

33. $I \cup Q = R$ 34. $J \cap Q = \emptyset$
 35. $0.2121121112 \dots \in Q$ 36. $0.3333 \dots \in Q$
 37. $3.252525 \dots \in I$ 38. $3.1010010001 \dots \in I$
 39. $0.999 \dots \in I$ 40. $0.666 \dots \in Q$
 41. $\pi \in I$ 42. $\pi \in Q$

Place one of the symbols $\subseteq$, $\not\subseteq$, $\in$, or $\notin$ in each blank so that each statement is true.

43. $N \underline{\hspace{1cm}} W$ 44. $J \underline{\hspace{1cm}} Q$ 45. $J \underline{\hspace{1cm}} N$
 46. $Q \underline{\hspace{1cm}} W$ 47. $Q \underline{\hspace{1cm}} R$ 48. $I \underline{\hspace{1cm}} R$
 49. $\emptyset \underline{\hspace{1cm}} I$ 50. $\emptyset \underline{\hspace{1cm}} Q$ 51. $N \underline{\hspace{1cm}} R$
 52. $W \underline{\hspace{1cm}} R$ 53. $5 \underline{\hspace{1cm}} J$ 54. $-6 \underline{\hspace{1cm}} J$
 55. $7 \underline{\hspace{1cm}} Q$ 56. $8 \underline{\hspace{1cm}} Q$ 57. $\sqrt{2} \underline{\hspace{1cm}} R$
 58. $\sqrt{2} \underline{\hspace{1cm}} I$ 59. $0 \underline{\hspace{1cm}} I$ 60. $0 \underline{\hspace{1cm}} Q$
 61. $\{2, 3\} \underline{\hspace{1cm}} Q$ 62. $\{0, 1\} \underline{\hspace{1cm}} N$
 63. $\{3, \sqrt{2}\} \underline{\hspace{1cm}} R$ 64. $\{3, \sqrt{2}\} \underline{\hspace{1cm}} Q$

GETTING MORE INVOLVED



65. **Writing.** What is the difference between a rational and an irrational number? Why is $\sqrt{9}$ rational and $\sqrt{3}$ irrational?



66. **Cooperative learning.** Work in a small group to make a list of the real numbers of the form $\sqrt{n}$, where n is a natural number between 1 and 100 inclusive. Decide on a method for determining which of these numbers are rational and find them. Compare your group's method and results with other groups' work.



67. **Exploration.** Find the decimal representations of

$$\frac{2}{9}, \frac{2}{99}, \frac{23}{99}, \frac{23}{999}, \frac{234}{999}, \frac{23}{9999}, \text{ and } \frac{1234}{9999}.$$

- a) What do these decimals have in common?
 b) What is the relationship between each fraction and its decimal representation?

1.3

OPERATIONS ON THE SET OF REAL NUMBERS

In this section

- Absolute Value
- Addition
- Subtraction
- Multiplication
- Division
- Division by Zero

Computations in algebra are performed with positive and negative numbers. In this section we will extend the basic operations of arithmetic to the negative numbers.

Absolute Value

The real numbers are the coordinates of the points on the number line. However, we often refer to the points as numbers. For example, the numbers 5 and -5 are both five units away from 0 on the number line shown in Fig. 1.12. A number's *distance* from 0 on the number line is called the **absolute value** of the number. We write $|a|$ for “the absolute value of a .” Therefore $|5| = 5$ and $|-5| = 5$.

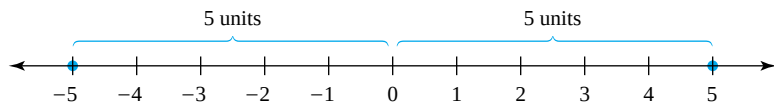


FIGURE 1.12

EXAMPLE 1

Absolute value

Find the value of $|4|$, $|-4|$, and $|0|$.

Solution

Because both 4 and -4 are four units from 0 on the number line, we have $|4| = 4$ and $|-4| = 4$. Because the distance from 0 to 0 on the number line is 0, we have $|0| = 0$. ■

calculator close-up

↑
TOTAL
MEMO
RESET
OFF

4
5
6
×

A graphing calculator uses `abs` for absolute value. Note that many calculators have a subtraction symbol for subtraction and a negative sign for indicating a negative number. You cannot use the subtraction symbol to indicate a negative number.

