

# 2.2

## Addition of Real Numbers

### GOAL 1 ADDING REAL NUMBERS

Addition can be modeled with movements on a number line.

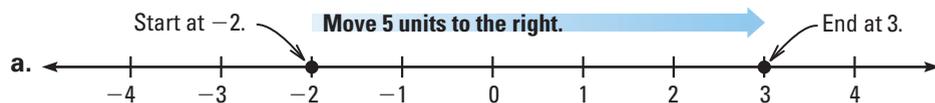
- You add a positive number by moving to the right.
- You add a negative number by moving to the left.

### EXAMPLE 1 Adding Two Real Numbers

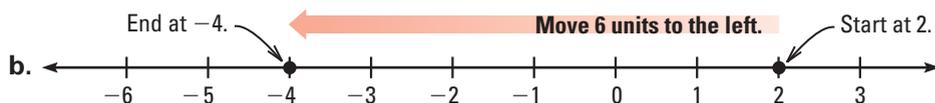
Use a number line to find the sum.

- a.  $-2 + 5$                       b.  $2 + (-6)$

#### SOLUTION



- ▶ The sum can be written as  $-2 + 5 = 3$ .

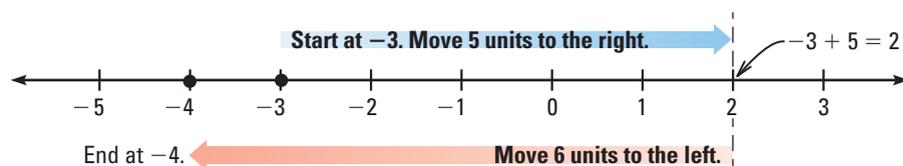


- ▶ The sum can be written as  $2 + (-6) = -4$ .

### EXAMPLE 2 Adding Three Real Numbers

Use a number line to find the sum:  $-3 + 5 + (-6)$ .

#### SOLUTION



- ▶ The sum can be written as  $-3 + 5 + (-6) = -4$ .

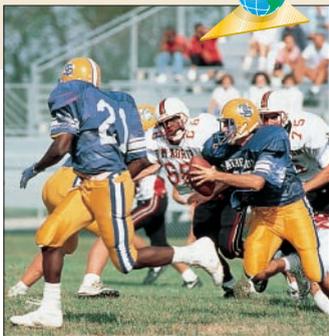
#### What you should learn

**GOAL 1** Add real numbers using a number line or addition rules.

**GOAL 2** Use addition of real numbers to solve **real-life** problems such as finding the profit of a business in **Example 5**.

#### Why you should learn it

▼ To solve **real-life** problems, such as finding the number of yards gained by a football team in **Ex. 51**.



The rules of addition show how to add two real numbers without a number line.

### RULES OF ADDITION

#### TO ADD TWO NUMBERS WITH THE SAME SIGN:

**STEP 1** Add their absolute values.

**STEP 2** Attach the common sign.

Example:  $-4 + (-5)$  **Step 1**  $\rightarrow$   $|-4| + |-5| = 9$  **Step 2**  $\rightarrow$   $-9$

#### TO ADD TWO NUMBERS WITH OPPOSITE SIGNS:

**STEP 1** Subtract the smaller absolute value from the larger absolute value.

**STEP 2** Attach the sign of the number with the larger absolute value.

Example:  $3 + (-9)$  **Step 1**  $\rightarrow$   $|-9| - |3| = 6$  **Step 2**  $\rightarrow$   $-6$

The above rules of addition will help you find sums of positive and negative numbers. It can be shown that these rules are a consequence of the following Properties of Addition.

