac{31}{5}=6\frac{1}{5}$.

3. False; this is an improper fraction. Its value is 1.

4. False; the number 1 is neither prime nor composite.

5. False; the fraction $\frac{13}{39}$ can be written in lowest terms as $\frac{1}{3}$ since $\frac{13}{39}=\frac{13\cdot 1}{13\cdot 3}=\frac{1}{3}$.

6. False; the reciprocal of $\frac{6}{2}=3$ is $\frac{2}{6}=\frac{1}{3}$.

7. False; *product* refers to multiplication, so the product of 10 and 2 is 20. The *sum* of 10 and 2 is 12.

8. False; *difference* refers to subtraction, so the difference between 10 and 2 is 8. The *quotient* of 10 and 2 is 5.

9. $\frac{16}{24}=\frac{2\cdot 8}{3\cdot 8}=\frac{2}{3}$

Therefore, C is correct.

10. Simplify each fraction to find which are equal to $\frac{5}{9}$.

$\frac{15}{27} = \frac{3 \cdot 5}{3 \cdot 9} = \frac{5}{9}$

$\frac{30}{54} = \frac{6 \cdot 5}{6 \cdot 9} = \frac{5}{9}$

$\frac{40}{74} = \frac{2 \cdot 20}{2 \cdot 37} = \frac{20}{37}$

$\frac{55}{99} = \frac{11 \cdot 5}{11 \cdot 9} = \frac{5}{9}$

Therefore, C is correct.

11. A common denominator for $\frac{p}{q}$ and $\frac{r}{s}$ must be a multiple of both denominators, q and s. Such a number is $q \cdot s$. Therefore, A is correct.

12. We need to multiply 8 by 3 to get 24 in the denominator, so we must multiply 5 by 3 as well.

$\frac{5}{8} = \frac{5 \cdot 3}{8 \cdot 3} = \frac{15}{24}$

Therefore, B is correct.

13. Since 19 has only itself and 1 as factors, it is a prime number.

14. Since 31 has only itself and 1 as factors, it is a prime number.

15. $30 = 2 \cdot 15$

$= 2 \cdot 3 \cdot 5$

Since 30 has factors other than itself and 1, it is a composite number.

16. $50 = 2 \cdot 25$

$= 2 \cdot 5 \cdot 5,$

so 50 is a composite number.

17. $64 = 2 \cdot 32$

$= 2 \cdot 2 \cdot 16$

$= 2 \cdot 2 \cdot 2 \cdot 8$

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

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

Since 64 has factors other than itself and 1, it is a composite number.

18. $81 = 3 \cdot 27$

$= 3 \cdot 3 \cdot 9$

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

Since 81 has factors other than itself and 1, it is a composite number.

19. As stated in the text, the number 1 is neither prime nor composite, by agreement.

20. The number 0 is not a natural number, so it is neither prime nor composite.

21. $57 = 3 \cdot 19,$ so 57 is a composite number.

22. $51 = 3 \cdot 17,$ so 51 is a composite number.

23. Since 79 has only itself and 1 as factors, it is a prime number.

24. Since 83 has only itself and 1 as factors, it is a prime number.

25. $124 = 2 \cdot 62$

$= 2 \cdot 2 \cdot 31,$

so 124 is a composite number.

26. $138 = 2 \cdot 69$

$= 2 \cdot 3 \cdot 23,$

so 138 is a composite number.

27. $500 = 2 \cdot 250$

$= 2 \cdot 2 \cdot 125$

$= 2 \cdot 2 \cdot 5 \cdot 25$

$= 2 \cdot 2 \cdot 5 \cdot 5 \cdot 5,$

so 500 is a composite number.

28. $700 = 2 \cdot 350$

$= 2 \cdot 2 \cdot 175$

$= 2 \cdot 2 \cdot 5 \cdot 35$

$= 2 \cdot 2 \cdot 5 \cdot 5 \cdot 7,$

so 700 is a composite number.

29. $3458 = 2 \cdot 1729$

$= 2 \cdot 7 \cdot 247$

$= 2 \cdot 7 \cdot 13 \cdot 19$

Since 3458 has factors other than itself and 1, it is a composite number.

30. $1025 = 5 \cdot 205$

$= 5 \cdot 5 \cdot 41$

Since 1025 has factors other than itself and 1, it is a composite number.

31. $\frac{8}{16} = \frac{1 \cdot 8}{2 \cdot 8} = \frac{1}{2} \cdot \frac{8}{8} = \frac{1}{2} \cdot 1 = \frac{1}{2}$

32. $\frac{4}{12} = \frac{1 \cdot 4}{3 \cdot 4} = \frac{1}{3} \cdot \frac{4}{4} = \frac{1}{3} \cdot 1 = \frac{1}{3}$

33. $\frac{15}{18} = \frac{3 \cdot 5}{3 \cdot 6} = \frac{3}{3} \cdot \frac{5}{6} = 1 \cdot \frac{5}{6} = \frac{5}{6}$

34. $\frac{16}{20}=\frac{4\cdot 4}{5\cdot 4}=\frac{4}{5}\cdot\frac{4}{4}=\frac{4}{5}\cdot 1=\frac{4}{5}$

35. $\frac{90}{150}=\frac{3\cdot 30}{5\cdot 30}=\frac{3}{5}\cdot\frac{30}{30}=\frac{3}{5}\cdot 1=\frac{3}{5}$

36. $\frac{100}{140}=\frac{5\cdot 20}{7\cdot 20}=\frac{5}{7}\cdot\frac{20}{20}=\frac{5}{7}\cdot 1=\frac{5}{7}$

37. $\frac{18}{90}=\frac{1\cdot 18}{5\cdot 18}=\frac{1}{5}\cdot\frac{18}{18}=\frac{1}{5}\cdot 1=\frac{1}{5}$

38. $\frac{16}{64}=\frac{1\cdot 16}{4\cdot 16}=\frac{1}{4}\cdot\frac{16}{16}=\frac{1}{4}\cdot 1=\frac{1}{4}$

39. $\frac{144}{120}=\frac{6\cdot 24}{5\cdot 24}=\frac{6}{5}\cdot\frac{24}{24}=\frac{6}{5}\cdot 1=\frac{6}{5}$

40. $\frac{132}{77}=\frac{12\cdot 11}{7\cdot 11}=\frac{12}{7}\cdot\frac{11}{11}=\frac{12}{7}\cdot 1=\frac{12}{7}$

41. $$\begin{array}{r} 1 \\ 7\overline{)12} \\ \underline{7} \\ 5 \end{array}$$

Therefore, $\frac{12}{7}=1\frac{5}{7}$.

42. $$\begin{array}{r} 1 \\ 9\overline{)16} \\ \underline{9} \\ 7 \end{array}$$

Therefore, $\frac{16}{9}=1\frac{7}{9}$.

43. $$\begin{array}{r} 6 \\ 12\overline{)77} \\ \underline{72} \\ 5 \end{array}$$

Therefore, $\frac{77}{12}=6\frac{5}{12}$.

44. $$\begin{array}{r} 6 \\ 15\overline{)101} \\ \underline{90} \\ 11 \end{array}$$

Therefore, $\frac{101}{15}=6\frac{11}{15}$.

45. $$\begin{array}{r} 7 \\ 11\overline{)83} \\ \underline{77} \\ 6 \end{array}$$

Therefore, $\frac{83}{11}=7\frac{6}{11}$.

46. $$\begin{array}{r} 5 \\ 13\overline{)67} \\ \underline{65} \\ 2 \end{array}$$

Therefore, $\frac{67}{13}=5\frac{2}{13}$.

47. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$5\cdot 2=10$ and $10+3=13$
The denominator of the improper fraction is the same as the denominator in the mixed number.
Thus, $2\frac{3}{5}=\frac{13}{5}$.

48. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$7\cdot 5=35$ and $35+6=41$
The denominator of the improper fraction is the same as the denominator in the mixed number.
Thus, $5\frac{6}{7}=\frac{41}{7}$.

49. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$8\cdot 10=80$ and $80+3=83$
The denominator of the improper fraction is the same as the denominator in the mixed number.
Thus, $10\frac{3}{8}=\frac{83}{8}$.

50. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$3\cdot 12=36$ and $36+2=38$
The denominator of the improper fraction is the same as the denominator in the mixed number.
Thus, $12\frac{2}{3}=\frac{38}{3}$.

51. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$5\cdot 10=50$ and $50+1=51$
The denominator of the improper fraction is the same as the denominator in the mixed number.
Thus, $10\frac{1}{5}=\frac{51}{5}$.

52. Multiply the denominator of the fraction by the natural number and then add the numerator to obtain the numerator of the improper fraction.
$6\cdot 18=108$ and $108+1=109$
The denominator of the improper fraction is the same as the denominator in the mixed number.
Thus, $18\frac{1}{6}=\frac{109}{6}$.

53. $\frac{4}{5}\cdot\frac{6}{7}=\frac{4\cdot 6}{5\cdot 7}=\frac{24}{35}$

54. $\frac{5}{9}\cdot\frac{2}{7}=\frac{5\cdot 2}{9\cdot 7}=\frac{10}{63}$

55. $\frac{2}{15}\cdot\frac{3}{8}=\frac{2\cdot 3}{15\cdot 8}=\frac{6}{120}=\frac{1\cdot 6}{20\cdot 6}=\frac{1}{20}$

56. $\frac{3}{20}\cdot\frac{5}{21}=\frac{3\cdot 5}{20\cdot 21}=\frac{15}{420}=\frac{1\cdot 15}{28\cdot 15}=\frac{1}{28}$

57. $\frac{1}{10}\cdot\frac{12}{5}=\frac{1\cdot 12}{10\cdot 5}=\frac{1\cdot 2\cdot 6}{2\cdot 5\cdot 5}=\frac{6}{25}$

58. $\frac{1}{8}\cdot\frac{10}{7}=\frac{1\cdot 10}{8\cdot 7}=\frac{1\cdot 2\cdot 5}{2\cdot 4\cdot 7}=\frac{5}{28}$

59. $$\begin{aligned}\frac{15}{4}\cdot\frac{8}{25}&=\frac{15\cdot 8}{4\cdot 25}\\&=\frac{3\cdot 5\cdot 4\cdot 2}{4\cdot 5\cdot 5}\\&=\frac{3\cdot 2}{5}\\&=\frac{6}{5},\ \text{or}\ 1\frac{1}{5}\end{aligned}$$

60. $$\begin{aligned}\frac{21}{8}\cdot\frac{4}{7}&=\frac{21\cdot 4}{8\cdot 7}\\&=\frac{3\cdot 7\cdot 4}{4\cdot 2\cdot 7}\\&=\frac{3}{2},\ \text{or}\ 1\frac{1}{2}\end{aligned}$$

61. $$\begin{aligned}21\cdot\frac{3}{7}&=\frac{21}{1}\cdot\frac{3}{7}\\&=\frac{21\cdot 3}{1\cdot 7}\\&=\frac{3\cdot 7\cdot 3}{1\cdot 7}\\&=\frac{3\cdot 3}{1}=9\end{aligned}$$

62. $$\begin{aligned}36\cdot\frac{4}{9}&=\frac{36}{1}\cdot\frac{4}{9}\\&=\frac{36\cdot 4}{1\cdot 9}\\&=\frac{4\cdot 9\cdot 4}{1\cdot 9}\\&=\frac{4\cdot 4}{1}=16\end{aligned}$$

63. Change both mixed numbers to improper fractions.
$$\begin{aligned}3\frac{1}{4}\cdot 1\frac{2}{3}&=\frac{13}{4}\cdot\frac{5}{3}\\&=\frac{13\cdot 5}{4\cdot 3}\\&=\frac{65}{12},\ \text{or}\ 5\frac{5}{12}\end{aligned}$$

64. Change both mixed numbers to improper fractions.
$$\begin{aligned}2\frac{2}{3}\cdot 1\frac{3}{5}&=\frac{8}{3}\cdot\frac{8}{5}\\&=\frac{8\cdot 8}{3\cdot 5}\\&=\frac{64}{15},\ \text{or}\ 4\frac{4}{15}\end{aligned}$$

65. Change both mixed numbers to improper fractions.
$$\begin{aligned}2\frac{3}{8}\cdot 3\frac{1}{5}&=\frac{19}{8}\cdot\frac{16}{5}\\&=\frac{19\cdot 16}{8\cdot 5}\\&=\frac{19\cdot 2\cdot 8}{8\cdot 5}\\&=\frac{38}{5},\ \text{or}\ 7\frac{3}{5}\end{aligned}$$

66. Change both mixed numbers to improper fractions.

$$3\frac{3}{5}\cdot 7\frac{1}{6}=\frac{18}{5}\cdot\frac{43}{6}$$
$$=\frac{18\cdot 43}{5\cdot 6}$$
$$=\frac{3\cdot 6\cdot 43}{5\cdot 6}$$
$$=\frac{3\cdot 43}{5}$$
$$=\frac{129}{5}, \text{ or } 25\frac{4}{5}$$

67. Change both numbers to improper fractions.

$$5\cdot 2\frac{1}{10}=\frac{5}{1}\cdot\frac{21}{10}$$
$$=\frac{5\cdot 21}{1\cdot 10}$$
$$=\frac{5\cdot 21}{1\cdot 2\cdot 5}$$
$$=\frac{21}{1\cdot 2}$$
$$=\frac{21}{2}, \text{ or } 10\frac{1}{2}$$

68. Change both numbers to improper fractions.

$$3\cdot 4\frac{2}{9}=\frac{3}{1}\cdot\frac{38}{9}$$
$$=\frac{3\cdot 38}{1\cdot 9}$$
$$=\frac{3\cdot 38}{1\cdot 3\cdot 3}$$
$$=\frac{38}{1\cdot 3}$$
$$=\frac{38}{3}, \text{ or } 12\frac{2}{3}$$

69. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{7}{9}\div\frac{3}{2}=\frac{7}{9}\cdot\frac{2}{3}$$
$$=\frac{7\cdot 2}{9\cdot 3}$$
$$=\frac{14}{27}$$

70. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{6}{11}\div\frac{5}{4}=\frac{6}{11}\cdot\frac{4}{5}$$
$$=\frac{6\cdot 4}{11\cdot 5}$$
$$=\frac{24}{55}$$

71. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{5}{4}\div\frac{3}{8}=\frac{5}{4}\cdot\frac{8}{3}$$
$$=\frac{5\cdot 8}{4\cdot 3}$$
$$=\frac{5\cdot 4\cdot 2}{4\cdot 3}$$
$$=\frac{5\cdot 2}{3}$$
$$=\frac{10}{3}, \text{ or } 3\frac{1}{3}$$

72. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{7}{5}\div\frac{3}{10}=\frac{7}{5}\cdot\frac{10}{3}$$
$$=\frac{7\cdot 10}{5\cdot 3}$$
$$=\frac{7\cdot 2\cdot 5}{5\cdot 3}$$
$$=\frac{14}{3}, \text{ or } 4\frac{2}{3}$$

73. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{32}{5}\div\frac{8}{15}=\frac{32}{5}\cdot\frac{15}{8}$$
$$=\frac{32\cdot 15}{5\cdot 8}$$
$$=\frac{8\cdot 4\cdot 3\cdot 5}{1\cdot 5\cdot 8}$$
$$=\frac{4\cdot 3}{1}=12$$

74. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{24}{7} \div \frac{6}{21} = \frac{24}{7} \cdot \frac{21}{6} = \frac{24 \cdot 21}{7 \cdot 6} = \frac{4 \cdot 6 \cdot 3 \cdot 7}{1 \cdot 7 \cdot 6} = \frac{4 \cdot 3}{1} = 12$$

75. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{3}{4} \div 12 = \frac{3}{4} \cdot \frac{1}{12} = \frac{3 \cdot 1}{4 \cdot 12} = \frac{3 \cdot 1}{4 \cdot 3 \cdot 4} = \frac{1}{4 \cdot 4} = \frac{1}{16}$$

76. To divide fractions, multiply by the reciprocal of the divisor.

$$\frac{2}{5} \div 30 = \frac{2}{5} \cdot \frac{1}{30} = \frac{2 \cdot 1}{5 \cdot 30} = \frac{2 \cdot 1}{5 \cdot 2 \cdot 15} = \frac{1}{5 \cdot 15} = \frac{1}{75}$$

77. To divide fractions, multiply by the reciprocal of the divisor.

$$6 \div \frac{3}{5} = \frac{6}{1} \cdot \frac{5}{3} = \frac{6 \cdot 5}{1 \cdot 3} = \frac{2 \cdot 3 \cdot 5}{1 \cdot 3} = \frac{2 \cdot 5}{1} = 10$$

78. To divide fractions, multiply by the reciprocal of the divisor.

$$8 \div \frac{4}{9} = \frac{8}{1} \cdot \frac{9}{4} = \frac{8 \cdot 9}{1 \cdot 4} = \frac{2 \cdot 4 \cdot 9}{1 \cdot 4} = \frac{2 \cdot 9}{1} = 18$$

79. Change the first number to an improper fraction, and then multiply by the reciprocal of the divisor.

$$6\frac{3}{4} \div \frac{3}{8} = \frac{27}{4} \div \frac{3}{8} = \frac{27}{4} \cdot \frac{8}{3} = \frac{27 \cdot 8}{4 \cdot 3} = \frac{3 \cdot 9 \cdot 2 \cdot 4}{4 \cdot 3} = \frac{9 \cdot 2}{1} = 18$$

80. Change the first number to an improper fraction, and then multiply by the reciprocal of the divisor.

$$5\frac{3}{5} \div \frac{7}{10} = \frac{28}{5} \div \frac{7}{10} = \frac{28}{5} \cdot \frac{10}{7} = \frac{28 \cdot 10}{5 \cdot 7} = \frac{4 \cdot 7 \cdot 2 \cdot 5}{5 \cdot 7} = \frac{4 \cdot 2}{1} = 8$$

81. Change both mixed numbers to improper fractions, and then multiply by the reciprocal of the divisor.

$$2\frac{1}{2} \div 1\frac{5}{7} = \frac{5}{2} \div \frac{12}{7} = \frac{5}{2} \cdot \frac{7}{12} = \frac{5 \cdot 7}{2 \cdot 12} = \frac{35}{24}, \text{ or } 1\frac{11}{24}$$

82. Change both mixed numbers to improper fractions, and then multiply by the reciprocal of the divisor.

$$2\frac{2}{9} \div 1\frac{2}{5} = \frac{20}{9} \div \frac{7}{5}$$
$$= \frac{20}{9} \cdot \frac{5}{7}$$
$$= \frac{20 \cdot 5}{9 \cdot 7}$$
$$= \frac{100}{63}, \text{ or } 1\frac{37}{63}$$