<code>abs(4)</code>	4
<code>abs(-4)</code>	4
<code>abs(0)</code>	0

study tip

Exchange phone numbers, cellular phone numbers, pager numbers, and e-mail addresses with several students in your class. If you miss class and you can't reach your instructor, then you will have someone who can tell you the assignments. If you are stuck on a problem, you can contact a classmate for help.

Note that $|a|$ represents distance, and distance is never negative. So $|a|$ is greater than or equal to zero for any number a .

Two numbers that are located on opposite sides of zero and have the same absolute value are called **opposites** of each other. The opposite of zero is zero. Every number has a unique opposite. The numbers 9 and -9 are opposites of one another. The minus sign, $-$, is used to signify “opposite” in addition to “negative.” When the minus sign is used in front of a number, it is read as “negative.” When it is used in front of parentheses or a variable, it is read as “opposite.” For example,

$$-(9) = -9$$

is read as “the opposite of 9 is negative 9,” and

$$-(-9) = 9$$

is read as “the opposite of negative 9 is 9.” In general, $-a$ is read “the opposite of a .” If a is positive, $-a$ is negative. If a is negative, $-a$ is positive. Opposites have the following property.

Opposite of an Opposite

For any number a ,

$$-(-a) = a.$$

EXAMPLE 2

Opposite of an opposite

Evaluate.

a) $-(-12)$

b) $-(-(-8))$

Solution

a) The opposite of negative 12 is 12. So $-(-12) = 12$.

b) The opposite of the opposite of -8 is -8 . So $-(-(-8)) = -8$. ■

Remember that we have defined $|a|$ to be the distance between 0 and a on the number line. Using opposites, we can give a symbolic definition of absolute value.

Absolute Value

$$|a| = \begin{cases} a & \text{if } a \text{ is positive or zero} \\ -a & \text{if } a \text{ is negative} \end{cases}$$

Using this definition, we write

$$|7| = 7$$

because 7 is positive. To find the absolute value of -7 , we use the second line of the definition and write

$$|-7| = -(-7) = 7.$$

Addition

helpful hint

We use the illustrations with debts and assets to make the rules for adding signed numbers understandable. However, in the end the carefully written rules tell us exactly how to perform operations with signed numbers and we must obey the rules.

A good way to understand positive and negative numbers is to think of the *positive numbers as assets* and the *negative numbers as debts*. For this illustration we can think of assets simply as cash. Think of debts as unpaid bills such as the electric bill, the phone bill, and so on. If you have assets of \$4 and \$11 and no debts, then your net worth is \$15. **Net worth** is the total of your debts and assets. If you have debts of \$6 and \$7 and no assets, then your net worth is $-\$13$. In symbols,

$$\begin{array}{ccccccc} (-6) & + & (-7) & = & -13. \\ \uparrow & \uparrow & \uparrow & & \uparrow \\ \$6 \text{ debt} & \text{Added to} & \$7 \text{ debt} & & \$13 \text{ debt} \end{array}$$

We can think of this addition as adding the absolute values of -6 and -7 (that is, $6 + 7 = 13$) and then putting a negative sign on that result to get -13 . These examples illustrate the following rule.

Sum of Two Numbers with Like Signs

To find the sum of two numbers with the same sign, add their absolute values. The sum has the same sign as the original numbers.

If you have a debt of \$5 and have only \$5 in cash, then your debts equal your assets (in absolute value), and your net worth is \$0. In symbols,

$$\begin{array}{ccccccc} -5 & + & 5 & = & 0. \\ \uparrow & & \uparrow & & \uparrow \\ \text{Debt of } \$5 & & \text{Asset of } \$5 & & \text{Net worth} \end{array}$$

The number a and its opposite $-a$ have a sum of zero for any a . For this reason, a and $-a$ are called **additive inverses** of each other. Note that the words “negative,” “opposite,” and “additive inverse” are often used interchangeably.