### PROPERTIES OF ADDITION

#### COMMUTATIVE PROPERTY

The order in which two numbers are added does not change the sum.

$$a + b = b + a \quad \text{Example: } 3 + (-2) = -2 + 3$$

#### ASSOCIATIVE PROPERTY

The way you group three numbers when adding does not change the sum.

$$(a + b) + c = a + (b + c) \quad \text{Example: } (-5 + 6) + 2 = -5 + (6 + 2)$$

#### IDENTITY PROPERTY

The sum of a number and 0 is the number.

$$a + 0 = a \quad \text{Example: } -4 + 0 = -4$$

#### PROPERTY OF ZERO (INVERSE PROPERTY)

The sum of a number and its opposite is 0.

$$a + (-a) = 0 \quad \text{Example: } 5 + (-5) = 0$$

### EXAMPLE 3 Finding a Sum

a.  $1.4 + (-2.6) + 3.1 = 1.4 + (-2.6 + 3.1)$  **Use associative property.**  
 $= 1.4 + 0.5$  **Simplify.**  
 $= 1.9$

b.  $-\frac{1}{2} + 3 + \frac{1}{2} = -\frac{1}{2} + \frac{1}{2} + 3$  **Use commutative property.**  
 $= \left(-\frac{1}{2} + \frac{1}{2}\right) + 3$  **Use associative property.**  
 $= 0 + 3 = 3$  **Use identity property and property of zero.**

#### STUDENT HELP



#### HOMEWORK HELP

Visit our Web site  
[www.mcdougallittell.com](http://www.mcdougallittell.com)  
for extra examples.

#### Look Back

For help with fraction operations, see pp. 781–783.

**FOCUS ON APPLICATIONS**



**CRYSTALS** are often made up of ions. The attraction of positive and negative ions to each other results in a regular geometric pattern.

**GOAL 2 USING ADDITION IN REAL LIFE**

**EXAMPLE 4 Adding Real Numbers**

**SCIENCE CONNECTION** Atoms are composed of electrons, neutrons, and protons. Each electron has a charge of  $-1$ , each neutron has a charge of  $0$ , and each proton has a charge of  $+1$ . The total charge of an atom is the sum of all the charges of its electrons, neutrons, and protons. An atom is an ion if it has a positive or negative charge. If an atom has a charge of zero, it is *not* an ion. Are the following atoms ions?

- a. Aluminum: 13 electrons, 13 neutrons, 13 protons
- b. Aluminum: 10 electrons, 13 neutrons, 13 protons

**SOLUTION**

- a. The total charge is  $-13 + 0 + 13 = 0$ , so the atom is not an ion. In chemistry this aluminum atom is written as Al.
- b. The total charge is  $-10 + 0 + 13 = 3$ , so the atom is an ion. In chemistry this aluminum ion is written as  $Al^{3+}$ .

**PROFIT AND LOSS** A company has a *profit* if its income is greater than its expenses. It has a *loss* if its income is less than its expenses. Business losses can be indicated by negative numbers.

**EXAMPLE 5 Finding the Total Profit**

A consulting company had the following monthly results after comparing income and expenses. Add the monthly profits and losses to find the overall profit or loss during the six-month period.

JANUARY	FEBRUARY	MARCH
-\$13,142.50	-\$6,783.16	-\$4,734.86
APRIL	MAY	JUNE
\$3,825.01	\$7,613.17	\$12,932.54

**SOLUTION** With this many large numbers, you may want to use a calculator.

$$13142.50 \text{ +/- } + 6783.16 \text{ +/- } + 4734.86 \text{ +/- } + 3825.01 \text{ +/- } + 7613.17 \text{ +/- } + 12932.54 \text{ +/- } = -289.8$$

▶ The display is  $-289.8$ . This means the company had a loss of \$289.80.

**STUDENT HELP**

**KEYSTROKE HELP**

To enter  $-5$  on a calculator with a +/- key, enter 5 +/- . To enter  $-5$  on a calculator with a (-) key, enter (-) 5.

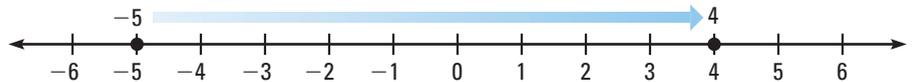
# GUIDED PRACTICE

## Vocabulary Check ✓

## Concept Check ✓

## Skill Check ✓

1. Would a business represent *profits* or *losses* with negative numbers?
2. Is the order in which you add two numbers important? Make a sketch to help explain your answer. What property does this illustrate?
3. Show how to model the sum of  $-3$ ,  $2$ , and  $-1$  in two ways. Make a sketch to illustrate both ways.
4. Write an addition equation to represent the sum modeled on the number line.