83. Change both mixed numbers to improper fractions, and then multiply by the reciprocal of the divisor.

$$2\frac{5}{8} \div 1\frac{15}{32} = \frac{21}{8} \div \frac{47}{32}$$
$$= \frac{21}{8} \cdot \frac{32}{47}$$
$$= \frac{21 \cdot 32}{8 \cdot 47}$$
$$= \frac{21 \cdot 8 \cdot 4}{8 \cdot 47}$$
$$= \frac{21 \cdot 4}{47}$$
$$= \frac{84}{47}, \text{ or } 1\frac{37}{47}$$

84. Change both mixed numbers to improper fractions, and then multiply by the reciprocal of the divisor.

$$2\frac{3}{10} \div 1\frac{4}{5} = \frac{23}{10} \div \frac{9}{5}$$
$$= \frac{23}{10} \cdot \frac{5}{9}$$
$$= \frac{23 \cdot 5}{2 \cdot 5 \cdot 9}$$
$$= \frac{23}{18}, \text{ or } 1\frac{5}{8}$$

85. $\frac{7}{15} + \frac{4}{15} = \frac{7+4}{15} = \frac{11}{15}$

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

87.
$$\frac{7}{12} + \frac{1}{12} = \frac{7+1}{12}$$
$$= \frac{8}{12}$$
$$= \frac{2 \cdot 4}{3 \cdot 4}$$
$$= \frac{2}{3}$$

88. $\frac{3}{16} + \frac{5}{16} = \frac{3+5}{16} = \frac{8}{16} = \frac{1}{2}$

89. Since $9 = 3 \cdot 3$, and 3 is prime, the LCD (least common denominator) is $3 \cdot 3 = 9$.

$$\frac{1}{3} = \frac{1}{3} \cdot \frac{3}{3} = \frac{3}{9}$$

Now add the two fractions with the same denominator.

$$\frac{5}{9} + \frac{1}{3} = \frac{5}{9} + \frac{3}{9} = \frac{8}{9}$$

90. To add $\frac{4}{15}$ and $\frac{1}{5}$, first find the LCD. Since $15 = 3 \cdot 5$ and 5 is prime, the LCD is 15.

$$\frac{4}{15} + \frac{1}{5} = \frac{4}{15} + \frac{1}{5} \cdot \frac{3}{3}$$
$$= \frac{4}{15} + \frac{3}{15}$$
$$= \frac{4+3}{15}$$
$$= \frac{7}{15}$$

91. Since $8 = 2 \cdot 2 \cdot 2$ and $6 = 2 \cdot 3$, the LCD is $2 \cdot 2 \cdot 2 \cdot 3 = 24$.

$$\frac{3}{8} = \frac{3}{8} \cdot \frac{3}{3} = \frac{9}{24} \text{ and } \frac{5}{6} = \frac{5}{6} \cdot \frac{4}{4} = \frac{20}{24}$$

Now add fractions with the same denominator.

$$\frac{3}{8} + \frac{5}{6} = \frac{9}{24} + \frac{20}{24} = \frac{29}{24}, \text{ or } 1\frac{5}{24}$$

92. Since $6 = 2 \cdot 3$ and $9 = 3 \cdot 3$, the LCD is $2 \cdot 3 \cdot 3 = 18$.

$$\frac{5}{6} = \frac{5}{6} \cdot \frac{3}{3} = \frac{15}{18} \text{ and } \frac{2}{9} = \frac{2}{9} \cdot \frac{2}{2} = \frac{4}{18}$$

Now add fractions with the same denominator.

$$\frac{5}{6} + \frac{2}{9} = \frac{15}{18} + \frac{4}{18} = \frac{19}{18}, \text{ or } 1\frac{1}{18}$$

93. Since $9 = 3 \cdot 3$ and $16 = 4 \cdot 4$, the LCD is $3 \cdot 3 \cdot 4 \cdot 4 = 144$.

$$\frac{5}{9} = \frac{5}{9} \cdot \frac{16}{16} = \frac{80}{144} \text{ and } \frac{3}{16} = \frac{3}{16} \cdot \frac{9}{9} = \frac{27}{144}$$

Now add fractions with the same denominator.

$$\frac{5}{9} + \frac{3}{16} = \frac{80}{144} + \frac{27}{144} = \frac{107}{144}$$

94. Since $4 = 2 \cdot 2$ and $25 = 5 \cdot 5$, the LCD is $2 \cdot 2 \cdot 5 \cdot 5 = 100$.

$$\frac{3}{4} = \frac{3}{4} \cdot \frac{25}{25} = \frac{75}{100} \text{ and } \frac{6}{25} = \frac{6}{25} \cdot \frac{4}{4} = \frac{24}{100}$$

Now add fractions with the same denominator.

$$\frac{3}{4} + \frac{6}{25} = \frac{75}{100} + \frac{24}{100} = \frac{99}{100}$$

95.

$$3\frac{1}{8} = 3 + \frac{1}{8} = \frac{24}{8} + \frac{1}{8} = \frac{25}{8}$$

$$2\frac{1}{4} = 2 + \frac{1}{4} = \frac{8}{4} + \frac{1}{4} = \frac{9}{4}$$

$$3\frac{1}{8} + 2\frac{1}{4} = \frac{25}{8} + \frac{9}{4}$$

Since $8 = 2 \cdot 2 \cdot 2$ and $4 = 2 \cdot 2$, the LCD is $2 \cdot 2 \cdot 2$ or 8.

$$3\frac{1}{8} + 2\frac{1}{4} = \frac{25}{8} + \frac{9}{4} \cdot \frac{2}{2} = \frac{25}{8} + \frac{18}{8} = \frac{43}{8}, \text{ or } 5\frac{3}{8}$$

96.

$$4\frac{2}{3} = 4 + \frac{2}{3} = \frac{12}{3} + \frac{2}{3} = \frac{14}{3}$$

$$2\frac{1}{6} = 2 + \frac{1}{6} = \frac{12}{6} + \frac{1}{6} = \frac{13}{6}$$

Since $6 = 2 \cdot 3$, the LCD is 6.

$$4\frac{2}{3} + 2\frac{1}{6} = \frac{14}{3} \cdot \frac{2}{2} + \frac{13}{6} = \frac{28}{6} + \frac{13}{6} = \frac{41}{6}, \text{ or } 6\frac{5}{6}$$

97.

$$3\frac{1}{4} = 3 + \frac{1}{4} = \frac{12}{4} + \frac{1}{4} = \frac{13}{4}$$

$$1\frac{4}{5} = 1 + \frac{4}{5} = \frac{5}{5} + \frac{4}{5} = \frac{9}{5}$$

Since $4 = 2 \cdot 2$, and 5 is prime, the LCD is $2 \cdot 2 \cdot 5 = 20$.

$$3\frac{1}{4} + 1\frac{4}{5} = \frac{13}{4} \cdot \frac{5}{5} + \frac{9}{5} \cdot \frac{4}{4} = \frac{65}{20} + \frac{36}{20} = \frac{101}{20}, \text{ or } 5\frac{1}{20}$$

98. To add $5\frac{3}{4}$ and $1\frac{1}{3}$, first change to improper fractions then find the LCD, which is 12.

$$5\frac{3}{4} + 1\frac{1}{3} = \frac{23}{4} + \frac{4}{3} = \frac{23}{4} \cdot \frac{3}{3} + \frac{4}{3} \cdot \frac{4}{4} = \frac{69}{12} + \frac{16}{12} = \frac{85}{12}, \text{ or } 7\frac{1}{12}$$

99. $\frac{7}{9} - \frac{2}{9} = \frac{7-2}{9} = \frac{5}{9}$

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

101.

$$\frac{13}{15} - \frac{3}{15} = \frac{13-3}{15} = \frac{10}{15} = \frac{2 \cdot 5}{3 \cdot 5} = \frac{2}{3}$$

102.

$$\frac{11}{12} - \frac{3}{12} = \frac{11-3}{12} = \frac{8}{12} = \frac{2 \cdot 4}{3 \cdot 4} = \frac{2}{3}$$

103. Since $12 = 4 \cdot 3$ (12 is a multiple of 3), the LCD is 12.

$$\frac{1}{3} \cdot \frac{4}{4} = \frac{4}{12}$$

Now subtract fractions with the same denominator.

$$\frac{7}{12} - \frac{1}{3} = \frac{7}{12} - \frac{4}{12} = \frac{3}{12} = \frac{1 \cdot 3}{4 \cdot 3} = \frac{1}{4}$$

104. Since $6 = 3 \cdot 2$ (6 is a multiple of 2), the LCD is 6.

$\frac{1}{2} \cdot \frac{3}{3} = \frac{3}{6}$

Now subtract fractions with the same denominator.

$\frac{5}{6} - \frac{1}{2} = \frac{5}{6} - \frac{3}{6} = \frac{2}{6} = \frac{1 \cdot 2}{3 \cdot 2} = \frac{1}{3}$

105. Since $12 = 2 \cdot 2 \cdot 3$ and $9 = 3 \cdot 3$, the LCD is $2 \cdot 2 \cdot 3 \cdot 3 = 36$.

$\frac{7}{12} = \frac{7}{12} \cdot \frac{3}{3} = \frac{21}{36}$ and $\frac{1}{9} \cdot \frac{4}{4} = \frac{4}{36}$

Now subtract fractions with the same denominator.

$\frac{7}{12} - \frac{1}{9} = \frac{21}{36} - \frac{4}{36} = \frac{17}{36}$

106. $\frac{11}{16} - \frac{1}{12} = \frac{11}{16} \cdot \frac{3}{3} - \frac{1}{12} \cdot \frac{4}{4}$ The LCD of 12 and 16 is 48.

$= \frac{33}{48} - \frac{4}{48}$

$= \frac{29}{48}$

107. $4\frac{3}{4} = 4 + \frac{3}{4} = \frac{16}{4} + \frac{3}{4} = \frac{19}{4}$

$1\frac{2}{5} = 1 + \frac{2}{5} = \frac{5}{5} + \frac{2}{5} = \frac{7}{5}$

Since $4 = 2 \cdot 2$, and 5 is prime, the LCD is $2 \cdot 2 \cdot 5 = 20$.

$4\frac{3}{4} - 1\frac{2}{5} = \frac{19}{4} \cdot \frac{5}{5} - \frac{7}{5} \cdot \frac{4}{4}$

$= \frac{95}{20} - \frac{28}{20}$

$= \frac{67}{20}$, or $3\frac{7}{20}$

108. Change both numbers to improper fractions then add, using 45 as the common denominator.

$3\frac{4}{5} - 1\frac{4}{9} = \frac{19}{5} - \frac{13}{9}$

$= \frac{19}{5} \cdot \frac{9}{9} - \frac{13}{9} \cdot \frac{5}{5}$

$= \frac{171}{45} - \frac{65}{45}$

$= \frac{106}{45}$, or $2\frac{16}{45}$

109. $6\frac{1}{4} = 6 + \frac{1}{4} = \frac{24}{4} + \frac{1}{4} = \frac{25}{4}$

$5\frac{1}{3} = 5 + \frac{1}{3} = \frac{15}{3} + \frac{1}{3} = \frac{16}{3}$

Since $4 = 2 \cdot 2$, and 3 is prime, the LCD is $2 \cdot 2 \cdot 3 = 12$.

$6\frac{1}{4} - 5\frac{1}{3} = \frac{25}{4} - \frac{16}{3}$

$= \frac{25}{4} \cdot \frac{3}{3} - \frac{16}{3} \cdot \frac{4}{4}$

$= \frac{75}{12} - \frac{64}{12}$

$= \frac{11}{12}$

110. $5\frac{1}{3} = 5 + \frac{1}{3} = \frac{15}{3} + \frac{1}{3} = \frac{16}{3}$

$4\frac{1}{2} = 4 + \frac{1}{2} = \frac{8}{2} + \frac{1}{2} = \frac{9}{2}$

2 and 3 are prime, so the LCD is $2 \cdot 3 = 6$.

$5\frac{1}{3} - 4\frac{1}{2} = \frac{16}{3} \cdot \frac{2}{2} - \frac{9}{2} \cdot \frac{3}{3}$

$= \frac{32}{6} - \frac{27}{6}$

$= \frac{5}{6}$

111. $8\frac{2}{9} = 8 + \frac{2}{9} = \frac{72}{9} + \frac{2}{9} = \frac{74}{9}$

$4\frac{2}{3} = 4 + \frac{2}{3} = \frac{12}{3} + \frac{2}{3} = \frac{14}{3}$

Since $9 = 3 \cdot 3$, and 3 is prime, the LCD is $3 \cdot 3 = 9$.

$8\frac{2}{9} - 4\frac{2}{3} = \frac{74}{9} - \frac{14}{3} \cdot \frac{3}{3}$

$= \frac{74}{9} - \frac{42}{9}$

$= \frac{32}{9}$, or $3\frac{5}{9}$

112. $7\frac{5}{12}=7+\frac{5}{12}=\frac{84}{12}+\frac{5}{12}=\frac{89}{12}$

$4\frac{5}{6}=4+\frac{5}{6}=\frac{24}{6}+\frac{5}{6}=\frac{29}{6}$

Since $12=2\cdot 2\cdot 3$ and $6=2\cdot 3$, the LCD is $2\cdot 2\cdot 3=12$.

$$\begin{aligned}7\frac{5}{12}-4\frac{5}{6}&=\frac{89}{12}-\frac{29}{6}\cdot\frac{2}{2}\\&=\frac{89}{12}-\frac{58}{12}\\&=\frac{31}{12},\text{ or } 2\frac{7}{12}\end{aligned}$$

113. Observe that there are 24 dots in the entire figure, 6 dots in the triangle, 12 dots in the rectangle, and 2 dots in the overlapping region.

(a) $\frac{12}{24}=\frac{1}{2}$ of all the dots are in the rectangle.

(b) $\frac{6}{24}=\frac{1}{4}$ of all the dots are in the triangle.

(c) $\frac{2}{6}=\frac{1}{3}$ of the dots in the triangle are in the overlapping region.

(d) $\frac{2}{12}=\frac{1}{6}$ of the dots in the rectangle are in the overlapping region.

114. (a) 12 is $\frac{1}{3}$ of 36, so Maureen got a hit in exactly $\frac{1}{3}$ of her at-bats.

(b) 5 is a little less than $\frac{1}{2}$ of 11, so Chase got a hit in just less than $\frac{1}{2}$ of his at-bats.

(c) 1 is a little less than $\frac{1}{10}$ of 11, so Chase got a home run in just less than $\frac{1}{10}$ of his at-bats.

(d) 9 is a little less than $\frac{1}{4}$ of 40, so Christine got a hit in just less than $\frac{1}{4}$ of her at-bats.

(e) 8 is $\frac{1}{2}$ of 16, and 10 is $\frac{1}{2}$ of 20, so Joe and Greg each got hits $\frac{1}{2}$ of the time they were at bat.

115. Multiply the number of cups of water per serving by the number of servings.

$$\begin{aligned}\frac{3}{4}\cdot 8&=\frac{3}{4}\cdot\frac{8}{1}\\&=\frac{3\cdot 8}{4\cdot 1}\\&=\frac{24}{4}\\&=6\text{ cups}\end{aligned}$$

For 8 microwave servings, 6 cups of water will be needed.

116. Four stove-top servings require $\frac{1}{4}$ tsp, or $\frac{2}{8}$ tsp, of salt. Six stove-top servings require $\frac{1}{2}$ tsp, or $\frac{4}{8}$ tsp, of salt. Five is halfway between 4 and 6, and $\frac{3}{8}$ is halfway between $\frac{2}{8}$ and $\frac{4}{8}$. Therefore, 5 stove-top servings would require $\frac{3}{8}$ tsp of salt.

117. The difference in length is found by subtracting.

$$\begin{aligned}3\frac{1}{4}-2\frac{1}{8}&=\frac{13}{4}-\frac{17}{8}\\&=\frac{13}{4}\cdot\frac{2}{2}-\frac{17}{8}\quad\text{LCD}=8\\&=\frac{26}{8}-\frac{17}{8}\\&=\frac{9}{8},\text{ or } 1\frac{1}{8}\end{aligned}$$

The difference is $1\frac{1}{8}$ inches.

118. The difference in length is found by subtracting.

$$4-2\frac{1}{8}=\frac{4}{1}-\frac{17}{8}$$
$$=\frac{4}{1}\cdot\frac{8}{8}-\frac{17}{8} \quad \text{LCD}=8$$
$$=\frac{32}{8}-\frac{17}{8}$$
$$=\frac{15}{8}, \text{ or } 1\frac{7}{8}$$

The difference is $1\frac{7}{8}$ inches.

119. The difference between the two measures is found by subtracting, using 16 as the LCD.

$$\frac{3}{4}-\frac{3}{16}=\frac{3}{4}\cdot\frac{4}{4}-\frac{3}{16}$$
$$=\frac{12}{16}-\frac{3}{16}$$
$$=\frac{12-3}{16}$$
$$=\frac{9}{16}$$

The difference is $\frac{9}{16}$ inch.

120. The difference between the two measures is found by subtracting, using 16 as a common denominator.

$$\frac{9}{16}-\frac{3}{8}=\frac{9}{16}-\frac{3}{8}\cdot\frac{2}{2}$$
$$=\frac{9}{16}-\frac{6}{16}$$
$$=\frac{9-6}{16}$$
$$=\frac{3}{16}$$

The difference is $\frac{3}{16}$ inch.

121. The perimeter is the sum of the measures of the 5 sides.

$$196+98\frac{3}{4}+146\frac{1}{2}+100\frac{7}{8}+76\frac{5}{8}$$
$$=196+98\frac{6}{8}+146\frac{4}{8}+100\frac{7}{8}+76\frac{5}{8}$$
$$=196+98+146+100+76+\frac{6+4+7+5}{8}$$
$$=616+\frac{22}{8} \quad \left(\frac{22}{8}=2\frac{6}{8}=2\frac{3}{4}\right)$$
$$=618\frac{3}{4} \text{ feet}$$

The perimeter is $618\frac{3}{4}$ feet.

122. To find the perimeter of a triangle, add the lengths of the three sides.

$$5\frac{1}{4}+7\frac{1}{2}+10\frac{1}{8}=5\frac{2}{8}+7\frac{4}{8}+10\frac{1}{8}$$
$$=22\frac{7}{8}$$

The perimeter of the triangle is $22\frac{7}{8}$ feet.

123. Divide the total board length by 3.

$$15\frac{5}{8}\div 3=\frac{125}{8}\div\frac{3}{1}$$
$$=\frac{125}{8}\cdot\frac{1}{3}$$
$$=\frac{125\cdot 1}{8\cdot 3}$$
$$=\frac{125}{24}, \text{ or } 5\frac{5}{24}$$

The length of each of the three pieces must be $5\frac{5}{24}$ inches.