Additive Inverse Property

For any real number a , there is a unique number $-a$ such that

$$a + (-a) = -a + a = 0.$$

To understand the sum of a positive and a negative number, consider the following situation. If you have a debt of \$7 and \$10 in cash, you may have \$10 in hand, but your net worth is only \$3. Your assets exceed your debts (in absolute value), and you have a positive net worth. In symbols,

$$-7 + 10 = 3.$$

Note that to get 3, we actually subtract 7 from 10. If you have a debt of \$8 but have only \$5 in cash, then your debts exceed your assets (in absolute value). You have a net worth of $-\$3$. In symbols,

$$-8 + 5 = -3.$$

Note that to get the 3 in the answer, we subtract 5 from 8.

study tip

The keys to success are desire and discipline. You must want success and you must discipline yourself to do what it takes to get success. There are a lot of things that you cannot do anything about, but you can learn to be disciplined. Set your goals, make plans, and schedule your time. Before you know it, you will have the discipline that is necessary for success.

As you can see from these examples, the sum of a positive number and a negative number (with different absolute values) may be either positive or negative. These examples illustrate the rule for adding numbers with unlike signs and different absolute values.

helpful hint

The sum of two numbers with unlike signs and the same absolute value is zero because of the additive inverse property.

Sum of Two Numbers with Unlike Signs (and Different Absolute Values)

To find the sum of two numbers with unlike signs, subtract their absolute values.

The sum is positive if the number with the larger absolute value is positive.

The sum is negative if the number with the larger absolute value is negative.

EXAMPLE 3

Adding signed numbers

Find each sum.

a) $-6 + 13$

b) $-9 + (-7)$

c) $2 + (-2)$

d) $-35.4 + 2.51$

e) $-7 + 0.05$

f) $\frac{1}{5} + \left(-\frac{3}{4}\right)$

Solution

a) The absolute values of -6 and 13 are 6 and 13 . Subtract 6 from 13 to get 7 . Because the number with the larger absolute value is 13 and it is positive, the result is 7 .

b) $-9 + (-7) = -16$

c) $2 + (-2) = 0$

d) Line up the decimal points and subtract 2.51 from 35.40 to get 32.89 . Because 35.4 is larger than 2.51 and 35.4 has a negative sign, the answer is negative.

$$-35.4 + 2.51 = -32.89$$

e) Line up the decimal points and subtract 0.05 from 7.00 to get 6.95 . Because 7.00 is larger than 0.05 and 7.00 has a negative sign, the answer is negative.

$$-7 + 0.05 = -6.95$$

f) $\frac{1}{5} + \left(-\frac{3}{4}\right) = \frac{4}{20} + \left(-\frac{15}{20}\right) = -\frac{11}{20}$

Subtraction

Think of subtraction as removing debts or assets, and think of addition as receiving debts or assets. For example, if you have \$10 in cash and \$4 is taken from you, your resulting net worth is the same as if you have \$10 and a water bill for \$4 arrives in the mail. In symbols,

$$10 \quad \begin{array}{c} - \\ \uparrow \\ \text{Remove} \end{array} \quad 4 \quad \begin{array}{c} \uparrow \\ \text{Cash} \end{array} = 10 \quad \begin{array}{c} + \\ \uparrow \\ \text{Receive} \end{array} \quad (-4). \quad \begin{array}{c} \uparrow \\ \text{Debt} \end{array}$$

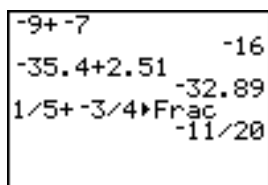
Removing cash is equivalent to receiving a debt.

Suppose that you have \$17 in cash and owe \$7 in library fines. Your net worth is \$10. If the debt of \$7 is canceled or forgiven, your net worth will increase to \$17,

calculator

close-up

A graphing calculator can add signed numbers in any form. If you use the fraction feature, the answer is given as a fraction.



No one knows what calculators will be like in 10 or 20 years. So concentrate on understanding the mathematics and you will have no trouble with changing technology.

the same as if you received \$7 in cash. In symbols,

$$\begin{array}{ccccccc}
 10 & - & (-7) & = & 10 & + & 7. \\
 \uparrow & & \uparrow & & & \uparrow & \uparrow \\
 \text{Remove} & & \text{Debt} & & & \text{Receive} & \text{Cash}
 \end{array}$$

Removing a debt is equivalent to receiving cash.