Find the sum.

5.  $-2 + 0$                       6.  $4 + (-3)$                       7.  $-2 + (-3)$

8.  $-7 + 7$                       9.  $-1 + 6$                       10.  $-4 + \frac{1}{2}$

11. **TEMPERATURE** The highest recorded temperature in Hawaii is  $100^{\circ}\text{F}$ . The highest recorded temperature in Colorado is  $18^{\circ}\text{F}$  higher than that of Hawaii. What is the highest recorded temperature in Colorado?

► Source: National Oceanographic and Atmospheric Administration

# PRACTICE AND APPLICATIONS

## STUDENT HELP

► **Extra Practice** to help you master skills is on p. 798.

## NUMBER LINE SUMS Use a number line to find the sum.

12.  $-8 + 12$                       13.  $2 + (-5)$                       14.  $-3 + (-3)$   
 15.  $-3 + (-7)$                       16.  $-4 + 5$                       17.  $-10 + 4$   
 18.  $-5 + 8 + (-2)$                       19.  $2 + (-9) + 3$                       20.  $-5 + 8 + \left(-3\frac{1}{2}\right)$

## RULES OF ADDITION Find the sum.

21.  $-4 + 6$                       22.  $17 + 35$                       23.  $19 + 0$   
 24.  $0 + (-5)$                       25.  $-13 + (-6)$                       26.  $14 + (-11)$   
 27.  $-5 + 10 + (-3)$                       28.  $-4 + 10 + (-6)$                       29.  $-11.6 + 6.4 + (-3.0)$   
 30.  $5.7 + (-9.5) + 5.2$                       31.  $6.8 + 3.3 + (-4.1)$                       32.  $9.8 + (-6.3) + (-7.2)$

## ADDITION PROPERTIES Name the property that makes the statement true.

33.  $-8 + 0 = -8$                       34.  $2 + (-3) = -3 + 2$   
 35.  $-2 + 2 = 0$                       36.  $(-4 + 3) + 1 = -4 + (3 + 1)$



## FINDING SUMS Find the sum. Use a calculator if you wish.

37.  $-2.95 + 5.76 + (-88.6)$                       38.  $10.97 + (-51.14) + (-40.97)$   
 39.  $20.37 + 190.8 + (-85.13)$                       40.  $300.3 + (-22.24) + 78.713$   
 41.  $-1.567 + (-2.645) + 5308.34$                       42.  $-7344.28 + 2997.65 + (-255.11)$

## STUDENT HELP

### ► HOMEWORK HELP

**Example 1:** Exs. 12–17  
**Example 2:** Exs. 18–20  
**Example 3:** Exs. 21–36  
**Example 4:** Exs. 52–54  
**Example 5:** Exs. 37–42, 55

**STUDENT HELP**

**Look Back**

For help with evaluating expressions, see p. 3.

**EVALUATING EXPRESSIONS** Evaluate the expression for the given value of  $x$ .

- 43.  $5 + x + (-8)$ ;  $x = 2$
- 44.  $4 + x + 10 + (-10)$ ;  $x = 3$
- 45.  $-24 + 6 + x$ ;  $x = 8$
- 46.  $-6 + x + 4$ ;  $x = -3$
- 47.  $2 + (-5) + x + 14$ ;  $x = -8$
- 48.  $-11 + (-2) + 11 + x$ ;  $x = -10$
- 49.  $x + (-6) + (-11)$ ;  $x = -7$
- 50.  $9 + x + (-8) + (-3)$ ;  $x = -12$
- 51. **CHAMPIONSHIP GAME** In the game that decides the high school football championship, your team needs to gain 14 yards to score a touchdown and win. Your team's final four plays result in a 9-yard gain, a 5-yard loss, a 4-yard gain, and a 5-yard gain as time runs out. Use a number line to model the gains and losses. Did your team win?