124. Divide the total amount of tomato sauce by the number of servings.

$$2\frac{1}{3}\div 7=\frac{7}{3}\div\frac{7}{1}=\frac{7}{3}\cdot\frac{1}{7}=\frac{7\cdot 1}{3\cdot 7}=\frac{1}{3}$$

For 1 serving of barbecue sauce, $\frac{1}{3}$ cup of tomato sauce is needed.

125. To find the number of cakes the caterer can make, divide $15\frac{1}{2}$ by $1\frac{3}{4}$.

$$15\frac{1}{2} \div 1\frac{3}{4} = \frac{31}{2} \div \frac{7}{4}$$
$$= \frac{31}{2} \cdot \frac{4}{7}$$
$$= \frac{31 \cdot 2 \cdot 2}{2 \cdot 7}$$
$$= \frac{62}{7}, \text{ or } 8\frac{6}{7}$$

There is not quite enough sugar for 9 cakes. The caterer can make 8 cakes with some sugar left over.

126. Divide the total amount of fabric by the amount of fabric needed to cover one chair.

$$23\frac{2}{3} \div 2\frac{1}{4} = \frac{71}{3} \div \frac{9}{4}$$
$$= \frac{71}{3} \cdot \frac{4}{9}$$
$$= \frac{71 \cdot 4}{3 \cdot 9}$$
$$= \frac{284}{27}, \text{ or } 10\frac{14}{27}$$

Kyla can cover 10 chairs. There will be some fabric left over.

127. Multiply the amount of fabric it takes to make one costume by the number of costumes.

$$2\frac{3}{8} \cdot 7 = \frac{19}{8} \cdot \frac{7}{1}$$
$$= \frac{19 \cdot 7}{8 \cdot 1}$$
$$= \frac{133}{8}, \text{ or } 16\frac{5}{8} \text{ yd}$$

For 7 costumes, $16\frac{5}{8}$ yards of fabric would be needed.

128. Multiply the amount of sugar for one batch times the number of batches.

$$2\frac{2}{3} \cdot 4 = \frac{8}{3} \cdot \frac{4}{1}$$
$$= \frac{8 \cdot 4}{3 \cdot 1}$$
$$= \frac{32}{3}, \text{ or } 10\frac{2}{3}$$

$10\frac{2}{3}$ cups of sugar are required to make four batches of cookies.

129. Subtract the heights to find the difference.

$$10\frac{1}{2} - 7\frac{1}{8} = \frac{21}{2} - \frac{57}{8}$$
$$= \frac{21}{2} \cdot \frac{4}{4} - \frac{57}{8} \qquad \text{LCD} = 8$$
$$= \frac{84}{8} - \frac{57}{8}$$
$$= \frac{27}{8}, \text{ or } 3\frac{3}{8}$$

The difference in heights is $3\frac{3}{8}$ inches.

130. Subtract $\frac{3}{8}$ from $\frac{11}{16}$ using 16 as the LCD.

$$\frac{11}{16} - \frac{3}{8} = \frac{11}{16} - \frac{3}{8} \cdot \frac{2}{2}$$
$$= \frac{11}{16} - \frac{6}{16}$$
$$= \frac{5}{16}$$

Thus, $\frac{3}{8}$ inch is $\frac{5}{16}$ inch smaller than $\frac{11}{16}$ inch.

131. A share of $\frac{11}{100}$ can be rounded to $\frac{10}{100} = \frac{1}{10}$.

Multiply by the total number of foreign-born people in the U.S., approximately 40 million.

$$\frac{1}{10} \cdot 40 = \frac{1}{10} \cdot \frac{40}{1} = \frac{4 \cdot 10}{1 \cdot 10} = \frac{4}{1} = 4,$$

There were approximately 4 million (or 4,000,000) foreign-born people in the U.S. who were born in Europe.

For the actual number:

$$\frac{11}{100} \cdot 40 = \frac{11}{100} \cdot \frac{40}{1} = \frac{11 \cdot 2 \cdot 20}{5 \cdot 20 \cdot 1} = \frac{22}{5}, \text{ or } 4\frac{2}{5}$$

The actual number who were born in Europe was $4\frac{2}{5}$ million (or 4,400,000) people.

132. Multiply the fraction representing the U.S. foreign-born population from Latin America, $\frac{13}{25}$, by the total number of foreign-born people in the U.S., approximately 40 million.

$$\frac{13}{25} \cdot 40 = \frac{13}{25} \cdot \frac{40}{1} = \frac{13 \cdot 5 \cdot 8}{5 \cdot 5 \cdot 1} = \frac{104}{5}, \text{ or } 20\frac{4}{5}$$

There were approximately $20\frac{4}{5}$ million (or 20,800,000) foreign-born people in the U.S. who were born in Latin America.

133. The sum of the fractions representing the U.S. foreign-born population from Latin America, Asia, or Europe is

$$\frac{13}{25}+\frac{29}{100}+\frac{11}{100}=\frac{13}{25}\cdot\frac{4}{4}+\frac{29}{100}+\frac{11}{100}=\frac{52+29+11}{100}=\frac{92}{100}=\frac{23\cdot 4}{25\cdot 4}=\frac{23}{25}.$$

So the fraction representing the U.S. foreign-born population from other regions is

$$1-\frac{23}{25}=\frac{25}{25}-\frac{23}{25}=\frac{2}{25}.$$

134. The sum of the fractions representing the U.S. foreign-born population from Latin America or Asia is

$$\frac{13}{25}+\frac{29}{100}=\frac{13}{25}\cdot\frac{4}{4}+\frac{29}{100}=\frac{52+29}{100}=\frac{81}{100}.$$

135. Estimate each fraction. $\frac{14}{26}$ is about $\frac{1}{2}$, $\frac{98}{99}$ is about 1, $\frac{100}{51}$ is about 2, $\frac{90}{31}$ is about 3, and $\frac{13}{27}$ is about $\frac{1}{2}$.

Therefore, the sum is approximately

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

The correct choice is C.

136. Estimate each fraction. $\frac{202}{50}$ is about 4, $\frac{99}{100}$ is about 1, $\frac{21}{40}$ is about $\frac{1}{2}$, and $\frac{75}{36}$ is about 2.

Therefore, the product is approximately

$$4\cdot 1\cdot\frac{1}{2}\cdot 2=4$$

The correct choice is B.

R.2 Decimals and Percents

Classroom Examples, Now Try Exercises

1. **(a)** $0.15=\frac{15}{100}$

(b) $0.009=\frac{9}{1000}$

(c) $2.5=2\frac{5}{10}=\frac{25}{10}$

N1. **(a)** $0.8=\frac{8}{10}$

(b) $0.431=\frac{431}{1000}$

(c) $2.58=2\frac{58}{100}=\frac{258}{100}$

2. **(a)**

$$\begin{array}{r} 42.830 \\ 71.000 \\ +\ 3.074 \\ \hline 116.904 \end{array}$$

(b)

$$\begin{array}{r} 32.50 \\ -\ 21.72 \\ \hline 10.78 \end{array}$$

N2. **(a)**

$$\begin{array}{r} 68.900 \\ 42.720 \\ +\ 8.973 \\ \hline 120.593 \end{array}$$

(b)

$$\begin{array}{r} 351.800 \\ -\ 2.706 \\ \hline 349.094 \end{array}$$

3. **(a)**

$$\begin{array}{rr} 30.2 & \text{1 decimal place} \\ \times 0.052 & \text{3 decimal places} \\ \hline 604 & \downarrow \\ 1510 & 1+3=4 \\ \hline 1.5704 & \text{4 decimal places} \end{array}$$

(b)

$$\begin{array}{rr} 0.06 & \text{2 decimal places} \\ \times 0.12 & \text{2 decimal places} \\ \hline 12 & \downarrow \\ 6 & 2+2=4 \\ \hline 0.0072 & \text{4 decimal places} \end{array}$$

N3. (a)

9.32	2 decimal places
× 1.4	1 decimal place
3728	↓
932	2 + 1 = 3
13.048	3 decimal places

(b)

0.6	1 decimal place
× 0.004	3 decimal places
24	1 + 3 = 4
0.0024	4 decimal places

4. (a) To change the divisor 0.37 into a whole number, move each decimal point two places to the right. Move the decimal point straight up and divide as with whole numbers.

$$\begin{array}{r} 14.8 \\ 37\overline{)547.6} \\ \underline{37} \\ 177 \\ \underline{148} \\ 296 \\ \underline{296} \\ 0 \end{array}$$

Therefore, $5.476 \div 0.37 = 14.8$.

(b) To change the divisor 3.1 into a whole number, move each decimal point one place to the right. Move the decimal point straight up and divide as with whole numbers.

$$\begin{array}{r} 1.21 \\ 31\overline{)37.60} \\ \underline{31} \\ 66 \\ \underline{62} \\ 40 \\ \underline{31} \\ 9 \end{array}$$

We carried out the division to 2 decimal places so that we could round to 1 decimal place. Therefore, $3.76 \div 3.1 \approx 1.2$.

N4. (a) To change the divisor 14.9 into a whole number, move each decimal point one place to the right. Move the decimal point straight up and divide as with whole numbers.

$$\begin{array}{r} 30.3 \\ 149\overline{)4514.7} \\ \underline{447} \\ 447 \\ \underline{447} \\ 0 \end{array}$$

Therefore, $451.47 \div 14.9 = 30.3$.

(b) To change the divisor 1.3 into a whole number, move each decimal point one place to the right. Move the decimal point straight up and divide as with whole numbers.

$$\begin{array}{r} 5.641 \\ 13\overline{)73.340} \\ \underline{65} \\ 83 \\ \underline{78} \\ 54 \\ \underline{52} \\ 20 \\ \underline{13} \\ 7 \end{array}$$

We carried out the division to 3 decimal places so that we could round to 2 decimal places. Therefore, $7.334 \div 1.3 \approx 5.64$.

5. (a) Move the decimal point three places to the right.
$19.5 \times 1000 = 19{,}500$

(b) Move the decimal point one place to the left.
$960.1 \div 10 = 96.01$

N5. (a) Move the decimal point one place to the right.
$294.72 \times 10 = 2947.2$

(b) Move the decimal point two places to the left. Insert a 0 in front of the 4 to do this.
$4.793 \div 100 = 0.04793$

6. **(a)** Divide 3 by 50. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.06 \\ 50\overline{)3.00} \\ \underline{3\ 00} \\ 0 \end{array}$$

Therefore, $\frac{3}{50} = 0.06.$

(b) Divide 11 by 1. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.090909... \\ 11\overline{)1.000000...} \\ \underline{99} \\ 100 \\ \underline{99} \\ 100 \\ \underline{99} \\ 1 \end{array}$$

Note that the pattern repeats. Therefore,

$\frac{1}{11} = 0.\overline{09},$ or about $0.091.$

N6. **(a)** Divide 20 by 17. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.85 \\ 20\overline{)17.00} \\ \underline{160} \\ 100 \\ \underline{100} \\ 0 \end{array}$$

Therefore, $\frac{17}{20} = 0.85.$

(b) Divide 2 by 9. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.222... \\ 9\overline{)2.000...} \\ \underline{18} \\ 20 \\ \underline{18} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

Note that the pattern repeats. Therefore,

$\frac{2}{9} = 0.\overline{2},$ or $0.222.$

7. **(a)** $5\frac{1}{4}\% = 5.25\%$

$= \frac{5.25}{100}$

$= 0.0525$

(b) $200\% = \frac{200}{100} = 2.00,$ or 2

N7. **(a)** $23\% = \frac{23}{100} = 0.23$

(b) $350\% = \frac{350}{100} = 3.50,$ or 3.5

8. **(a)** $0.06 = 0.06 \cdot 100\% = 6\%$

(b) $1.75 = 1.75 \cdot 100\% = 175\%$

N8. **(a)** $0.31 = 0.31 \cdot 100\% = 31\%$

(b) $1.32 = 1.32 \cdot 100\% = 132\%$

9. **(a)** $85\% = 0.85$

(b) $110\% = 1.10,$ or 1.1

(c) $0.30 = 30\%$

(d) $0.165 = 16.5\%$

N9. **(a)** $52\% = 0.52$

(b) $2\% = 02\% = 0.02$

(c) $0.45 = 45\%$

(d) $3.5 = 3.50 = 350\%$

10. **(a)** $65\% = \frac{65}{100}$

In lowest terms,

$\frac{65}{100} = \frac{13 \cdot 5}{20 \cdot 5} = \frac{13}{20}$

(b) $1.5\% = \frac{1.5}{100} = \frac{1.5}{100} \cdot \frac{10}{10} = \frac{15}{1000} = \frac{3}{200}$

N10. **(a)** $20\% = \frac{20}{100}$

In lowest terms,

$\frac{20}{100} = \frac{1 \cdot 20}{5 \cdot 20} = \frac{1}{5}$

(b) $160\% = \frac{160}{100}$

In lowest terms,

$\frac{160}{100} = \frac{8 \cdot 20}{5 \cdot 20} = \frac{8}{5},$ or $1\frac{3}{5}$

11. **(a)** $\frac{3}{50} = \frac{3}{50} \cdot 100\%$
$= \frac{3}{50} \cdot \frac{100}{1}\%$
$= \frac{3 \cdot 50 \cdot 2}{50}\%$
$= 6\%$

(b) $\frac{1}{3} = \frac{1}{3} \cdot 100\%$
$= \frac{1}{3} \cdot \frac{100}{1}\%$
$= \frac{100}{3}\%$
$= 33\frac{1}{3}\%$, or $33.\overline{3}\%$

N11. **(a)** $\frac{6}{25} = \frac{6}{25} \cdot 100\%$
$= \frac{6}{25} \cdot \frac{100}{1}\%$
$= \frac{6 \cdot 25 \cdot 4}{25}\%$
$= 24\%$

(b) $\frac{7}{9} = \frac{7}{9} \cdot 100\%$
$= \frac{7}{9} \cdot \frac{100}{1}\%$
$= \frac{700}{9}\%$
$= 77\frac{7}{9}\%$, or $77.\overline{7}\%$

12. The discount is 30% of \$69. The word *of* here means multiply.

30% of 69
↓ ↓ ↓
$0.30 \cdot 69 = 20.7$

The discount is \$20.70. The sale price is found by subtracting.
$\$69.00 - \$20.70 = \$48.30$

N12. The discount is 60% of \$120. The word *of* here means multiply.

60% of 120
↓ ↓ ↓
$0.60 \cdot 120 = 72$

The discount is \$72. The sale price is found by subtracting.
$\$120.00 - \$72 = \$48$

Exercises

1. 367.9412

(a) Tens: 6

(b) Tenths: 9

(c) Thousandths: 1

(d) Ones: 7

(e) Hundredths: 4

2. Answers will vary. One example is 5243.0164.

3. 46.249

(a) 46.25

(b) 46.2

(c) 46

(d) 50

4. **(a)** 0.889

(b) 0.444

(c) 0.976

(d) 0.865

5. $0.4 = \frac{4}{10}$

6. $0.6 = \frac{6}{10}$

7. $0.64 = \frac{64}{100}$

8. $0.82 = \frac{82}{100}$

9. $0.138 = \frac{138}{1000}$

10. $0.104 = \frac{104}{1000}$

11. $0.043 = \frac{43}{1000}$

12. $0.087 = \frac{87}{1000}$

13. $3.805 = 3\frac{805}{1000} = \frac{3805}{1000}$

14. $5.166 = 5\frac{166}{1000} = \frac{5166}{1000}$

15.
$$\begin{array}{r} 25.320 \\ 109.200 \\ +\ \ 8.574 \\ \hline 143.094 \end{array}$$

16.
$$\begin{array}{r} 90.527 \\ 32.430 \\ +589.800 \\ \hline 712.757 \end{array}$$

17.
$$\begin{array}{r} 28.73 \\ -\ \ 3.12 \\ \hline 25.61 \end{array}$$

18.
$$\begin{array}{r} 46.88 \\ -13.45 \\ \hline 33.43 \end{array}$$

19.
$$\begin{array}{r} 43.50 \\ -28.17 \\ \hline 15.33 \end{array}$$

20.
$$\begin{array}{r} 345.10 \\ -\ \ 56.31 \\ \hline 288.79 \end{array}$$

21.
$$\begin{array}{r} 3.87 \\ 15.00 \\ +\ \ 2.90 \\ \hline 21.77 \end{array}$$

22.
$$\begin{array}{r} 8.20 \\ 1.09 \\ +12.00 \\ \hline 21.29 \end{array}$$

23.
$$\begin{array}{r} 32.560 \\ 47.356 \\ +\ \ 1.800 \\ \hline 81.716 \end{array}$$

24.
$$\begin{array}{r} 75.200 \\ 123.960 \\ +\ \ 3.897 \\ \hline 203.057 \end{array}$$

25.
$$\begin{array}{r} 18.000 \\ -\ \ 2.789 \\ \hline 15.211 \end{array}$$

26.
$$\begin{array}{r} 29.000 \\ -\ \ 8.582 \\ \hline 20.418 \end{array}$$

27.
$$\begin{array}{rr} 12.8 & \text{1 decimal place} \\ \times\ 9.1 & \text{1 decimal place} \\ \hline 128 & \downarrow \\ 1152\ \ & 1+1=2 \\ \hline 116.48 & \text{2 decimal places} \end{array}$$

28.
$$\begin{array}{rr} 34.04 & \text{2 decimal places} \\ \times\ 0.56 & \text{2 decimal places} \\ \hline 20424 & \downarrow \\ 17020\ \ & 2+2=4 \\ \hline 19.0624 & \text{4 decimal places} \end{array}$$

29.
$$\begin{array}{rr} 22.41 & \text{2 decimal places} \\ \times\ 33 & \text{0 decimal places} \\ \hline 6723 & \downarrow \\ 6723\ \ & 2+0=2 \\ \hline 739.53 & \text{2 decimal places} \end{array}$$

30.
$$\begin{array}{rr} 55.76 & \text{2 decimal places} \\ \times\ 72 & \text{0 decimal places} \\ \hline 11152 & \downarrow \\ 39032\ \ & 2+0=2 \\ \hline 4014.72 & \text{2 decimal places} \end{array}$$

31.
$$\begin{array}{rr} 0.2 & \text{1 decimal place} \\ \times 0.03 & \text{2 decimal places} \\ \hline 6 & 1+2=3 \\ \hline 0.006 & \text{3 decimal places} \end{array}$$

32.
$$\begin{array}{rr} 0.07 & \text{2 decimal places} \\ \times 0.004 & \text{3 decimal places} \\ \hline 28 & 2+3=5 \\ \hline 0.00028 & \text{5 decimal places} \end{array}$$

33.
$$\begin{array}{r} 7.15 \\ 11\overline{)78.65} \\ \underline{77} \\ 16 \\ \underline{11} \\ 55 \\ \underline{55} \\ 0 \end{array}$$

34.
$$\begin{array}{r} 5.24 \\ 14\overline{)73.36} \\ \underline{70} \\ 33 \\ \underline{28} \\ 56 \\ \underline{56} \\ 0 \end{array}$$

35. To change the divisor 11.6 into a whole number, move each decimal point one place to the right. Move the decimal point straight up and divide as with whole numbers.
$$\begin{array}{r} 2.8 \\ 116\overline{)324.8} \\ \underline{232} \\ 928 \\ \underline{928} \\ 0 \end{array}$$
Therefore, $32.48 \div 11.6 = 2.8$.