Notice that each preceding subtraction problem is equivalent to an addition problem in which we add the opposite of what we were going to subtract. These examples illustrate the definition of subtraction.

Subtraction of Real Numbers

For any real numbers a and b ,

$$a - b = a + (-b).$$

EXAMPLE 4

calculator

↑ 4 5 6 x

close-up

A graphing calculator can subtract signed numbers in any form. If your calculator has a subtraction symbol and a negative symbol, you will get an error message if you do not use them appropriately.

$$\begin{array}{r}
 -3.6 - -7 \\
 0.02 - 7 \\
 1/3 - -1/6 \rightarrow \text{Frac} \\
 \hline
 3.4 \\
 -6.98 \\
 1/2
 \end{array}$$

Subtracting signed numbers

Find each difference.

- a) $-7 - 3$ b) $7 - (-3)$ c) $48 - 99$
d) $-3.6 - (-7)$ e) $0.02 - 7$ f) $\frac{1}{3} - \left(-\frac{1}{6}\right)$

Solution

- a) To subtract 3 from -7 , add the opposite of 3 and -7 :

$$-7 - 3 = -7 + (-3) = -10$$

- b) To subtract -3 from 7, add the opposite of -3 and 7. The opposite of -3 is 3:

$$7 - (-3) = 7 + (3) = 10$$

- c) To subtract 99 from 48, add -99 and 48:

$$48 - 99 = 48 + (-99) = -51$$

- d) $-3.6 - (-7) = -3.6 + 7 = 3.4$

- e) $0.02 - 7 = 0.02 + (-7) = -6.98$

- f) $\frac{1}{3} - \left(-\frac{1}{6}\right) = \frac{1}{3} + \frac{1}{6} = \frac{2}{6} + \frac{1}{6} = \frac{3}{6} = \frac{1}{2}$

Multiplication

The result of multiplying two numbers is called the **product** of the numbers. The numbers multiplied are **factors**. In algebra we use a raised dot to indicate multiplication, or we place symbols next to one another. For example, the product of a and b is written as $a \cdot b$ or ab . The product of 4 and x is $4x$. We also use parentheses to indicate multiplication. For example, the product of 4 and 3 is written as $4 \cdot 3$, $4(3)$, $(4)3$, or $(4)(3)$.

Multiplication is just a short way to do repeated additions. Adding five 2's gives

$$2 + 2 + 2 + 2 + 2 = 10.$$

So we have the multiplication fact $5 \cdot 2 = 10$. Adding together five negative 2's gives

$$(-2) + (-2) + (-2) + (-2) + (-2) = -10.$$

So we must have $5(-2) = -10$. We can think of $5(-2) = -10$ as saying that taking on five debts of \$2 each is equivalent to a debt of \$10. Losing five debts of \$2 each is equivalent to gaining \$10, so we must have $-5(-2) = 10$.

The rules for multiplying signed numbers are easy to state and remember.

Product of Signed Numbers

To find the product of two nonzero real numbers, multiply their absolute values.

The product is *positive* if the numbers have the *same* sign.

The product is *negative* if the numbers have *unlike* signs.

For example, to multiply -4 and -5 , we multiply their absolute values ($4 \cdot 5 = 20$). Since -4 and -5 have the same sign, $(-4)(-5) = 20$. To multiply -6 and 3 , we multiply their absolute values ($6 \cdot 3 = 18$). Since -6 and 3 have unlike signs, $-6 \cdot 3 = -18$.

EXAMPLE 5

Multiplying signed numbers

Find each product.

- a) $(-3)(-6)$ b) $-4(10)$ c) $(-0.01)(0.02)$ d) $\frac{4}{9} \cdot \left(-\frac{1}{5}\right)$

Solution

- a) First multiply the absolute values ($3 \cdot 6 = 18$). Because -3 and -6 have the same sign, we get $(-3)(-6) = 18$.
- b) $-4(10) = -40$ **Opposite signs, negative result**
- c) When multiplying decimals, we total the number of decimal places used in the numbers multiplied to get the number of decimal places in the answer. Thus $(-0.01)(0.02) = -0.0002$.
- d) $\frac{4}{9} \cdot \left(-\frac{1}{5}\right) = -\frac{4}{45}$ ■

Division

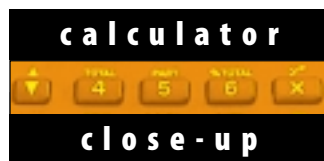
Just as every real number has an additive inverse or opposite, every nonzero real number a has a **multiplicative inverse** or **reciprocal** $\frac{1}{a}$. The reciprocal of 3 is $\frac{1}{3}$, and

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

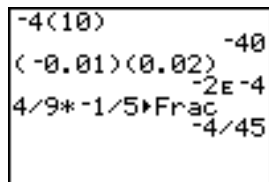
Multiplicative Inverse Property

For any nonzero real number a , there is a unique number $\frac{1}{a}$ such that

$$a \cdot \frac{1}{a} = \frac{1}{a} \cdot a = 1.$$



You can use parentheses or the times symbol to multiply on a graphing calculator. The answer for $(-0.01)(-0.02)$ is given in scientific notation. The -4 after the E means that the decimal point belongs four places to the left. So the answer is -0.0002 . See Section 5.1 for more information on scientific notation.



EXAMPLE 6

Finding multiplicative inverses

Find the multiplicative inverse (reciprocal) of each number.

- a) -2 b) $\frac{3}{8}$ c) -0.2

helpful hint

A doctor told a nurse to give a patient half the usual dose of a certain medicine. The nurse figured, “dividing in half means dividing by $\frac{1}{2}$, which means multiplying by 2.” So the patient got four times the prescribed amount and died (true story). There is a big difference between dividing a quantity in half and dividing by one-half.

Solution

a) The multiplicative inverse (reciprocal) of -2 is $-\frac{1}{2}$ because

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

b) The reciprocal of $\frac{3}{8}$ is $\frac{8}{3}$ because

$$\frac{3}{8} \cdot \frac{8}{3} = 1.$$

c) First convert the decimal number -0.2 to a fraction:

$$\begin{aligned} -0.2 &= -\frac{2}{10} \\ &= -\frac{1}{5} \end{aligned}$$

So the reciprocal of -0.2 is -5 and $-0.2(-5) = 1$. ■

Note that the reciprocal of any negative number is negative.

Earlier we defined subtraction for real numbers as addition of the additive inverse. We now define division for real numbers as multiplication by the multiplicative inverse (reciprocal).

Division of Real Numbers

For any real numbers a and b with $b \neq 0$,

$$a \div b = a \cdot \frac{1}{b}.$$

If $a \div b = c$, then a is called the **dividend**, b the **divisor**, and c the **quotient**. We also refer to $a \div b$ and $\frac{a}{b}$ as the quotient of a and b .

EXAMPLE 7**calculator****close-up**

A graphing calculator uses a forward slash to indicate division. Note that to divide by the fraction $\frac{3}{8}$ you must use parentheses around the fraction.

-60/-2	
-24/(3/8)	30
-24/3/8	-64
	-1

Dividing signed numbers

Find each quotient.

a) $-60 \div (-2)$

b) $-24 \div \frac{3}{8}$

c) $6 \div (-0.2)$

Solution

a) $-60 \div (-2) = -60 \cdot \left(-\frac{1}{2} \right) = 30$ Multiply by $-\frac{1}{2}$, the reciprocal of -2 .

b) $-24 \div \frac{3}{8} = -24 \cdot \frac{8}{3} = -64$

c) $6 \div (-0.2) = 6(-5) = -30$ ■

You can see from Examples 6 and 7 that a product or quotient is positive when the signs are the same and is negative when the signs are opposite:

same signs $\leftrightarrow$ positive result,

opposite signs $\leftrightarrow$ negative result.

Even though all division can be done as multiplication by a reciprocal, we generally use reciprocals only when dividing fractions. Instead, we find quotients using our knowledge of multiplication and the fact that

$$a \div b = c \quad \text{if and only if} \quad c \cdot b = a.$$

For example, $-72 \div 9 = -8$ because $-8 \cdot 9 = -72$. Using long division or a calculator, you can get

$$-43.74 \div 1.8 = -24.3$$

and check that you have it correct by finding $-24.3 \cdot 1.8 = -43.74$.