36. To change the divisor 17.4 into a whole number, move each decimal point one place to the right. Move the decimal point straight up and divide as with whole numbers.
$$\begin{array}{r} 4.9 \\ 174\overline{)852.6} \\ \underline{696} \\ 1566 \\ \underline{1566} \\ 0 \end{array}$$
Therefore, $85.26 \div 17.4 = 4.9$.

37. To change the divisor 9.74 into a whole number, move each decimal point two places to the right. Move the decimal point straight up and divide as with whole numbers.
$$\begin{array}{r} 2.05 \\ 974\overline{)1996.70} \\ \underline{1948} \\ 4870 \\ \underline{4870} \\ 0 \end{array}$$
Therefore, $19.967 \div 9.74 = 2.05$.

38. To change the divisor 5.27 into a whole number, move each decimal point two places to the right. Move the decimal point straight up and divide as with whole numbers.
$$\begin{array}{r} 8.44 \\ 527\overline{)4447.88} \\ \underline{4216} \\ 2318 \\ \underline{2108} \\ 2108 \\ \underline{2108} \\ 0 \end{array}$$
Therefore, $44.4788 \div 5.27 = 8.44$.

39. Move the decimal point one place to the right.
$123.26 \times 10 = 1232.6$

40. Move the decimal point one place to the right.
$785.91 \times 10 = 7859.1$

41. Move the decimal point two places to the right.
$57.116 \times 100 = 5711.6$

42. Move the decimal point two places to the right.
$82.053 \times 100 = 8205.3$

43. Move the decimal point three places to the right.
$0.094 \times 1000 = 94$

44. Move the decimal point three places to the right.
$0.025 \times 1000 = 25$

45. Move the decimal point one place to the left.
$1.62 \div 10 = 0.162$

46. Move the decimal point one place to the left.
$8.04 \div 10 = 0.804$

47. Move the decimal point two places to the left.
$124.03 \div 100 = 1.2403$

48. Move the decimal point two places to the left.
$490.35 \div 100 = 4.9035$

49. Move the decimal point three places to the left.
$23.29 \div 1000 = 023.29 \div 1000 = 0.02329$

50. Move the decimal point three places to the left.
$59.8 \div 1000 = 059.8 \div 1000 = 0.0598$

51. Convert from a decimal to a percent.
$0.01 = 0.01 \cdot 100\% = 1\%$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{100}$	0.01	1%

52. Convert from a percent to a decimal.

$2\% = \frac{2}{100} = 0.02$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{50}$	0.02	2%

53. Convert from a percent to a fraction.

$5\% = \frac{5}{100}$

In lowest terms,

$\frac{5}{100} = \frac{1 \cdot 5}{20 \cdot 5} = \frac{1}{20}$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{20}$	0.05	5%

54. Convert to a decimal first. Divide 1 by 10. Move the decimal point one place to the left.

$1 \div 10 = 0.1$

Convert the decimal to a percent.

$0.1 = 0.1 \cdot 100\% = 10\%$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{10}$	0.1	10%

55. Convert the decimal to a percent.

$0.125 = 0.125 \cdot 100\% = 12.5\%$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{8}$	0.125	12.5%

56. Convert the percent to a decimal first.

$20\% = 0.20, \text{ or } 0.2$

Convert from a percent to a fraction.

$20\% = \frac{20}{100}$

In lowest terms,

$\frac{20}{100} = \frac{1 \cdot 20}{5 \cdot 20} = \frac{1}{5}$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{5}$	0.2	20%

57. Convert to a decimal first. Divide 1 by 4. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.25 \\ 4\overline{)1.00} \\ \underline{8} \\ 20 \\ \underline{20} \\ 0 \end{array}$$

Convert the decimal to a percent.

$0.25 = 0.25 \cdot 100\% = 25\%$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{4}$	0.25	25%

58. Convert to a decimal first. Divide 1 by 3. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.33... \\ 3\overline{)1.00...} \\ \underline{9} \\ 10 \\ \underline{9} \\ 1 \end{array}$$

Note that the pattern repeats. Therefore,

$\frac{1}{3} = 0.\overline{3}.$

Convert the decimal to a percent.

$0.33\overline{3} = 0.33\overline{3} \cdot 100\% = 33.\overline{3}\%, \text{ or } 33\frac{1}{3}\%$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{3}$	$0.\overline{3}$	$33.\overline{3}\%$ or $33\frac{1}{3}\%$

59. Convert the percent to a decimal first.
$50\% = 0.50$, or 0.5
Convert from a percentl to a fraction.
$50\% = \frac{50}{100}$
In lowest terms,
$\frac{50}{100} = \frac{1 \cdot 50}{2 \cdot 50} = \frac{1}{2}$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{1}{2}$	0.5	50%

60. Divide 2 by 3. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.66\ldots \\ 3\overline{)2.00\ldots} \\ \underline{18} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

Note that the pattern repeats. Therefore,
$\frac{2}{3} = 0.\overline{6}.$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{2}{3}$	$0.\overline{6}$	$66.\overline{6}\%$ or $66\frac{2}{3}\%$

61. Convert the decimal to a percent first.
$0.75 = 0.75 \cdot 100\% = 75\%$
Convert from a percent to a fraction.
$75\% = \frac{75}{100}$
In lowest terms,
$\frac{75}{100} = \frac{3 \cdot 25}{4 \cdot 25} = \frac{3}{4}$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
$\frac{3}{4}$	0.75	75%

62. Convert the decimal to a percent.
$1.0 = 1.0 \cdot 100\% = 100\%$

Fraction in Lowest Terms (or Whole Number)	Decimal	Percent
1	1.0	100%

63. Divide 21 by 5. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 4.2 \\ 5\overline{)21.0} \\ \underline{20} \\ 10 \\ \underline{10} \\ 0 \end{array}$$

64. Divide 9 by 5. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 1.8 \\ 5\overline{)9.0} \\ \underline{5} \\ 40 \\ \underline{40} \\ 0 \end{array}$$

65. Divide 9 by 4. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
2.25 \\
4\overline{)9.00} \\
\underline{8} \\
10 \\
\underline{8} \\
20 \\
\underline{20} \\
0
\end{array}
$$

66. Divide 15 by 4. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
3.75 \\
4\overline{)15.00} \\
\underline{12} \\
30 \\
\underline{28} \\
20 \\
\underline{20} \\
0
\end{array}
$$

67. Divide 3 by 8. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
0.375 \\
8\overline{)3.000} \\
\underline{24} \\
60 \\
\underline{56} \\
40 \\
\underline{40} \\
0
\end{array}
$$

68. Divide 7 by 8. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
0.875 \\
8\overline{)7.000} \\
\underline{64} \\
60 \\
\underline{56} \\
40 \\
\underline{40} \\
0
\end{array}
$$

69. Divide 5 by 9. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
0.555... \\
9\overline{)5.000...} \\
\underline{45} \\
50 \\
\underline{45} \\
50 \\
\underline{45} \\
5
\end{array}
$$

Note that the pattern repeats. Therefore, $\frac{5}{9} = 0.\overline{5}$, or about 0.556.

70. Divide 8 by 9. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
0.888... \\
9\overline{)8.000...} \\
\underline{72} \\
80 \\
\underline{72} \\
80 \\
\underline{72} \\
8
\end{array}
$$

Note that the pattern repeats. Therefore, $\frac{8}{9} = 0.\overline{8}$, or about 0.889.

71. Divide 1 by 6. Add a decimal point and as many 0s as necessary.

$$
\begin{array}{r}
0.166... \\
6\overline{)1.000...} \\
\underline{6} \\
40 \\
\underline{36} \\
40 \\
\underline{36} \\
4
\end{array}
$$

Note that the pattern repeats. Therefore, $\frac{1}{6} = 0.1\overline{6}$, or about 0.167.

72. Divide 5 by 6. Add a decimal point and as many 0s as necessary.

$$\begin{array}{r} 0.833\ldots \\ 6\overline{)5.000\ldots} \\ \underline{48} \\ 20 \\ \underline{18} \\ 20 \\ \underline{18} \\ 2 \end{array}$$

Note that the pattern repeats. Therefore, $\frac{5}{6} = 0.8\overline{3}$, or about 0.833.

73. $54\% = 0.54$

74. $39\% = 0.39$

75. $7\% = 07\% = 0.07$

76. $4\% = 04\% = 0.04$

77. $117\% = 1.17$

78. $189\% = 1.89$

79. $2.4\% = 02.4\% = 0.024$

80. $3.1\% = 03.1\% = 0.031$

81. $6\frac{1}{4}\% = 6.25\% = 06.25\% = 0.0625$

82. $5\frac{1}{2}\% = 5.5\% = 05.5\% = 0.055$

83. $0.8\% = 00.8\% = 0.008$

84. $0.9\% = 00.9\% = 0.009$

85. $0.79 = 79\%$

86. $0.83 = 83\%$

87. $0.02 = 2\%$

88. $0.08 = 8\%$

89. $0.004 = 0.4\%$

90. $0.005 = 0.5\%$

91. $1.28 = 128\%$

92. $2.35 = 235\%$

93. $0.40 = 40\%$

94. $0.6 = 0.60 = 60\%$

95. $6 = 6.00 = 600\%$

96. $10 = 10.00 = 1000\%$

97. $51\% = \frac{51}{100}$

98. $47\% = \frac{47}{100}$

99. $15\% = \frac{15}{100}$

In lowest terms,

$\frac{15}{100} = \frac{3 \cdot 5}{20 \cdot 5} = \frac{3}{20}$

100. $35\% = \frac{35}{100}$

In lowest terms,

$\frac{35}{100} = \frac{7 \cdot 5}{20 \cdot 5} = \frac{7}{20}$

101. $2\% = \frac{2}{100}$

In lowest terms,

$\frac{2}{100} = \frac{1 \cdot 2}{50 \cdot 2} = \frac{1}{50}$

102. $8\% = \frac{8}{100}$

In lowest terms,

$\frac{8}{100} = \frac{2 \cdot 4}{25 \cdot 4} = \frac{2}{25}$

103. $140\% = \frac{140}{100}$

In lowest terms,

$\frac{140}{100} = \frac{7 \cdot 20}{5 \cdot 20} = \frac{7}{5}$, or $1\frac{2}{5}$

104. $180\% = \frac{180}{100}$

In lowest terms,

$\frac{180}{100} = \frac{9 \cdot 20}{5 \cdot 20} = \frac{9}{5}$, or $1\frac{4}{5}$

105. $7.5\% = \frac{7.5}{100} = \frac{7.5}{100} \cdot \frac{10}{10} = \frac{75}{1000}$

In lowest terms,

$\frac{75}{1000} = \frac{3 \cdot 25}{40 \cdot 25} = \frac{3}{40}$

106. $2.5\% = \frac{2.5}{100} = \frac{2.5}{100} \cdot \frac{10}{10} = \frac{25}{1000}$

In lowest terms,

$\frac{25}{1000} = \frac{1 \cdot 25}{40 \cdot 25} = \frac{1}{40}$

107. $\frac{4}{5} = \frac{4}{5} \cdot 100\% = \frac{4}{5} \cdot \frac{100}{1}\% = \frac{4 \cdot 5 \cdot 20}{5}\% = 80\%$

108. $\frac{3}{25} = \frac{3}{25} \cdot 100\%$
$= \frac{3}{25} \cdot \frac{100}{1}\%$
$= \frac{3 \cdot 4 \cdot 25}{25}\%$
$= 12\%$

109. $\frac{7}{50} = \frac{7}{50} \cdot 100\%$
$= \frac{7}{50} \cdot \frac{100}{1}\%$
$= \frac{7 \cdot 2 \cdot 50}{50}\%$
$= 14\%$

110. $\frac{9}{20} = \frac{9}{20} \cdot 100\%$
$= \frac{9}{20} \cdot \frac{100}{1}\%$
$= \frac{9 \cdot 5 \cdot 20}{20}\%$
$= 45\%$

111. $\frac{2}{11} = \frac{2}{11} \cdot 100\%$
$= \frac{2}{11} \cdot \frac{100}{1}\%$
$= \frac{200}{11}\%$
$= 18.\overline{18}\%$

112. $\frac{4}{9} = \frac{4}{9} \cdot 100\% = \frac{4}{9} \cdot \frac{100}{1}\% = \frac{400}{9}\% = 44.\overline{4}\%$

113. $\frac{9}{4} = \frac{9}{4} \cdot 100\% = \frac{9}{4} \cdot \frac{100}{1}\% = \frac{9 \cdot 4 \cdot 25}{4}\% = 225\%$

114. $\frac{8}{5} = \frac{8}{5} \cdot 100\% = \frac{8}{5} \cdot \frac{100}{1}\% = \frac{8 \cdot 5 \cdot 20}{5}\% = 160\%$

115. $\frac{13}{6} = \frac{13}{6} \cdot 100\%$
$= \frac{13}{6} \cdot \frac{100}{1}\%$
$= \frac{13 \cdot 2 \cdot 50}{2 \cdot 3}\%$
$= 216.\overline{6}\%$

116. $\frac{31}{9} = \frac{31}{9} \cdot 100\%$
$= \frac{31}{9} \cdot \frac{100}{1}\%$
$= \frac{3100}{9}\%$
$= 344.\overline{4}\%$

117. The word *of* here means multiply.

$$\begin{array}{ccccc} 50\% & \text{of} & 320 & & \\ \downarrow & \downarrow & \downarrow & & \\ 0.50 & \cdot & 320 & = 160 \end{array}$$

118. The word *of* here means multiply.

$$\begin{array}{ccccc} 25\% & \text{of} & 120 & & \\ \downarrow & \downarrow & \downarrow & & \\ 0.25 & \cdot & 120 & = 30 \end{array}$$

119. The word *of* here means multiply.

$$\begin{array}{ccccc} 6\% & \text{of} & 80 & & \\ \downarrow & \downarrow & \downarrow & & \\ 0.06 & \cdot & 80 & = 4.8 \end{array}$$

120. The word *of* here means multiply.

$$\begin{array}{ccccc} 5\% & \text{of} & 70 & & \\ \downarrow & \downarrow & \downarrow & & \\ 0.05 & \cdot & 70 & = 3.5 \end{array}$$

121. The word *of* here means multiply.

$$\begin{array}{ccccc} 14\% & \text{of} & 780 & & \\ \downarrow & \downarrow & \downarrow & & \\ 0.14 & \cdot & 780 & = 109.2 \end{array}$$

122. The word *of* here means multiply.

$$\begin{array}{ccccc} 26\% & \text{of} & 480 & & \\ \downarrow & \downarrow & \downarrow & & \\ 0.26 & \cdot & 480 & = 124.8 \end{array}$$

123. The tip is 20% of \$89. The word *of* here means multiply.

$$\begin{array}{ccc} 20\% & \text{of} & \$89 \\ \downarrow & \downarrow & \downarrow \\ 0.20 & \cdot & \$89 \end{array} = \$17.80$$

The tip is \$17.80. The total bill is found by adding.

$\$89 + \$17.80 = \$106.80$

124. The raise is 7% of \$15. The word *of* here means multiply.

$$\begin{array}{ccc} 7\% & \text{of} & \$15 \\ \downarrow & \downarrow & \downarrow \\ 0.07 & \cdot & \$15 \end{array} = \$1.05$$

The amount of the raise is \$1.05 per hour. The new hourly rate is found by adding.

$\$15 + \$1.05 = \$16.05$

125. The discount is 15% of \$795. The word *of* here means multiply.

$$\begin{array}{ccc} 15\% & \text{of} & \$795 \\ \downarrow & \downarrow & \downarrow \\ 0.15 & \cdot & \$795 \end{array} = \$119.25$$

The amount of the discount is \$119.25. The sale price is found by subtracting.

$\$795 - \$119.25 = \$675.75$

126. The discount is 20% of \$597. The word *of* here means multiply.

$$\begin{array}{ccc} 20\% & \text{of} & \$597 \\ \downarrow & \downarrow & \downarrow \\ 0.20 & \cdot & \$597 \end{array} = \$119.40$$

The amount of the discount is \$119.40. The sale price is found by subtracting.

$\$597 - \$119.40 = \$477.60$

127. The portion of the circle graph showing the number of travelers from Canada is 26% of the circle. Find 26% of 76 million.

$$\begin{array}{ccc} 26\% & \text{of} & 76 \text{ million} \\ \downarrow & \downarrow & \downarrow \\ 0.26 & \cdot & 76 \text{ million} \end{array} = 19.76 \text{ million},$$

or approximately 19,760,000 travelers.

128. The portion of the circle graph showing the number of travelers from Mexico is 25% of the circle. Find 25% of 76 million.

$$\begin{array}{ccc} 25\% & \text{of} & 76 \text{ million} \\ \downarrow & \downarrow & \downarrow \\ 0.25 & \cdot & 76 \text{ million} \end{array} = 19 \text{ million},$$

or approximately 19,000,000 travelers.

129. First, find the portion of the circle graph that represents "Other."

$100\% - (26\% + 25\% + 19\% + 15\%) = 15\%$

The portion of the circle graph showing the number of travelers from "Other" countries is 15% of the circle.

130. The portion of the circle graph showing the number of travelers from "Other" countries is 15% of the circle. Find 15% of 76 million.

$$\begin{array}{ccc} 15\% & \text{of} & 76 \text{ million} \\ \downarrow & \downarrow & \downarrow \\ 0.15 & \cdot & 76 \text{ million} \end{array} = 11.4 \text{ million},$$

or approximately 11,400,000 travelers.

Chapter 1
The Real Number System

1.1 Exponents, Order of Operations, and Inequality

Classroom Examples, Now Try Exercises

1. (a) $9^2 = 9 \cdot 9 = 81$

(b) $\left(\frac{1}{2}\right)^4 = \underbrace{\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}} = \frac{1}{16}$

$\frac{1}{2}$ is used as a factor 4 times.