We use the same rules for division when division is indicated by a fraction bar. For example,

$$\frac{-6}{3} = -2, \quad \frac{6}{-3} = -2, \quad \frac{-1}{3} = \frac{1}{-3} = -\frac{1}{3}, \quad \text{and} \quad \frac{-6}{-3} = 2.$$

Note that if one negative sign appears in a fraction, the fraction has the same value whether the negative sign is in the numerator, in the denominator, or in front of the fraction. If the numerator and denominator of a fraction are both negative, then the fraction has a positive value.

Division by Zero

Why do we omit division by zero from the definition of division? If we write $10 \div 0 = c$, we need to find c such that $c \cdot 0 = 10$. But there is no such number. If we write $0 \div 0 = c$, we need to find c such that $c \cdot 0 = 0$. But $c \cdot 0 = 0$ is true for any number c . Having $0 \div 0$ equal to any number would be confusing. Thus $a \div b$ is defined only for $b \neq 0$. Quotients such as

$$5 \div 0, \quad 0 \div 0, \quad \frac{7}{0}, \quad \text{and} \quad \frac{0}{0}$$

are said to be *undefined*.

helpful hint

Some people remember that “two positives make a positive, a negative and a positive make a negative, and two negatives make a positive.” Of course, that is true only for multiplication, division, and cute stories like the following: If a good person comes to town, that’s good. If a bad person comes to town, that’s bad. If a good person leaves town, that’s bad. If a bad person leaves town, that’s good.

WARM-UPS

True or false? Explain your answer.

1. The additive inverse of -6 is 6 .
2. The opposite of negative 5 is positive 5 .
3. The absolute value of 6 is -6 .
4. The result of a subtracted from b is the same as $b + (-a)$.
5. If a is positive and b is negative, then ab is negative.
6. If a is positive and b is negative, then $a + b$ is negative.
7. $(-3) - (-6) = -9$
8. $6 \div \left(-\frac{1}{2}\right) = -3$
9. $-3 \div 0 = 0$
10. $0 \div (-7) = 0$

1.3 EXERCISES

Reading and Writing After reading this section, write out the answers to these questions. Use complete sentences.

1. What is absolute value?
2. How do you add two numbers with the same sign?
3. How do you add two numbers with unlike signs and different absolute values?
4. What is the relationship between subtraction and addition?

5. How do you multiply signed numbers?

6. What is the relationship between division and multiplication?

Evaluate. See Examples 1 and 2.

- | | |
|-------------------|------------------|
| 7. $ -34 $ | 8. $ 17 $ |
| 9. $ 0 $ | 10. $ -15 $ |
| 11. $ -6 - -6 $ | 12. $ 8 - -8 $ |
| 13. $- -9 $ | 14. $- -3 $ |
| 15. $-(-9)$ | 16. $-(-8)$ |
| 17. $-(-(-3))$ | 18. $-(-(-2))$ |

Find each sum. See Example 3.

- | | |
|---|--|
| 19. $(-5) + 9$ | 20. $(-3) + 10$ |
| 21. $(-4) + (-3)$ | 22. $(-15) + (-11)$ |
| 23. $-6 + 4$ | 24. $5 + (-15)$ |
| 25. $7 + (-17)$ | 26. $-8 + 13$ |
| 27. $(-11) + (-15)$ | 28. $-18 + 18$ |
| 29. $18 + (-20)$ | 30. $7 + (-19)$ |
| 31. $-14 + 9$ | 32. $-6 + (-7)$ |
| 33. $-4 + 4$ | 34. $-7 + 9$ |
| 35. $-\frac{1}{10} + \frac{1}{5}$ | 36. $-\frac{1}{8} + \left(-\frac{1}{8}\right)$ |
| 37. $\frac{1}{2} + \left(-\frac{2}{3}\right)$ | 38. $\frac{3}{4} + \frac{1}{2}$ |
| 39. $-15 + 0.02$ | 40. $0.45 + (-1.3)$ |

- | | |
|----------------------|------------------|
| 41. $-2.7 + (-0.01)$ | 42. $0.8 + (-1)$ |
|----------------------|------------------|

 43. $47.39 + (-44.587)$  44. $0.65357 + (-2.375)$

 45. $0.2351 + (-0.5)$  46. $-1.234 + (-4.756)$

Find each difference. See Example 4.