(c) $(0.5)^2 = 0.5 \cdot 0.5 = 0.25$

N1. (a) $6^2 = 6 \cdot 6 = 36$

(b) $\left(\frac{4}{5}\right)^3 = \underbrace{\frac{4}{5} \cdot \frac{4}{5} \cdot \frac{4}{5}} = \frac{64}{125}$

$\frac{4}{5}$ is used as a factor 3 times.

(c) $(0.7)^2 = 0.7 \cdot 0.7 = 0.49$

2. (a) $10 - 6 \div 2$

$= 10 - 3$ Divide.

$= 7$ Subtract.

(b) $18 + 2(6 - 3)$

$= 18 + 2(3)$ Subtract inside parentheses.

$= 18 + 6$ Multiply.

$= 24$ Add.

(c) $7 \cdot 6 - 3(8 + 1)$

$= 7 \cdot 6 - 3(9)$ Add inside parentheses.

$= 42 - 27$ Multiply.

$= 15$ Subtract.

(d) $2 + 3^2 - 5 \cdot 2$

$= 2 + 9 - 5 \cdot 2$ Apply exponents.

$= 2 + 9 - 10$ Multiply.

$= 11 - 10$ Add.

$= 1$ Subtract.

N2. (a) $15 - 2 \cdot 6$

$= 15 - 12$ Multiply.

$= 3$ Subtract.

(b) $8 + 2(5 - 1)$

$= 8 + 2(4)$ Subtract inside parentheses.

$= 8 + 8$ Multiply.

$= 16$ Add.

(c) $6(2 + 4) - 7 \cdot 5$

$= 6(6) - 7 \cdot 5$ Add inside parentheses.

$= 36 - 35$ Multiply.

$= 1$ Subtract.

(d) $8 \cdot 10 \div 4 - 2^3 + 3 \cdot 4^2$

$= 8 \cdot 10 \div 4 - 8 + 3 \cdot 16$ Apply exponents.

$= 80 \div 4 - 8 + 3 \cdot 16$ Multiply.

$= 20 - 8 + 48$ Divide/multiply.

$= 12 + 48$ Subtract.

$= 60$ Add.

3. (a) $9[36 - 2(4 + 8)]$

$= 9[36 - 2(12)]$ Add inside parentheses.

$= 9[36 - 24]$ Multiply inside brackets.

$= 9[12]$ Subtract inside brackets.

$= 108$ Multiply.

(b) $\frac{2(7+8)+2}{3 \cdot 5 + 1}$

$= \frac{2(15)+2}{3 \cdot 5 + 1}$ Add inside parentheses.

$= \frac{30+2}{15+1}$ Multiply.

$= \frac{32}{16}$ Add.

$= 2$ Divide.

N3. (a) $7[3(3 - 1) + 4]$

$= 7[3(2) + 4]$ Subtract inside parentheses.

$= 7[6 + 4]$ Multiply inside brackets.

$= 7[10]$ Add inside brackets.

$= 70$ Multiply.

(b) $\dfrac{9(14-4)-2}{4+3\cdot 6}$

$=\dfrac{9(10)-2}{4+3\cdot 6}$ Subtract inside parentheses.

$=\dfrac{90-2}{4+18}$ Multiply.

$=\dfrac{88}{22}$ Subtract and add.

$=4$ Divide.

4. **(a)** The statement $12>6$ is *true* because 12 is greater than 6. Note that the inequality symbol points to the lesser number.

(b) The statement $28\neq 4\cdot 7$ is *false* because 28 *is equal to* $4\cdot 7$.

(c) The statement $\frac{1}{10}\leq 0.1$ is *true* because $\frac{1}{10}=0.1$

(d) Write the fractions with a common denominator. The statement $\frac{1}{3}<\frac{1}{4}$ is equivalent to the statement $\frac{4}{12}<\frac{3}{12}$. Because 4 is *greater* than 3, the original statement is *false*.

N4. **(a)** The statement $12\neq 10-2$ is *true* because 12 *is not equal to* 8.

(b) The statement $5>4\cdot 2$ is *false* because 5 *is less than* 8.

(c) The statement $\frac{1}{4}\leq 0.25$ is *true* because $\frac{1}{4}=0.25$

(d) Write the fractions with a common denominator. The statement $\frac{5}{9}>\frac{7}{11}$ is equivalent to the statement $\frac{55}{99}>\frac{63}{99}$. Because 55 is *less* than 63, the original statement is *false*.

5. **(a)** "Nine is equal to eleven minus two" is written as $9=11-2$.

(b) "Fourteen is greater than twelve" is written as $14>12$.

(c) "Two is greater than or equal to two" is written as $2\geq 2$.

N5. **(a)** "Ten is not equal to eight minus two" is written as $10\neq 8-2$.

(b) "Fifty is greater than fifteen" is written as $50>15$.

(c) "Eleven is less than or equal to twenty" is written as $11\leq 20$.

6. $9\leq 15$ is equivalent to $15\geq 9$.

N6. $8<9$ is equivalent to $9>8$.

Exercises

1. False; $3^2=3\cdot 3=9$.

2. False; 1 raised to *any* power is 1. Here, $1^3=1\cdot 1\cdot 1=1$.

3. False; a number raised to the first power is that number, so $3^1=3$.

4. False; 6^2 means that 6 is used as a factor 2 times, so $6^2=6\cdot 6=36$.

5. False; the common error leading to 42 is adding 4 to 3 and then multiplying by 6. One must follow the rules for order of operations.

$4+3(8-2)$
$=4+3(6)$
$=4+18$
$=22$

6. False; multiplications and divisions are performed *in order from left to right.*

$12\div 2\cdot 3$
$=6\cdot 3$
$=18$

7. Additions and subtractions are performed in order from left to right.

$18\underbrace{-}_{1}2\underbrace{+}_{2}3$

8. Multiplications and divisions are performed in order from left to right, and then additions and subtractions are performed in order from left to right.

$28\underbrace{-}_{2}6\underbrace{\div}_{1}2$

9. Multiplications and divisions are performed in order from left to right, and then additions and subtractions are performed in order from left to right.
$2\underset{1}{\cdot}8\underset{3}{-}6\underset{2}{\div}3$

10. Multiplications and divisions are performed in order from left to right, and then additions and subtractions are performed in order from left to right. If grouping symbols are present, work within them first, starting with the innermost.
$40\underset{3}{+}6\underset{2}{\,}(3\underset{1}{-}1)$

11. Multiplications and divisions are performed in order from left to right, and then additions and subtractions are performed in order from left to right. If grouping symbols are present, work within them first, starting with the innermost.
$3\underset{2}{\cdot}5\underset{4}{-}2\underset{3}{\,}(4\underset{1}{+}2)$

12. Apply all exponents. Then, multiplications and divisions are performed in order from left to right, and additions and subtractions are performed in order from left to right.
$9\underset{3}{-}\underset{1}{2^3}\underset{4}{+}3\underset{2}{\cdot}4$

13. $7^2 = 7\cdot 7 = 49$

14. $8^2 = 8\cdot 8 = 64$

15. $12^2 = 12\cdot 12 = 144$

16. $14^2 = 14\cdot 14 = 196$

17. $4^3 = 4\cdot 4\cdot 4 = 64$

18. $5^3 = 5\cdot 5\cdot 5 = 125$

19. $10^3 = 10\cdot 10\cdot 10 = 1000$

20. $11^3 = 11\cdot 11\cdot 11 = 1331$

21. $3^4 = 3\cdot 3\cdot 3\cdot 3 = 81$

22. $6^4 = 6\cdot 6\cdot 6\cdot 6 = 1296$

23. $4^5 = 4\cdot 4\cdot 4\cdot 4\cdot 4 = 1024$

24. $3^5 = 3\cdot 3\cdot 3\cdot 3\cdot 3 = 243$

25. $\left(\frac{1}{6}\right)^2 = \frac{1}{6}\cdot\frac{1}{6} = \frac{1}{36}$

26. $\left(\frac{1}{3}\right)^2 = \frac{1}{3}\cdot\frac{1}{3} = \frac{1}{9}$

27. $\left(\frac{2}{3}\right)^4 = \frac{2}{3}\cdot\frac{2}{3}\cdot\frac{2}{3}\cdot\frac{2}{3} = \frac{16}{81}$

28. $\left(\frac{3}{4}\right)^3 = \frac{3}{4}\cdot\frac{3}{4}\cdot\frac{3}{4} = \frac{27}{64}$

29. $(0.6)^2 = 0.6\cdot 0.6 = 0.36$

30. $(0.9)^2 = 0.9\cdot 0.9 = 0.81$

31. $(0.4)^3 = 0.4\cdot 0.4\cdot 0.4 = 0.064$

32. $(0.5)^4 = 0.5\cdot 0.5\cdot 0.5\cdot 0.5 = 0.0625$

33. The multiplication should be performed before the addition.
$8 + 2\cdot 3 = 8 + 6$ Multiply.
$= 14$ Add.
The correct value of the expression is 14.

34. When cubing 2, the correct value is $2\cdot 2\cdot 2 = 8$, *not* $2\cdot 3 = 6$.
$16 - 2^3 + 5 = 16 - 8 + 5$ Apply exponents.
$= 8 + 5$ Subtract.
$= 13$ Add.
The correct value of the expression is 13.

35. $64 \div 4\cdot 2 = 16\cdot 2$ Divide.
$= 32$ Multiply.

36. $250 \div 5\cdot 2 = 50\cdot 2$ Divide.
$= 100$ Multiply.

37. $13 + 9\cdot 5 = 13 + 45$ Multiply.
$= 58$ Add.

38. $11 + 7\cdot 6 = 11 + 42$ Multiply.
$= 53$ Add.

39. $25.2 - 12.6 \div 4.2 = 25.2 - 3$ Divide.
$= 22.2$ Subtract.

40. $12.4 - 9.3 \div 3.1 = 12.4 - 3$ Divide.
$= 9.4$ Subtract.

41. $9\cdot 4 - 8\cdot 3 = 36 - 24$ Multiply.
$= 12$ Subtract.

42. $11\cdot 4+10\cdot 3=44+30$ Multiply.
$=74$ Add.

43. $\frac{1}{4}\cdot\frac{2}{3}+\frac{2}{5}\cdot\frac{11}{3}=\frac{1}{6}+\frac{22}{15}$ Multiply.
$=\frac{5}{30}+\frac{44}{30}$ LCD = 30
$=\frac{49}{30}$, or $1\frac{19}{30}$ Add.

44. $\frac{9}{4}\cdot\frac{2}{3}+\frac{4}{5}\cdot\frac{5}{3}=\frac{3}{2}+\frac{4}{3}$ Multiply.
$=\frac{9}{6}+\frac{8}{6}$ LCD = 6
$=\frac{17}{6}$, or $2\frac{5}{6}$ Add.

45. $20-4\cdot 3+5=20-12+5$ Multiply.
$=8+5$ Subtract.
$=13$ Add.

46. $18-7\cdot 2+6=18-14+6$ Multiply.
$=4+6$ Subtract.
$=10$ Add.

47. $10+40\div 5\cdot 2=10+8\cdot 2$ Divide.
$=10+16$ Multiply.
$=26$ Add.

48. $12+64\div 8-4=12+8-4$ Divide.
$=20-4$ Add.
$=16$ Subtract.

49. $18-2(3+4)$
$=18-2(7)$ Add inside parentheses.
$=18-14$ Multiply.
$=4$ Subtract.

50. $30-3(4+2)$
$=30-3(6)$ Add inside parentheses.
$=30-18$ Multiply.
$=12$ Subtract.

51. $3(4+2)+8\cdot 3=3\cdot 6+8\cdot 3$ Add.
$=18+24$ Multiply.
$=42$ Add.

52. $9(1+7)+2\cdot 5=9\cdot 8+2\cdot 5$ Add.
$=72+10$ Multiply.
$=82$ Add.

53. $18-4^2+3=18-16+3$ Apply exponents.
$=2+3$ Subtract.
$=5$ Add.

54. $22-2^3+9=22-8+9$ Apply exponents.
$=14+9$ Subtract.
$=23$ Add.

55. $2+3[5+4(2)]=2+3[5+8]$ Multiply.
$=2+3[13]$ Add.
$=2+39$ Multiply.
$=41$ Add.

56. $5+4[1+7(3)]=5+4[1+21]$ Multiply.
$=5+4[22]$ Add.
$=5+88$ Multiply.
$=93$ Add.

57. $5\left[3+4\left(2^2\right)\right]=5[3+4(4)]$ Apply exponents.
$=5(3+16)$ Multiply.
$=5(19)$ Add.
$=95$ Multiply.

58. $6\left[2+8\left(3^3\right)\right]$
$=6[2+8\cdot 27]$ Apply exponents.
$=6(2+216)$ Multiply.
$=6\cdot 218$ Add.
$=1308$ Multiply.

59. $3^2[(11+3)-4]$
$=3^2[14-4]$ Add inside parentheses.
$=3^2[10]$ Subtract.
$=9[10]$ Apply exponents.
$=90$ Multiply.

60. $4^2[(13+4)-8]$
$=4^2[17-8]$ Add inside parentheses.
$=4^2[9]$ Subtract.
$=16[9]$ Apply exponents.
$=144$ Multiply.

61. Simplify the numerator and denominator separately, and then divide.

$$\frac{6\left(3^2-1\right)+8}{8-2^2}=\frac{6(9-1)+8}{8-4}=\frac{6(8)+8}{4}=\frac{48+8}{4}=\frac{56}{4}=14$$

62. Simplify the numerator and denominator separately, and then divide.

$$\frac{2\left(8^2-4\right)+8}{29-3^3}=\frac{2(64-4)+8}{29-27}=\frac{2(60)+8}{2}=\frac{120+8}{2}=\frac{128}{2}=64$$

63. Simplify the numerator and denominator separately, and then divide.

$$\frac{4(6+2)+8(8-3)}{6(4-2)-2^2}=\frac{4(8)+8(5)}{6(2)-2^2}=\frac{4(8)+8(5)}{6(2)-4}=\frac{32+40}{12-4}=\frac{72}{8}=9$$

64. Simplify the numerator and denominator separately, and then divide.

$$\frac{6(5+1)-9(1+1)}{5(8-6)-2^3}=\frac{6(6)-9(2)}{5(2)-2^3}=\frac{36-18}{10-8}=\frac{18}{2}=9$$

65. $3\cdot 6+4\cdot 2=60$

Listed below are some possibilities. Use trial and error until you get the desired result.

$(3\cdot 6)+4\cdot 2=18+8=26\neq 60$

$(3\cdot 6+4)\cdot 2=22\cdot 2=44\neq 60$

$3\cdot(6+4\cdot 2)=3\cdot 14=42\neq 60$

$3\cdot(6+4)\cdot 2=3\cdot 10\cdot 2=30\cdot 2=60$

66. $2\cdot 8-1\cdot 3=42$

$2\cdot(8-1)\cdot 3=2\cdot 7\cdot 3=14\cdot 3=42$

67. $10-7-3=6$

$10-(7-3)=10-4=6$

68. $8+2^2=100$

$(8+2)^2=10^2=10\cdot 10=100$

69. $9\cdot 3-11\le 16$

$27-11\le 16$

$16\le 16$

The statement is true since $16=16$.

70. $6\cdot 5-12\le 18$

$30-12\le 18$

$18\le 18$

The statement is true since $18=18$.

71. $5\cdot 11+2\cdot 3\le 60$

$55+6\le 60$

$61\le 60$

The statement is false since 61 *is greater than* 60.

72. $9\cdot 3+4\cdot 5\ge 48$

$27+20\ge 48$

$47\ge 48$

The statement is false since 47 *is less than* 48.

73. $0\ge 12\cdot 3-6\cdot 6$

$0\ge 36-36$

$0\ge 0$

The statement is true since $0=0$.

74. $10\le 13\cdot 2-15\cdot 1$

$10\le 26-15$

$10\le 11$

The statement is true since $10<11$.

75. $45\ge 2[2+3(2+5)]$

$45\ge 2[2+3(7)]$

$45\ge 2[2+21]$

$45\ge 2[23]$

$45\ge 46$

The statement is false since 45 *is less than* 46.

76. $55 \geq 3[4+3(4+1)]$
$55 \geq 3[4+3(5)]$
$55 \geq 3[4+15]$
$55 \geq 3[19]$
$55 \geq 57$
The statement is false since 55 *is less than* 57.

77. $[3 \cdot 4+5(2)] \cdot 3 > 72$
$[12+10] \cdot 3 > 72$
$[22] \cdot 3 > 72$
$66 > 72$
The statement is false since 66 *is less than* 72.

78. $2 \cdot [7 \cdot 5-3(2)] \leq 58$
$2 \cdot [35-6] \leq 58$
$2[29] \leq 58$
$58 \leq 58$
The statement is true since $58 = 58$.

79. $\frac{3+5(4-1)}{2 \cdot 4+1} \geq 3$
$\frac{3+5(3)}{8+1} \geq 3$
$\frac{3+15}{9} \geq 3$
$\frac{18}{9} \geq 3$
$2 \geq 3$
The statement is false since 2 *is less than* 3.

80. $\frac{7(3+1)-2}{3+5 \cdot 2} \leq 2$
$\frac{7(4)-2}{3+10} \leq 2$
$\frac{28-2}{13} \leq 2$
$\frac{26}{13} \leq 2$
$2 \leq 2$
The statement is true since $2 = 2$.

81. $3 \geq \frac{2(5+1)-3(1+1)}{5(8-6)-4 \cdot 2}$
$3 \geq \frac{2(6)-3(2)}{5(2)-8}$
$3 \geq \frac{12-6}{10-8}$
$3 \geq \frac{6}{2}$
$3 \geq 3$
The statement is true since $3 = 3$.

82. $7 \leq \frac{3(8-3)+2(4-1)}{9(6-2)-11(5-2)}$
$7 \leq \frac{3(5)+2(3)}{9(4)-11(3)}$
$7 \leq \frac{15+6}{36-33}$
$7 \leq \frac{21}{3}$
$7 \leq 7$
The statement is true since $7 = 7$.

83. "$5 < 17$" means "five is less than seventeen." The statement is true.

84. "$8 < 12$" means "eight is less than twelve." The statement is true.

85. "$5 \neq 8$" means "five is not equal to eight." The statement is true.

86. "$6 \neq 9$" means "six is not equal to nine." The statement is true.

87. "$7 \geq 14$" means "seven is greater than or equal to fourteen." The statement is false.

88. "$6 \geq 12$" means "six is greater than or equal to twelve." The statement is false.

89. "$15 \leq 15$" means "fifteen is less than or equal to fifteen." The statement is true.

90. "$21 \leq 21$" means "twenty-one is less than or equal to twenty-one." The statement is true.

91. "$\frac{1}{3} = \frac{3}{10}$" means "one-third is equal to three-tenths." The statement is false.

92. "$\frac{10}{6} = \frac{3}{2}$" means "ten-sixths is equal to three-halves." The statement is false.

93. "$2.5 > 2.50$" means "two and five-tenths is greater than two and fifty-hundredths." The statement is false.

94. "$1.80 > 1.8$" means "one and eighty-hundredths is greater than one and eight-tenths." The statement is false.

95. "Fifteen is equal to five plus ten" is written as $15 = 5 + 10$.

96. "Twelve is equal to twenty minus eight" is written as $12 = 20 - 8$.

97. "Nine is greater than five minus four" is written as $9 > 5 - 4$.

98. "Ten is greater than six plus one" is written as $10 > 6 + 1$.

99. "Sixteen is not equal to nineteen" is written as $16 \neq 19$.

100. "Three is not equal to four" is written as $3 \neq 4$.

101. "One-half is less than or equal to two-fourths" is written as $\frac{1}{2} \leq \frac{2}{4}$.

102. "One-third is less than or equal to three-ninths" is written as $\frac{1}{3} \leq \frac{3}{9}$.

103. $5 < 20$ becomes $20 > 5$ when the inequality symbol is reversed.

104. $30 > 9$ becomes $9 < 30$ when the inequality symbol is reversed.

105. $\frac{4}{5} > \frac{3}{4}$ becomes $\frac{3}{4} < \frac{4}{5}$ when the inequality symbol is reversed.

106. $\frac{5}{4} < \frac{3}{2}$ becomes $\frac{3}{2} > \frac{5}{4}$ when the inequality symbol is reversed.

107. $2.5 \geq 1.3$ becomes $1.3 \leq 2.5$ when the inequality symbol is reversed.

108. $4.1 \leq 5.3$ becomes $5.3 \geq 4.1$ when the inequality symbol is reversed.

109. **(a)** Substitute "40" for "age" in the expression for women.
$14.7 - 40 \cdot 0.13$

(b) $14.7 - 40 \cdot 0.13 = 14.7 - 5.2$ Multiply.
$= 9.5$ Subtract.

(c) 85% of 9.5 is $0.85(9.5) = 8.075$.
Walking at 5 mph is associated with 8.0 METs, which is the table value closest to 8.075.

(d) Substitute "55" for "age" in the expression for men.
$14.7 - 55 \cdot 0.11$

$14.7 - 55 \cdot 0.11 = 14.7 - 6.05$ Multiply.
$= 8.65$ Subtract.

85% of 8.65 is $0.85(8.65) = 7.3525$.
Swimming is associated with 7.0 METs, which is the table value closest to 7.3525.

110. Answers will vary.

111. The states that had a number greater than 12.6 are Alaska (16.4), Texas (15.2), California (22.5), and Idaho (19.7).

112. The states that had a number that was at most 15.2 are Texas (15.2), Virginia (12.6), Maine (12.4), and Missouri (12.1).

113. The states that had a number *not* less than 12.6, which is the same as greater than or equal to 12.6, are Alaska (16.4), Texas (15.2), California (22.5), Virginia (12.6), and Idaho (19.7).

114. The states that had a number less than 13.0 are Virginia (12.6), Maine (12.4), and Missouri (12.1).

1.2 Variables, Expressions, and Equations

Classroom Examples, Now Try Exercises

1. **(a)** $16p - 8 = 16 \cdot 3 - 8$ Replace p with 3.
$= 48 - 8$ Multiply.
$= 40$ Subtract.

(b) $2p^3 = 2 \cdot 3^3$ Replace p with 3.
$= 2 \cdot 27$ Cube 3.
$= 54$ Multiply.

N1. **(a)** $9x - 5 = 9 \cdot 6 - 5$ Replace x with 6.
$= 54 - 5$ Multiply.
$= 49$ Subtract.

(b) $4x^2 = 4 \cdot 6^2$ Replace x with 6.
$= 4 \cdot 36$ Square 6.
$= 144$ Multiply.

2. **(a)** $4x+5y=4\cdot 6+5\cdot 9$

$=24+45$ Multiply.

$=69$ Add.

(b) $\frac{4x-2y}{x+1}=\frac{4\cdot 6-2\cdot 9}{6+1}$

$=\frac{24-18}{6+1}$ Multiply.

$=\frac{6}{7}$ Subtract and add.

(c) $2x^2+y^2=2\cdot 6^2+9^2$

$=2\cdot 36+81$ Use exponents.

$=72+81$ Multiply.

$=153$ Add.

N2. **(a)** $3x+4y=3\cdot 4+4\cdot 7$

$=12+28$ Multiply.

$=40$ Add.

(b) $\frac{6x-2y}{2y-9}=\frac{6\cdot 4-2\cdot 7}{2\cdot 7-9}$

$=\frac{24-14}{14-9}$ Multiply.

$=\frac{10}{5}=2$ Subtract; reduce.

(c) $4x^2-y^2=4\cdot 4^2-7^2$

$=4\cdot 16-49$ Use exponents.

$=64-49$ Multiply.

$=15$ Subtract.

3. **(a)** "The difference of" indicates subtraction. Using x as the variable to represent the number, "the difference of 48 and a number" translates as $48-x$.

(b) "Divided by" indicates division. Using x as the variable to represent the number, "6 divided by a number" translates as $6\div x$ or $\frac{6}{x}$.

(c) "The sum of a number and 5" suggests a number plus 5. Using x as the variable to represent the number, "9 multiplied by the sum of a number and 5" translates as $9(x+5)$.

N3. **(a)** Using x as the variable to represent the number, "the sum of a number and 10" translates as $x+10$, or $10+x$.

(b) "A number divided by 7" translates as $x\div 7$, or $\frac{x}{7}$.

(c) "The difference between 9 and a number" translates as $9-x$. Thus, "the product of 3 and the difference between 9 and a number" translates as $3(9-x)$.

4. **(a)** $8p-10=5$

$8\cdot 2-10\stackrel{?}{=}5$ Replace p with 2.

$16-10\stackrel{?}{=}5$ Multiply.

$6=5$ False

The number 2 is not a solution of the equation.

(b) $0.1(x+3)=0.8$

$0.1(5+3)\stackrel{?}{=}0.8$ Replace x with 5.

$0.1(8)\stackrel{?}{=}0.8$ Add.

$0.8=0.8$ True

The number 5 is a solution of the equation.

N4. $8k+5=61$

$8\cdot 7+5\stackrel{?}{=}61$ Replace k with 7.

$56+5\stackrel{?}{=}61$ Multiply.

$61=61$ True

The number 7 is a solution of the equation.

5. Using x as the variable to represent the number, "three times a number is subtracted from 21, giving 15" translates as $21-3x=15$. Now try each number from the set $\{0, 2, 4, 6, 8, 10\}$.

$x=0$: $21-3(0)\stackrel{?}{=}15$

$21=15$ False

$x=2$: $21-3(2)\stackrel{?}{=}15$

$15=15$ True

$x=4$: $21-3(4)\stackrel{?}{=}15$

$9=15$ False

Similarly, $x=6, 8,$ or 10 result in false statements. Thus, 2 is the only solution.

N5. Using x as the variable to represent the number, "the sum of a number and nine is equal to the difference between 25 and the number" translates as $x+9=25-x$. Now try each number from the set {0, 2, 4, 6, 8, 10}.

$x=4$: $4+9\stackrel{?}{=}25-4$
$13=21$ False

$x=6$: $6+9\stackrel{?}{=}25-6$
$15=19$ False

$x=8$: $8+9\stackrel{?}{=}25-8$
$17=17$ True

Similarly, $x=0, 2,$ or 10 result in false statements. Thus, 8 is the only solution.

6. **(a)** $\frac{3x-1}{5}$ has no equality symbol, so this is an expression.

(b) $\frac{3x}{5}=1$ has an equality symbol, so this is an equation.

N6. **(a)** $2x+5=6$ has an equality symbol, so this is an equation.

(b) $2x+5-6$ has no equality symbol, so this is an expression.

Exercises

1. The expression $8x^2$ means $8\cdot x\cdot x$. The correct choice is B.

2. If $x=2$ and $y=1$, then the value of xy is $2\cdot 1=2$. The correct choice is C.

3. The sum of 15 and a number x is represented by the expression $15+x$. The correct choice is A.

4. 7 less than a number x is represented by the expression $x-7$. The correct choice is D.

5. Try each number in the equation $3x-1=5$.

$x=0$: $3\cdot 0-1\stackrel{?}{=}5$
$0-1\stackrel{?}{=}5$
$-1=5$ False

$x=2$: $3\cdot 2-1\stackrel{?}{=}5$
$6-1\stackrel{?}{=}5$
$5=5$ False

6. There is no equality symbol in $6x+7$ or $6x-7$, so those are expressions. $6x=7$ and $6x-7=0$ have equality symbols, so those are equations.

7. The exponent refers only to the 4.

$$\begin{aligned}5x^2&=5\cdot 4^2\\&=5\cdot 16\\&=80\end{aligned}$$

The correct value is 80.

8. Addition in the numerator comes before division.

$$\begin{aligned}\frac{x+3}{5}&=\frac{10+3}{5}\\&=\frac{13}{5}\end{aligned}$$

The correct value is $\frac{13}{5}$.

9. **(a)** $x+7=4+7$
$=11$

(b) $x+7=6+7$
$=13$

10. **(a)** $x-3=4-3$
$=1$

(b) $x-3=6-3$
$=3$

11. **(a)** $4x=4\cdot 4=16$

(b) $4x=4\cdot 6=24$

12. **(a)** $6x=6\cdot 4=24$

(b) $6x=6\cdot 6=36$

13. **(a)** $5x-4=5\cdot 4-4$
$=20-4$
$=16$

(b) $5x-4=5\cdot 6-4$
$=30-4$
$=26$

14. **(a)** $7x-9=7\cdot 4-9$
$=28-9$
$=19$

(b) $7x-9=7\cdot 6-9$
$=42-9$
$=33$

15. **(a)** $4x^2 = 4\cdot 4^2$
$= 4\cdot 16$
$= 64$

(b) $4x^2 = 4\cdot 6^2$
$= 4\cdot 36$
$= 144$

16. **(a)** $5x^2 = 5\cdot 4^2$
$= 5\cdot 16$
$= 80$

(b) $5x^2 = 5\cdot 6^2$
$= 5\cdot 36$
$= 180$

17. **(a)** $\frac{x+1}{3} = \frac{4+1}{3}$
$= \frac{5}{3}$

(b) $\frac{x+1}{3} = \frac{6+1}{3}$
$= \frac{7}{3}$

18. **(a)** $\frac{x+2}{5} = \frac{4+2}{5}$
$= \frac{6}{5}$

(b) $\frac{x+2}{5} = \frac{6+2}{5}$
$= \frac{8}{5}$

19. **(a)** $\frac{3x-5}{2x} = \frac{3\cdot 4-5}{2\cdot 4}$
$= \frac{12-5}{8}$
$= \frac{7}{8}$

(b) $\frac{3x-5}{2x} = \frac{3\cdot 6-5}{2\cdot 6}$
$= \frac{18-5}{12}$
$= \frac{13}{12}$

20. **(a)** $\frac{4x-1}{3x} = \frac{4\cdot 4-1}{3\cdot 4}$
$= \frac{16-1}{12}$
$= \frac{15}{12} = \frac{5}{4}$

(b) $\frac{4x-1}{3x} = \frac{4\cdot 6-1}{3\cdot 6}$
$= \frac{24-1}{18}$
$= \frac{23}{18}$

21. **(a)** $3x^2 + x = 3\cdot 4^2 + 4$
$= 3\cdot 16 + 4$
$= 48 + 4 = 52$

(b) $3x^2 + x = 3\cdot 6^2 + 6$
$= 3\cdot 36 + 6$
$= 108 + 6 = 114$

22. **(a)** $2x + x^2 = 2\cdot 4 + 4^2$
$= 8 + 16$
$= 24$

(b) $2x + x^2 = 2\cdot 6 + 6^2$
$= 12 + 36$
$= 48$

23. **(a)** $6.459x = 6.459\cdot 4$
$= 25.836$

(b) $6.459x = 6.459\cdot 6$
$= 38.754$

24. **(a)** $3.275x = 3.275\cdot 4$
$= 13.1$

(b) $3.275x = 3.275\cdot 6$
$= 19.65$

25. **(a)** $8x + 3y + 5 = 8\cdot 2 + 3\cdot 1 + 5$
$= 16 + 3 + 5$
$= 19 + 5$
$= 24$

(b) $8x + 3y + 5 = 8\cdot 1 + 3\cdot 5 + 5$
$= 8 + 15 + 5$
$= 23 + 5$
$= 28$

26. **(a)** $4x+2y+7=4(2)+2(1)+7$
$=8+2+7$
$=17$

(b) $4x+2y+7=4(1)+2(5)+7$
$=4+10+7$
$=21$

27. **(a)** $3(x+2y)=3(2+2\cdot 1)$
$=3(2+2)$
$=3(4)$
$=12$

(b) $3(x+2y)=3(1+2\cdot 5)$
$=3(1+10)$
$=3(11)$
$=33$

28. **(a)** $2(2x+y)=2\left[2(2)+1\right]$
$=2(4+1)$
$=2(5)$
$=10$

(b) $2(2x+y)=2\left[2(1)+5\right]$
$=2(2+5)$
$=2(7)$
$=14$

29. **(a)** $x+\frac{4}{y}=2+\frac{4}{1}$
$=2+4$
$=6$

(b) $x+\frac{4}{y}=1+\frac{4}{5}$
$=\frac{5}{5}+\frac{4}{5}$
$=\frac{9}{5}$

30. **(a)** $y+\frac{8}{x}=1+\frac{8}{2}$
$=1+4$
$=5$

(b) $y+\frac{8}{x}=5+\frac{8}{1}$
$=5+8$
$=13$

31. **(a)** $\frac{x}{2}+\frac{y}{3}=\frac{2}{2}+\frac{1}{3}$
$=\frac{6}{6}+\frac{2}{6}$
$=\frac{8}{6}=\frac{4}{3}$

(b) $\frac{x}{2}+\frac{y}{3}=\frac{1}{2}+\frac{5}{3}$
$=\frac{3}{6}+\frac{10}{6}$
$=\frac{13}{6}$

32. **(a)** $\frac{x}{5}+\frac{y}{4}=\frac{2}{5}+\frac{1}{4}$
$=\frac{8}{20}+\frac{5}{20}$
$=\frac{13}{20}$

(b) $\frac{x}{5}+\frac{y}{4}=\frac{1}{5}+\frac{5}{4}$
$=\frac{4}{20}+\frac{25}{20}$
$=\frac{29}{20}$

33. **(a)** $\frac{2x+4y}{5x+2y}=\frac{2\cdot 2+4\cdot 1}{5\cdot 2+2\cdot 1}$
$=\frac{4+4}{10+2}$
$=\frac{8}{12}$
$=\frac{2}{3}$

(b) $\frac{2x+4y}{5x+2y}=\frac{2\cdot 1+4\cdot 5}{5\cdot 1+2\cdot 5}$
$=\frac{2+20}{5+10}$
$=\frac{22}{15}$

34. **(a)** $\frac{7x+5y}{8x+y}=\frac{7(2)+5(1)}{8(2)+1}$
$=\frac{14+5}{16+1}$
$=\frac{19}{17}$

(b) $\frac{7x+5y}{8x+y}=\frac{7(1)+5(5)}{8(1)+5}$
$=\frac{7+25}{8+5}$
$=\frac{32}{13}$

35. **(a)** $3x^2+y^2=3\cdot 2^2+1^2$
$=3\cdot 4+1$
$=12+1$
$=13$

(b) $3x^2+y^2=3\cdot 1^2+5^2$
$=3\cdot 1+25$
$=3+25$
$=28$

36. **(a)** $4x^2+2y^2=4\cdot 2^2+2\cdot 1^2$
$=4\cdot 4+2\cdot 1$
$=16+2$
$=18$

(b) $4x^2+2y^2=4\cdot 1^2+2\cdot 5^2$
$=4\cdot 1+2\cdot 25$
$=4+50$
$=54$

37. **(a)** $\frac{3x+y^2}{2x+3y}=\frac{3\cdot 2+1^2}{2\cdot 2+3\cdot 1}$
$=\frac{3\cdot 2+1}{4+3}$
$=\frac{6+1}{7}$
$=\frac{7}{7}$
$=1$

(b) $\frac{3x+y^2}{2x+3y}=\frac{3\cdot 1+5^2}{2\cdot 1+3\cdot 5}$
$=\frac{3\cdot 1+25}{2+15}$
$=\frac{3+25}{17}$
$=\frac{28}{17}$

38. **(a)** $\frac{x^2+1}{4x+5y}=\frac{2^2+1}{4(2)+5(1)}$
$=\frac{4+1}{8+5}$
$=\frac{5}{13}$

(b) $\frac{x^2+1}{4x+5y}=\frac{1^2+1}{4(1)+5(5)}$
$=\frac{1+1}{4+25}$
$=\frac{2}{29}$

39. **(a)** $0.841x^2+0.32y^2$
$=0.841\cdot 2^2+0.32\cdot 1^2$
$=0.841\cdot 4+0.32\cdot 1$
$=3.364+0.32$
$=3.684$

(b) $0.841x^2+0.32y^2$
$=0.841\cdot 1^2+0.32\cdot 5^2$
$=0.841\cdot 1+0.32\cdot 25$
$=0.841+8$
$=8.841$

40. **(a)** $0.941x^2+0.25y^2$
$=0.941(2)^2+0.25(1)^2$
$=0.941(4)+0.25(1)$
$=3.764+0.25$
$=4.014$

(b) $0.941x^2+0.25y^2$
$=0.941(1)^2+0.25(5)^2$
$=0.941(1)+0.25(25)$
$=0.941+6.25$
$=7.191$

41. "Twelve times a number" translates as $12 \cdot x$, or $12x$.

42. "Fifteen times a number" translates as $15 \cdot x$, or $15x$.

43. "Added to" indicates addition. "Nine added to a number" translates as $x + 9$.

44. "Six added to a number" translates as $x + 6$.

45. "Two subtracted from a number" translates as $x - 2$.

46. "Seven subtracted from a number" translates as $x - 7$.

47. "A number subtracted from seven" translates as $7 - x$.

48. "A number subtracted from four" translates as $4 - x$.

49. "The difference between a number and 8" translates as $x - 8$.