- | | | |
|---|---------------------------------|-----------------------|
| 47. $7 - 10$ | 48. $8 - 19$ | 49. $-4 - 7$ |
| 50. $-5 - 12$ | 51. $7 - (-6)$ | 52. $3 - (-9)$ |
| 53. $-1 - 5$ | 54. $-4 - 6$ | 55. $-12 - (-3)$ |
| 56. $-15 - (-6)$ | 57. $20 - (-3)$ | 58. $50 - (-70)$ |
| 59. $\frac{9}{10} - \left(-\frac{1}{10}\right)$ | 60. $\frac{1}{8} - \frac{1}{4}$ | 61. $1 - \frac{3}{2}$ |
| 62. $-\frac{1}{2} - \left(-\frac{1}{3}\right)$ | 63. $2 - 0.03$ | 64. $-0.02 - 3$ |

65. $5.3 - (-2)$

66. $-4.1 - 0.13$

 67. $-2.44 - 48.29$

 68. $-8.8 - 9.164$

 69. $-3.89 - (-5.16)$

 70. $0 - (-3.5)$

Find each product. See Example 5.

- | | |
|--|--|
| 71. $(25)(-3)$ | 72. $(5)(-7)$ |
| 73. $\left(-\frac{1}{3}\right)\left(-\frac{1}{2}\right)$ | 74. $\left(-\frac{1}{2}\right)\left(-\frac{6}{7}\right)$ |
| 75. $(0.3)(-0.3)$ | 76. $(-0.1)(-0.5)$ |
| 77. $(-0.02)(-10)$ | 78. $(0.05)(-2.5)$ |

Find the multiplicative inverse of each number. See Example 6.

- | | | |
|--------|----------|--------------------|
| 79. 20 | 80. -5 | 81. $-\frac{6}{5}$ |
|--------|----------|--------------------|

- | | | |
|--------------------|------------|-----------|
| 82. $-\frac{1}{8}$ | 83. -0.3 | 84. 0.125 |
|--------------------|------------|-----------|

Evaluate. See Example 7.

- | | |
|---|--|
| 85. $-6 \div 3$ | 86. $84 \div (-2)$ |
| 87. $30 \div (-0.8)$ | 88. $(-9)(-6)$ |
| 89. $(-0.8)(0.1)$ | 90. $7 \div (-0.5)$ |
| 91. $(-0.1) \div (-0.4)$ | 92. $(-18) \div (-0.9)$ |
| 93. $9 \div \left(-\frac{3}{4}\right)$ | 94. $-\frac{1}{3} \div \left(-\frac{5}{8}\right)$ |
| 95. $-\frac{2}{3} \div \left(-\frac{9}{10}\right)$ | 96. $\frac{1}{2} \div \left(-\frac{2}{5}\right)$ |
|  97. $(0.25)(-365)$ |  98. $7.5 \div (-0.15)$ |
|  99. $(-51) \div (-0.003)$ |  100. $(-2.8)(5.9)$ |

Perform the following computations.

- | | |
|--|--|
| 101. $-62 + 13$ | 102. $-88 + 39$ |
| 103. $-32 - (-25)$ | 104. $-71 - (-19)$ |
| 105. $ -15 $ | 106. $- -75 $ |
| 107. $\frac{1}{2}(-684)$ | 108. $\frac{1}{3}(-123)$ |
| 109. $\frac{1}{2} - \left(-\frac{1}{4}\right)$ | 110. $\frac{1}{8} - \left(-\frac{1}{4}\right)$ |
| 111. $-57 \div 19$ | 112. $0 \div (-36)$ |
| 113. $ -17 + -3 $ | 114. $64 - -12 $ |
| 115. $0 \div (-0.15)$ | 116. $-20 \div \left(-\frac{8}{3}\right)$ |
| 117. $27 \div (-0.15)$ | 118. $33 \div (-0.2)$ |

119. $-\frac{1}{3} + \frac{1}{6}$

120. $-\frac{2}{3} + \frac{1}{6}$

121. $-63 + |8|$

122. $|-34| - 27$

123. $-\frac{1}{2} + \left(-\frac{1}{2}\right)$

124. $-\frac{2}{3} + \left(-\frac{2}{3}\right)$

125. $-\frac{1}{2} - 19$

126. $-\frac{1}{3} - 22$

127. $28 - 0.01$

128. $55 - 0.1$

129. $-29 - 0.3$

130. $-0.241 - 0.3$

131. $(-2)(0.35)$

132. $(-3)(0.19)$

133. $(-10)(-0.2)$

134. $\left(-\frac{1}{2}\right)(-50)$

Use an operation with signed numbers to solve each problem.

135. **Net worth of a family.** The average American family has an \$85,000 house, a \$45,000 mortgage, \$2,300 in credit card debt, \$1,500 in other debts, \$1,200 in savings, and two cars worth \$3,500 each. What is the net worth of the average American family?

136. **Net worth of a bank.** Just before the recession, First Federal Homestead had \$15.6 million in mortgage loans, had \$23.3 million on deposit, and owned \$8.5 million worth of real estate. After the recession started, the value of the real estate decreased to \$4.8 million. What was the net worth of First Federal before the recession and after the recession started? (To a financial institution a loan is an asset and a deposit is a liability.)

137. **Warming up.** On January 11 the temperature at noon was 14°F in St. Louis and -6°F in Duluth. How much warmer was it in St. Louis?

138. **Bitter cold.** On January 16 the temperature at midnight was -31°C in Calgary and -20°C in Toronto. How much warmer was it in Toronto?

139. **Below sea level.** The altitude of the floor of Death Valley is -282 feet (282 feet below sea level); the altitude of the shore of the Dead Sea is $-1,296$ feet (*Rand McNally World Atlas*). How many feet above the shore of the Dead Sea is the floor of Death Valley?

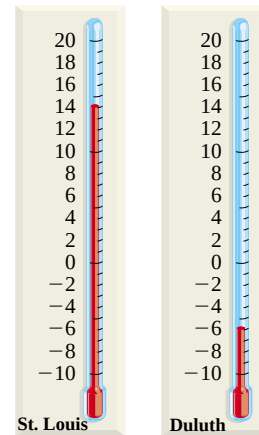


FIGURE FOR EXERCISE 137

140. **Highs and lows.** The altitude of the peak of Mt. Everest, the highest point on earth, is 29,028 feet. The world's greatest known ocean depth of $-36,201$ feet was recorded in the Marianas Trench (*Rand McNally World Atlas*). How many feet above the bottom of the Marianas Trench is a climber who has reached the top of Mt. Everest?

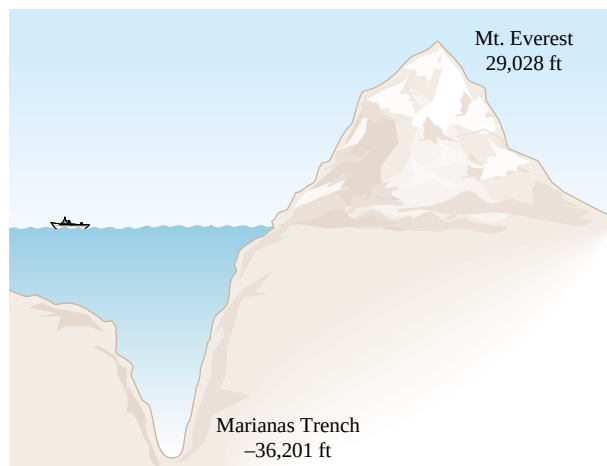


FIGURE FOR EXERCISE 140

GETTING MORE INVOLVED



141. **Discussion.** Why is it necessary to learn addition of signed numbers before learning subtraction of signed numbers and to learn multiplication of signed numbers before division of signed numbers?



142. **Writing.** Explain why 0 is the only real number that does not have a multiplicative inverse.