50. "The difference between 8 and a number" translates as $8 - x$.

51. "18 divided by a number" translates as $\frac{18}{x}$.

52. "A number divided by 18" translates as $\frac{x}{18}$.

53. "The product of 6 and four less than a number" translates as $6(x-4)$.

54. "The product of 9 and five more than a number" translates as $9(x+5)$.

55. $4m + 2 = 6; 1$

$4 \cdot 1 + 2 \stackrel{?}{=} 6$ Let $m = 1$.

$4 + 2 \stackrel{?}{=} 6$

$6 = 6$ True

Because substituting 1 for m results in a true statement, 1 is a solution of the equation.

56. $2r + 6 = 8; 1$

$2(1) + 6 \stackrel{?}{=} 8$ Let $r = 1$.

$2 + 6 \stackrel{?}{=} 8$

$8 = 8$ True

The true result shows that 1 is a solution of the equation.

57. $2y + 3(y-2) = 14; 3$

$2 \cdot 3 + 3(3-2) \stackrel{?}{=} 14$ Let $y = 3$.

$2 \cdot 3 + 3 \cdot 1 \stackrel{?}{=} 14$

$6 + 3 \stackrel{?}{=} 14$

$9 = 14$ False

Because substituting 3 for y results in a false statement, 3 is not a solution of the equation.

58. $6x + 2(x+3) = 14; 2$

$6(2) + 2(2+3) \stackrel{?}{=} 14$ Let $x = 2$.

$6(2) + 2(5) \stackrel{?}{=} 14$

$12 + 10 \stackrel{?}{=} 14$

$22 = 14$ False

The false result shows that 2 is not a solution of the equation.

59. $6p + 4p + 9 = 11; \frac{1}{5}$

$6 \cdot \frac{1}{5} + 4 \cdot \frac{1}{5} + 9 \stackrel{?}{=} 11$ Let $p = \frac{1}{5}$.

$\frac{6}{5} + \frac{4}{5} + 9 \stackrel{?}{=} 11$

$\frac{10}{5} + 9 \stackrel{?}{=} 11$

$2 + 9 \stackrel{?}{=} 11$

$11 = 11$ True

The true result shows that $\frac{1}{5}$ is a solution of the equation.

60. $2x + 3x + 8 = 20; \frac{12}{5}$

$2\left(\frac{12}{5}\right) + 3\left(\frac{12}{5}\right) + 8 \stackrel{?}{=} 20$ Let $x = \frac{12}{5}$.

$\frac{24}{5} + \frac{36}{5} + \frac{40}{5} \stackrel{?}{=} 20$

$\frac{100}{5} \stackrel{?}{=} 20$

$20 = 20$ True

The true result shows that $\frac{12}{5}$ is a solution of the equation.

61. $3r^2 - 2 = 46$; 4

$3 \cdot 4^2 - 2 \stackrel{?}{=} 46$ Let $r = 4$.

$3 \cdot 16 - 2 \stackrel{?}{=} 46$

$48 - 2 \stackrel{?}{=} 46$

$46 = 46$ True

The true result shows that 4 is a solution of the equation.

62. $2x^2 + 1 = 19$; 3

$2(3)^2 + 1 \stackrel{?}{=} 19$ Let $x = 3$.

$2 \cdot 9 + 1 \stackrel{?}{=} 19$

$18 + 1 \stackrel{?}{=} 19$

$19 = 19$ True

The true result shows that 3 is a solution of the equation.

63. $\frac{3}{8}x + \frac{1}{4} = 1$; 2

$\frac{3}{8} \cdot 2 + \frac{1}{4} \stackrel{?}{=} 1$ Let $x = 2$.

$\frac{3}{4} + \frac{1}{4} \stackrel{?}{=} 1$

$1 = 1$ True

The true result shows that 2 is a solution of the equation.

64. $\frac{7}{10}x + \frac{1}{2} = 4$; 5

$\frac{7}{10}(5) + \frac{1}{2} \stackrel{?}{=} 4$ Let $x = 5$.

$\frac{7}{2} + \frac{1}{2} \stackrel{?}{=} 4$

$4 = 4$ True

The true result shows that 5 is a solution of the equation.

65. $0.5(x - 4) = 80$; 20

$0.5(20 - 4) \stackrel{?}{=} 80$ Let $x = 20$.

$0.5(16) \stackrel{?}{=} 80$

$8 = 80$ False

The false result shows that 20 is not a solution of the equation.

66. $0.2(x - 5) = 70$; 40

$0.2(40 - 5) \stackrel{?}{=} 70$ Let $x = 40$.

$0.2(35) \stackrel{?}{=} 70$

$7 = 70$ False

The false result shows that 40 is not a solution of the equation.

67. "The sum of a number and 8 is 18" translates as $x + 8 = 18$. Try each number from the given set, $\{2, 4, 6, 8, 10\}$, in turn.

$x + 8 = 18$ Given equation

$2 + 8 = 18$ False

$4 + 8 = 18$ False

$6 + 8 = 18$ False

$8 + 8 = 18$ False

$10 + 8 = 18$ True

The only solution is 10.

68. "A number minus three equals 1" translates as $x - 3 = 1$. Replace x with each number in the given set. The only true statement results when $x = 4$, since $4 - 3 = 1$. Thus, 4 is the only solution.

69. "One more than twice a number is 5" translates as $2x + 1 = 5$. Try each number from the given set. The only resulting true equation is $2 \cdot 2 + 1 = 5$, so the only solution is 2.

70. "The product of a number and 3 is 6" translates as $3x = 6$. The only true statement results when $x = 2$, since, $3 \cdot 2 = 6$. Thus, 2 is the only solution.

71. "Sixteen minus three-fourths of a number is 13" translates as $16 - \frac{3}{4}x = 13$. Try each number from the given set, $\{2, 4, 6, 8, 10\}$, in turn.

$16 - \frac{3}{4}x = 13$ Given equation

$16 - \frac{3}{4}(2) = 13$ False

$16 - \frac{3}{4}(4) = 13$ True

$16 - \frac{3}{4}(6) = 13$ False

$16 - \frac{3}{4}(8) = 13$ False

$16 - \frac{3}{4}(10) = 13$ False

The only solution is 4.

72. "The sum of six-fifths of a number and 2 is 14" translates as $\frac{6}{5}x + 2 = 14$. Replace x with each number in the given set. The only true statement results as follows.

$$\frac{6}{5}(10) + 2 \stackrel{?}{=} 14 \quad \text{Let } x = 10.$$
$$12 + 2 \stackrel{?}{=} 14$$
$$14 = 14 \quad \text{True}$$

The only solution is 10.

73. "Three times a number is equal to 8 more than twice the number" translates as $3x = 2x + 8$. Try each number from the given set.

$$3x = 2x + 8 \quad \text{Given equation}$$
$$3(2) = 2(2) + 8 \quad \text{False}$$
$$3(4) = 2(4) + 8 \quad \text{False}$$
$$3(6) = 2(6) + 8 \quad \text{False}$$
$$3(8) = 2(8) + 8 \quad \text{True}$$
$$3(10) = 2(10) + 8 \quad \text{False}$$

The only solution is 8.

74. "Twelve divided by a number equals $\frac{1}{3}$ times that number" translates as $\frac{12}{x} = \frac{1}{3}x$. The only true statement results as follows.

$$\frac{12}{6} \stackrel{?}{=} \frac{1}{3}(6) \quad \text{Let } x = 6.$$
$$2 = 2 \quad \text{True}$$

The only solution is 6.

75. There is no equality symbol, so $3x + 2(x - 4)$ is an expression.

76. There is no equality symbol, so $8y - (3y + 5)$ is an expression.

77. There is an equality symbol, so $7t + 2(t + 1) = 4$ is an equation.

78. There is an equality symbol, so $9r + 3(r - 4) = 2$ is an equation.

79. There is an equality symbol, so $x + y = 9$ is an equation.

80. There is no equality symbol, so $x + y - 9$ is an expression.

81.
$$\begin{aligned} y &= 0.157x - 237 \\ &= 0.157 \cdot 1990 - 237 \\ &= 75.43 \end{aligned}$$

The life expectancy of an American born in 1990 is about 75 years.

82.
$$\begin{aligned} y &= 0.157x - 237 \\ &= 0.157(1995) - 237 \\ &= 76.215 \end{aligned}$$

The life expectancy of an American born in 1995 is about 76 years.

83.
$$\begin{aligned} y &= 0.157x - 237 \\ &= 0.157 \cdot 2005 - 237 \\ &= 77.785 \end{aligned}$$

The life expectancy of an American born in 2005 is about 78 years.

84.
$$\begin{aligned} y &= 0.157x - 237 \\ &= 0.157(2015) - 237 \\ &= 79.355 \end{aligned}$$

The life expectancy of an American born in 2015 is about 79 years.

1.3 Real Numbers and the Number Line

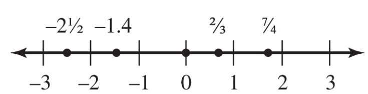
Classroom Examples, Now Try Exercises

1. **(a)** Since Erin spends \$53 more than she has in her checking account, her balance is -53.

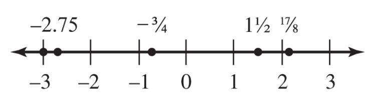
(b) Since the record high was 134° above zero, this temperature is expressed as 134°.

N1. Since the deepest point is below the water's surface, the depth is -136.

2.



N2.



3. **(a)** The whole number is 0.

(b) The integers are -5 and 0.

(c) The rational numbers are $-5, -1\frac{3}{5}\left(\text{or } -\frac{8}{5}\right)$, $0\left(\text{or } \frac{0}{1}\right)$, $0.\overline{45}\left(\text{or } \frac{5}{11}\right)$, and $\frac{5}{8}$ since each can be written as the quotient of integers.

(d) The irrational numbers are $-\pi$ and $\sqrt{11}$.

N3. **(a)** The whole numbers are 0 and 13.

(b) The integers are -7, 0, and 13.

(c) The rational numbers are $-7, -\frac{4}{5}, 0, 2.7,$ and 13.

(d) The irrational numbers are $\sqrt{3}$ and π.

4. Since -4 lies to the left of -1 on the number line, -4 is less than -1. Therefore, the statement $-4 \geq -1$ is *false.*

N4. Since -8 lies to the right of -9 on the number line, -8 is greater than -9. Therefore, the statement $-8 \leq -9$ is *false*.

5. **(a)** $|32| = 32$

(b) $|-32| = -(-32) = 32$

(c) $-|-32| = -[-(-32)] = -32$

(d) $-|32-2| = -|30| = -30$

N5. **(a)** $|4| = 4$

(b) $|-4| = -(-4) = 4$

(c) $-|-4| = -(4) = -4$

(d) $|4-4| = |0| = 0$

6. The largest positive percent increase from 2013 to 2014 is 2.6, so the category is Housing.

N6. The category Transportation is negative in both years.

Exercises

1. The number <u>0</u> is a whole number, but not a natural number.

2. The natural numbers, their additive inverses, and 0 form the set of <u>integers</u>.

3. The additive inverse of every negative number is a *positive* number.

4. If x and y are real numbers with $x > y$, then x lies to the *right* of y on a number line.

5. A rational number is the <u>quotient</u> of two integers with the <u>denominator</u> not equal to 0.

6. Decimal numbers that neither terminate nor repeat are <u>irrational</u> numbers.

7. The additive inverse of -5 is <u>5</u>, while the additive inverse of the absolute value of -5 is <u>-5</u>.

8. If a is negative, then $|a| = \underline{-a}$.

9. **(a)** $|-9| = 9$ A

The distance between -9 and 0 on the number line is 9 units.

(b) $-(-9) = 9$ A

The opposite of -9 is 9.

(c) $-|-9| = -(9) = -9$ B

(d)
$$\begin{aligned} -|-(-9)| &= -|9| \\ &= -(9) \\ &= -9 \quad \text{(B)} \end{aligned}$$

10. The statement "Absolute value is always positive" is not true. The absolute value of 0 is 0, and 0 is not positive. We could say that absolute value is never negative, or absolute value is always nonnegative.

11. The only integer between 3.6 and 4.6 is 4.

12. A rational number between 2.8 and 2.9 is 2.85. There are others.

13. There is only one whole number that is not positive and that is less than 1: the number 0.

14. A whole number greater than 3.5 is 4. There are others.

15. An irrational number that is between $\sqrt{12}$ and $\sqrt{14}$ is $\sqrt{13}$. There are others.

16. The only real number that is neither negative nor positive is 0.

17. True; every natural number is positive.

18. False; 0 is a whole number that is not positive. In fact, it is the *only* whole number that is not positive.

19. True; every integer is a rational number. For example, 5 can be written as $\frac{5}{1}$.

20. True; every rational number is a real number.

21. False; if a number is rational, it cannot be irrational, and vice versa.

22. True; every terminating decimal is a rational number.

23. Three examples of positive real numbers that are not integers are $\frac{1}{2}, \frac{5}{8},$ and $1\frac{3}{4}$. Other examples are $0.7, 4\frac{2}{3},$ and 5.1.

24. Real numbers that are not positive numbers are 0 and all numbers to the left of 0 on the number line. Three examples are $-1, -\frac{3}{4},$ and -5. Other examples are $0, -5, -\sqrt{7}, -1\frac{1}{2},$ and -0.3.

25. Three examples of real numbers that are not whole numbers are $-3\frac{1}{2}, -\frac{2}{3},$ and $\frac{3}{7}$. Other examples are $-4.3, -\sqrt{2},$ and $\sqrt{7}$.

26. Rational numbers that are not integers are all real numbers that can be expressed as a quotient of integers (with nonzero denominators) such that in lowest terms the denominator is not 1. Three examples are $\frac{1}{2}, -\frac{2}{3},$ and $\frac{2}{7}$. Other examples are $-5.6, -4\frac{3}{4}, -\frac{1}{2}, \frac{1}{2},$ and 5.2.

27. Three examples of real numbers that are not rational numbers are $\sqrt{5}, \pi,$ and $-\sqrt{3}$. All irrational numbers are real numbers that are not rational.

28. Rational numbers that are not negative numbers are 0 and all rational numbers to the right of zero on the number line. Three examples are $\frac{2}{3}, \frac{5}{6},$ and $\frac{5}{2}$. Other examples are $0, \frac{1}{2}, 1, 3\frac{1}{4},$ and 5.

29. Use the integer 2,216,602 since "increased by 2,216,602" indicates a positive number.

30. Use the integer 218 since "increased by 218" indicates a positive number.

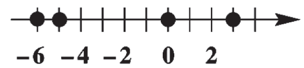
31. Use the integer $-10{,}971$ since "a decrease of 10,971" indicates a negative number.

32. Use the integer -9227 since "a decrease of 9227" indicates a negative number.

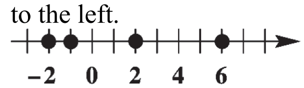
33. Use the rational number -39.73 since "closed down 39.73" indicates a negative number.

34. Use the rational number 21.34 since "closed up 21.34" indicates a positive number.

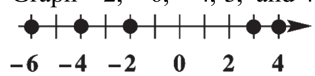
35. Graph $0, 3, -5,$ and -6.
Place a dot on the number line at the point that corresponds to each number. The order of the numbers from smallest to largest is $-6, -5, 0, 3$.



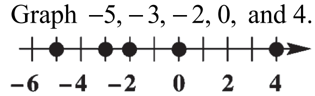
36. Graph $2, 6, -2,$ and -1.
The smallest number, -2, will be the farthest to the left.



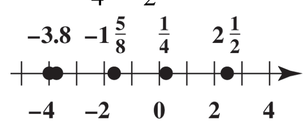
37. Graph $-2, -6, -4, 3,$ and 4.



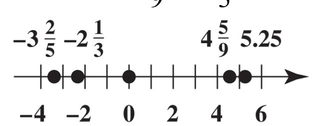
38. Graph $-5, -3, -2, 0,$ and 4.



39. Graph $\frac{1}{4}, 2\frac{1}{2}, -3.8, -4,$ and $-1\frac{5}{8}$.



40. Graph $5.25, 4\frac{5}{9}, -2\frac{1}{3}, 0,$ and $-3\frac{2}{5}$.



41. **(a)** The natural numbers in the given set are 3 and 7, since they are in the natural number set $\{1, 2, 3, \ldots\}$.

(b) The set of whole numbers includes the natural numbers and 0. The whole numbers in the given set are 0, 3, and 7.

(c) The integers are the set of numbers $\{\ldots, -3, -2, -1, 0, 1, 2, 3, \ldots\}$. The integers in the given set are -9, 0, 3, and 7.

(d) Rational numbers are the numbers that can be expressed as the quotient of two integers, with denominators not equal to 0.
We can write numbers from the given set in this form as follows:
$-9 = \frac{-9}{1},\ -1\frac{1}{4} = \frac{-5}{4},\ -\frac{3}{5} = \frac{-3}{5},\ 0 = \frac{0}{1},$
$0.\overline{1} = \frac{1}{9},\ 3 = \frac{3}{1},\ 5.9 = \frac{59}{10},$ and $7 = \frac{7}{1}.$
Thus, the rational numbers in the given set are $-9,\ -1\frac{1}{4},\ -\frac{3}{5},\ 0,\ 0.\overline{1},\ 3,\ 5.9,$ and 7.

(e) Irrational numbers are real numbers that are not rational. $-\sqrt{7}$ and $\sqrt{5}$ can be represented by points on the number line but cannot be written as a quotient of integers. Thus, the irrational numbers in the given set are $-\sqrt{7}$ and $\sqrt{5}$.

(f) Real numbers are all numbers that can be represented on the number line. All the numbers in the given set are real.

42. **(a)** The only natural number in the given set is 3.

(b) The whole numbers in the set are 0 and 3.

(c) The integers in the set are $-5, -1, 0,$ and 3.

(d) The rational numbers are $-5.3, -5, -1,$
$-\frac{1}{9}, 0, 0.\overline{27}, 1.2,$ and 3.

(e) The irrational numbers in the set are $-\sqrt{3}$ and $\sqrt{11}$.

(f) All the numbers in the set are real numbers.

43. **(a)** The natural number in the given set 11, since it is in the natural number set $\{1, 2, 3, \ldots\}$.

(b) The set of whole numbers includes the natural numbers and 0. The whole numbers in the given set are 0, and 11.

(c) The integers are the set of numbers $\{\ldots, -3, -2, -1, 0, 1, 2, 3, \ldots\}$. The integers in the given set are 0, 11, and -6.

(d) Rational numbers are the numbers that can be expressed as the quotient of two integers, with denominators not equal to 0.
We can write numbers from the given set in this form as follows:
$-2.\overline{3} = \frac{-7}{3},\ 0 = \frac{0}{1}, -8\frac{3}{4} = \frac{-35}{4},\ 11 = \frac{11}{1},$
and $-6 = \frac{-6}{1}.$
Thus, the rational numbers in the given set are $\frac{7}{9}, -2.\overline{3}, 0, -8\frac{3}{4}, 11,$ and -6.

(e) Irrational numbers are real numbers that are not rational. $\sqrt{3}$ and π can be represented by points on the number line but cannot be written as a quotient of integers. Thus, the irrational numbers in the given set are $\sqrt{3}$ and π.

(f) Real numbers are all numbers that can be represented on the number line. All the numbers in the given set are real.

44. **(a)** The only natural number in the given set is 9.

(b) The whole numbers in the set are 9 and 0.

(c) The integers in the set are 9, -12, and 0.

(d) The rational numbers are $1\frac{5}{8}$, $-0.\overline{4}$, 9,
-12, 0, and 0.026.

(e) The irrational numbers in the set are $\sqrt{6}$ and $\sqrt{10}$.

(f) All the numbers in the set are real numbers.

45. **(a)** The additive inverse of -2 is found by changing the sign of -2 The additive inverse of -2 is 2.

(b) The absolute value of -2 is the distance between 0 and -2 on the number line, so $|-2| = 2.$

46. **(a)** The additive inverse of a number is found by changing the sign of a number, so the additive inverse of -4 is 4.

(b) The distance between -4 and 0 on the number line is 4 units, so $|-4| = 4.$

47. **(a)** The additive inverse of 8 is $-8.$

(b) The distance between 0 and 8 on the number line is 8 units, so the absolute value of 8 is 8.

48. **(a)** The additive inverse of 10 is $-10.$

(b) The distance between 10 and 0 on the number line is 10 units, so $|10| = 10.$

49. **(a)** The additive inverse of a number is found by changing the sign of a number, so the additive inverse of $-\frac{3}{4}$ is $\frac{3}{4}$.

(b) The distance between $-\frac{3}{4}$ and 0 on the number line is $\frac{3}{4}$ unit, so $\left|-\frac{3}{4}\right| = \frac{3}{4}$.

50. **(a)** The additive inverse of a number is found by changing the sign of a number, so the additive inverse of $-\frac{2}{5}$ is $\frac{2}{5}$.

(b) The distance between $-\frac{2}{5}$ and 0 on the number line is $\frac{2}{5}$ unit, so $\left|-\frac{2}{5}\right| = \frac{2}{5}$.

51. **(a)** The additive inverse of a number is found by changing the sign of a number, so the additive inverse of 5.6 is -5.6.

(b) The distance between 5.6 and 0 on the number line is 5.6 units, so $|5.6| = 5.6$.

52. **(a)** The additive inverse of a number is found by changing the sign of a number, so the additive inverse of 8.1 is -8.1.

(b) The distance between 8.1 and 0 on the number line is 8.1 unit, so $|8.1| = 8.1$.

53. Since -6 is a negative number, its absolute value is the additive inverse of -6 — that is, $|-6| = -(-6) = 6$.

54. $|-14| = -(-14) = 14$

55. $-|12| = -(12) = -12$

56. $-|19| = -(19) = -19$

57. $-\left|-\frac{2}{3}\right| = -\left(\frac{2}{3}\right) = -\frac{2}{3}$

58. $-\left|-\frac{4}{5}\right| = -\left(\frac{4}{5}\right) = -\frac{4}{5}$

59. $|6-3| = |3| = 3$

60. $|9-4| = |5| = 5$

61. $-|6-3| = -|3| = -3$

62. $-|9-4| = -|5| = -5$

63. Since -11 is located to the left of -4 on the number line, -11 is the lesser number.

64. Since -13 is located to the left of -8 on the number line, -13 is the lesser number.

65. Since $-\frac{2}{3}$ is located to the left of $-\frac{1}{4}$ on the number line, $-\frac{2}{3}$ is the lesser number.

66. Since $-\frac{9}{16}$ is located to the left of $-\frac{3}{8}$ on the number line, $-\frac{9}{16}$ is the lesser number.

67. Since $|-5| = 5$, 4 is the lesser of the two numbers.

68. Since $|-3| = 3$, $|-3|$ or 3 is the lesser of the two numbers.

69. Since $|-3.5| = 3.5$ and $|-4.5| = 4.5$, $|-3.5|$ or 3.5 is the lesser number.

70. Since $|-8.9| = 8.9$ and $|-9.8| = 9.8$, $|-8.9|$ or 8.9 is the lesser number.

71. Since $-|-6| = -6$ and $-|-4| = -4$, $-|-6|$ is to the left of $-|-4|$ on the number line, so $-|-6|$ or -6 is the lesser number.

72. $-|-2| = -2$ and $-|-3| = -3$, so $-|-3|$ is to the left of $-|-2|$ on the number line; $-|-3|$ or -3 is the lesser number.

73. Since $|5-3| = |2| = 2$ and $|6-2| = |4| = 4$, $|5-3|$ or 2 is the lesser number.

74. Since $|7-2| = |5| = 5$ and $|8-1| = |7| = 7$, $|7-2|$ or 5 is the lesser number.

75. Since -5 is to the *left* of -2 on the number line, -5 is *less than* -2, and the statement $-5 < -2$ is true.

76. Since -8 is to the *left* of -2 on the number line, -8 is *less than* -2, and the statement $-8 > -2$ is false.

77. Since $-(-5) = 5$ and $-4 < 5$, $-4 \le -(-5)$ is true.

78. Since $-(-3)=3$ and $-6 \le 3$, $-6 \le -(-3)$ is true.

79. Since $|-6|=6$ and $|-9|=9$, and $6<9$, $|-6|<|-9|$ is true.

80. Since $|-12|=12$ and $|-20|=20$, and $12<20$, $|-12|<|-20|$ is true.

81. Since $-|8|=-8$ and $|-9|=-(-9)=9$, $-|8|<|-9|$, so $-|8|>|-9|$ is false.

82. Since $-|12|=-12$ and $|-15|=-(-15)=15$, $-|12|<|-15|$, so $-|12|>|-15|$ is false.

83. Since $-|-5|=-5, -|-9|=-9$, and $-5>-9, -|-5|\ge -|-9|$ is true.

84. Since $-|-12|=-12, -|-15|=-15$, and $-12>-15, -|-12|\le -|-15|$ is false.

85. Since $|6-5|=|1|=1$ and $|6-2|=|4|=4, |6-5|<|6-2|$, so $|6-5|\ge|6-2|$ is false.

86. Since $|13-8|=|5|=5$ and $|7-4|=|3|=3$, $|13-8|>|7-4|$, so $|13-8|\le|7-4|$ is false.

87. The number that represents the greatest percentage increase is 2.2, which corresponds to Natural gas service from March to April.

88. The negative number with the largest absolute value in the table is -6.4, so the greatest percentage decrease is Gasoline from April to May.

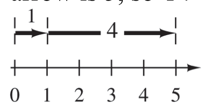
89. The number with the smallest absolute value in the table is 0.2, so the least change corresponds to Shelter from April to May.

90. The categories with two negative entries (representing a decrease for both time periods) are Apparel and Fuel oil.

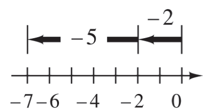
1.4 Adding and Subtracting Real Numbers

Classroom Examples, Now Try Exercises

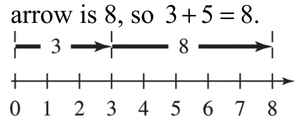
1. **(a)** Start at 0 on a number line. Draw an arrow 1 unit to the right to represent the positive number 1. From the right end of this arrow, draw a second arrow 4 units to the right to represent the addition of a positive number. The number below the end of this second arrow is 5, so $1+4=5$.



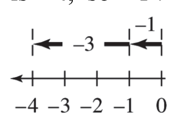
(b) Start at 0 on a number line. Draw an arrow 2 units to the left to represent the negative number -2. From the left end of this arrow, draw a second arrow 5 units to the left to represent the addition of a negative number. The number below the end of this second arrow is -7, so $-2+(-5)=-7$.



N1. **(a)** Start at 0 on a number line. Draw an arrow 3 units to the right to represent the positive number 3. From the right end of this arrow, draw a second arrow 5 units to the right to represent the addition of a positive number. The number below the end of this second arrow is 8, so $3+5=8$.



(b) Start at 0 on a number line. Draw an arrow 1 unit to the left to represent the negative number -1. From the left end of this arrow, draw a second arrow 3 units to the left. The number below the end of this second arrow is -4, so $-1+(-3)=-4$.



2. **(a)** $-15+(-4)=-19$

The sum of two negative numbers is negative.

(b) $-1.27+(-5.46)=-6.73$

The sum of two negative numbers is negative.

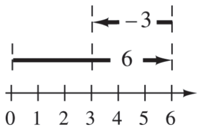
N2. **(a)** $-6+(-11)=-17$

The sum of two negative numbers is negative.

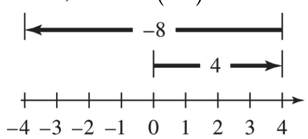
(b) $-\frac{2}{5}+\left(-\frac{1}{2}\right)=-\frac{9}{10}$

The sum of two negative numbers is negative.

3. Start at 0 on a number line. Draw an arrow 6 units to the right. From the right end of this arrow, draw a second arrow 3 units to the left. The number below the end of this second arrow is 3, so $6+(-3)=3$.



N3. Start at 0 on a number line. Draw an arrow 4 units to the right. From the right end of this arrow, draw a second arrow 8 units to the left. The number below the end of this second arrow is -4, so $4+(-8)=-4$.



4. **(a)** Since the numbers have different signs, find the difference between their absolute values: $17-10=7$. Because 17 has the larger absolute value, the sum is negative: $-10+17=7$.

(b) $\frac{3}{4}+\left(-1\frac{3}{8}\right)=-\frac{5}{8}$

(c) $-3.8+9.5=5.7$

(d) $25+(-25)=0$

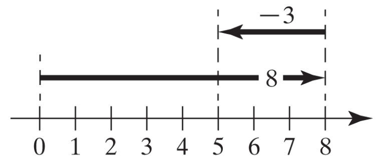
N4. **(a)** Since the numbers have different signs, find the difference between their absolute values: $7-4=3$. Because 7 has the larger absolute value, the sum is positive: $7+(-4)=3$.

(b)
$$\begin{aligned}\frac{2}{3}+\left(-2\frac{1}{9}\right)&=\frac{2}{3}+\left(-\frac{19}{9}\right)\\&=\frac{6}{9}+\left(-\frac{19}{9}\right)\\&=-\left(\frac{19}{9}-\frac{6}{9}\right)\\&=-\frac{13}{9}\text{ or }-1\frac{4}{9}\end{aligned}$$

(c) $-5.7+3.7=-(5.7-3.7)=-2$

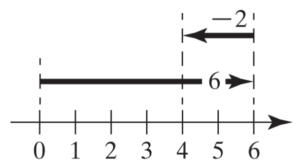
(d) $-10+10=0$

5. Use a number line to find the difference $8-3$.
Step 1 Start at 0 and draw an arrow 8 units to the *right.*
Step 2 From the right end of the first arrow, draw a second arrow 3 units to the *left* to represent the *subtraction*.



The number below the end of the second arrow is 5, so $8-3=5$.

N5. Use a number line to find the difference $6-2$.
Step 1 Start at 0 and draw an arrow 6 units to the *right.*
Step 2 From the right end of the first arrow, draw a second arrow 2 units to the *left* to represent the *subtraction*.



The number below the end of the second arrow is 4, so $6-2=4$.

6. **(a)** $10-4=10+(-4)$ Add the opposite.
$=6$

(b) $4-10=4+(-10)$ Add the opposite.
$=-6$

(c) $-8-5=-8+(-5)$ Add the opposite.
$=-13$

(d) $-8-(-12)=-8+(12)$ Add the opposite.
$=4$

(e) $\frac{5}{4}-\left(-\frac{3}{7}\right)=\frac{5}{4}+\frac{3}{7}=\frac{35}{28}+\frac{12}{28}=\frac{47}{28}$, or $1\frac{19}{28}$

(f) $7.5-9.2=-1.7$

N6. **(a)** $-5-(-11)=-5+(11)$ Add the opposite.
$=6$

(b) $4-15=4+(-15)$ Add the opposite.
$=-11$

(c) $-\frac{5}{7}-\frac{1}{3}=-\frac{5}{7}+\left(-\frac{1}{3}\right)$ Add the opposite.

$=-\frac{15}{21}+\left(-\frac{7}{21}\right)$

$=-\frac{22}{21}$, or $-1\frac{1}{21}$

(d) $5.25-(-3.24)=5.25+3.24$

$=8.49$

7. (a) $6+\left[(-1-4)-2\right]$

$=6+\left\{\left[-1+(-4)\right]-2\right\}$

$=6+(-5-2)$

$=6+\left[-5+(-2)\right]$

$=6+(-7)$

$=-1$

(b) $\left|-\frac{1}{6}-\left(-\frac{1}{3}\right)\right|-\frac{1}{4}$

$=\left|-\frac{2}{12}-\left(-\frac{4}{12}\right)\right|-\frac{3}{12}$

$=\left|-\frac{2}{12}+\frac{4}{12}\right|-\frac{3}{12}$

$=\left|\frac{2}{12}\right|-\frac{3}{12}$

$=\frac{2}{12}+\left(-\frac{3}{12}\right)$

$=-\frac{1}{12}$

N7. (a) $8-[(-3+7)-(3-9)]$

$=8-[(4)-(3+(-9))]$

$=8-[4-(-6)]$

$=8-[4+6]$

$=8-10$

$=8+(-10)$

$=-2$

(b) $3|6-9|-|4-12|$

$=3|6+(-9)|-|4+(-12)|$

$=3|-3|-|-8|$

$=3\cdot 3-8$

$=9-8$

$=1$

8. "7 is increased by the sum of 8 and -3" is written $7+\left[8+(-3)\right]$.

$7+\left[8+(-3)\right]=7+5=12$

N8. "The sum of -3 and 7, increased by 10" is written $(-3+7)+10$.

$(-3+7)+10=4+10=14$

9. (a) "The difference between -5 and -12" is written $-5-(-12)$.

$-5-(-12)=-5+12$

$=7$

(b) "-2 subtracted from the sum of 4 and -4" is written $\left[4+(-4)\right]-(-2)$.

$\left[4+(-4)\right]-(-2)=0-(-2)$

$=0+2$

$=2$

N9. (a) "The difference between 5 and -8, decreased by 4" is written $[5-(-8)]-4$.

$[5-(-8)]-4=[5+8]-4$

$=13-4$

$=9$

(b) "7 less than -2" is written $-2-7$.

$-2-7=-2+(-7)$

$=-9$

10. The difference between the highest and lowest temperatures is given by

$79-(-56)=79+56$

$=135.$

The difference is 135°F.

N10. The difference between a gain of 226 yards and a loss of 7 yards is given by

$226-(-7)=226+7$

$=233.$

The difference is 233 yards.

11. Subtract the enrollment number for 1995 from the enrollment number for 2000.

$13.52-12.5=13.52+(-12.5)=1.02$ million

A positive result indicates an increase.

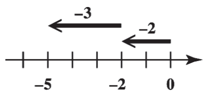
N11. Subtract the enrollment number for 1985 from the enrollment number for 1990.

$11.34-12.39=-1.05$ million

A negative result indicates a decrease.

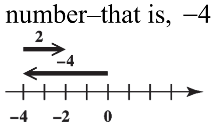
Exercises

1. The sum of two negative numbers will always be a *negative* number. In the illustration, we have $-2+(-3)=-5$.



2. The sum of a number and its opposite will always be zero (0).

3. When adding a positive number and a negative number, where the negative number has the greater absolute value, the sum will be a *negative* number. In the illustration, the absolute value of -4 is larger than the absolute value of 2, so the sum is a negative number–that is, $-4+2=-2$.



4. To simplify the expression $8+\left[-2+\left(-3+5\right)\right]$, one should begin by adding -3 and 5, according to the rules for order of operations.

5. By the definition of subtraction, in order to perform the subtraction $-6-(-8)$, we must add the opposite of -8 to -6 to obtain 2.

6. "The difference of 7 and 12" translates as $7-12$, while "the difference of 12 and 7" translates as $12-7$.

7. The expression $x-y$ would have to be positive since subtracting a negative number from a positive number is the same as adding a positive number to a positive number, which is a positive number.

8. $y-x=y+\left(-x\right)$
If *x* is a positive number and *y* is a negative number, $y-x$ will be the sum of two negative numbers, which is a negative number.

9. $|x|=x$, since *x* is a positive number.
$y-|x|=y-x$, which is a negative number. (See Exercise 8.)

10. Since $|y|$ is positive, $x+|y|$ is the sum of two positive numbers, which is positive.

11. The sum of two negative numbers is negative.
$-6+(-2)=-8$

12. Since the numbers have the same sign, add their absolute values: $9+2=11$. Since both numbers are negative, their sum is negative:
$-9+\left(-2\right)=-11$.

13. Because the numbers have the same sign, add their absolute values: $5+7=12$. Because both numbers are negative, their sum is negative:
$-5+(-7)=-12$.

14. Because the numbers have the same sign, add their absolute values: $11+5=16$. Because both numbers are negative, their sum is negative:
$-11+(-5)=-16$.

15. To add $6+(-4)$, find the difference between the absolute values of the numbers.
$|6|=6$ and $|-4|=4$
$6-4=2$
Since $|6|>|-4|$, the sum will be positive:
$6+(-4)=2$.

16. Since the numbers have different signs, find the difference between their absolute values: $11-8=3$. Since 11 has the larger absolute value, the answer is positive: $11+(-8)=3$.

17. Since the numbers have different signs, find the difference between their absolute values: $15-12=3$. Because -15 has the larger absolute value, the sum is negative:
$12+(-15)=-3$.

18. Since the numbers have different signs, find the difference between their absolute values: $7-3=4$. Since -7 has the larger absolute value, the sum is negative: $3+\left(-7\right)=-4$.

19. Since the numbers have different signs, find the difference between their absolute values: $16-7=9$. Since -16 has the larger absolute value, the answer is negative: $-16+7=-9$.

20. Since the numbers have different signs, find the difference between their absolute values: $13-6=7$. Since -13 has the larger absolute value, the answer is negative: $-13+6=-7$.

21. $6+(-6)=0$

22. $-11+11=0$

23. $-\frac{1}{3}+\left(-\frac{4}{15}\right)=-\frac{5}{15}+\left(-\frac{4}{15}\right)=-\frac{9}{15}=-\frac{3}{5}$