**FOCUS ON APPLICATIONS**



**SCIENCE CONNECTION** In Exercises 52–54, use the information in Example 4 on page 74 and in the table below. The table shows the number of electrons and protons in atoms of sodium (Na) and fluorine (F).

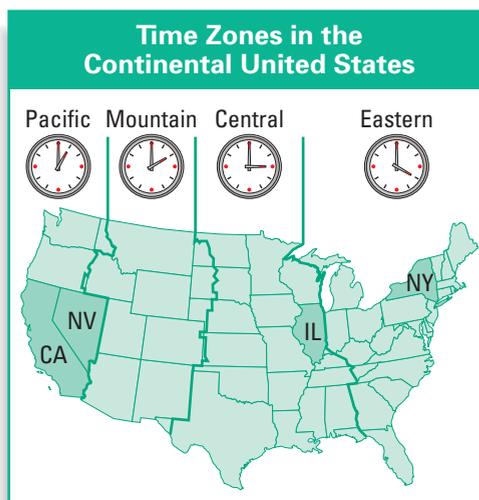
- 52. Find the total charge of each sodium atom. Then decide whether the atom is an ion. Which atom has a symbol of  $\text{Na}^+$ ?
- 53. Find the total charge of each fluorine atom. Then decide whether the atom is an ion. Which atom has a symbol of  $\text{F}^-$ ?

Atom	Electrons	Protons
Na atom 1	10	11
Na atom 2	11	11
F atom 1	9	9
F atom 2	10	9

- 54. **CRITICAL THINKING** You do not need to know the number of neutrons in an atom to find its total charge. Explain why not. Which property of addition supports your answer?
- 55. **PROFIT AND LOSS** A pest control company had a profit of \$3,514.65 in April, a profit of \$5,674.25 in May, a loss of \$8,992.88 in June, and a loss of \$1,207.03 in July. Did the company make a profit during the 4-month period? Explain.

**TIME ZONES** In Exercises 56 and 57, use the time zones map. It shows the time in different zones of the country when it is 1:00 P.M. in California.

- 56. A Thanksgiving Day parade in New York City is scheduled to begin at 9:00 A.M. and will be televised live. If you live in Nevada, at what time can you see the parade begin on television?
- 57. A New Year's Day parade in California is scheduled to begin at 8:00 A.M. and will be televised live. If you live in Illinois, at what time can you see the parade begin on television?



## Test Preparation



**MULTIPLE CHOICE** In Exercises 58–60, use the table, which shows a 6-month record of a household budget used to calculate monthly savings.

58. In which month did the household save the most money?

- (A) January      (B) March  
(C) May          (D) June

59. In which month did the household's spending most exceed its earnings?

- (A) January      (B) February  
(C) April          (D) June

60. How much money did the household save during the 6-month period?

- (A) \$83.31      (B) \$16.69      (C) \$116.69      (D) \$183.31

Month	\$ Earned	\$ Spent	\$ Saved
Jan.	1676.05	-1427.37	?
Feb.	1554.52	-1771.89	?
Mar.	1851.89	-1556.44	?
Apr.	1567.96	-1874.72	?
May	1921.03	-1602.19	?
June	1667.67	-1989.82	?

## ★ Challenge

### EXTRA CHALLENGE

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61. **LOGICAL REASONING** Formulate the following statement in terms of variables. Then decide whether it is *true* or *false*. *The opposite of the sum of two numbers is equal to the sum of the opposites of the numbers.* If false, give a counterexample. If true, give two examples involving negative numbers.

## MIXED REVIEW

**FRACTION OPERATIONS** Find the difference. (Skills Review, p. 781)

62.  $\frac{4}{5} - \frac{2}{5}$

63.  $\frac{8}{9} - \frac{2}{3}$

64.  $\frac{3}{4} - \frac{5}{12}$

65.  $\frac{7}{8} - \frac{1}{4}$

66.  $4\frac{2}{3} - 2\frac{1}{5}$

67.  $\frac{5}{6} - \frac{1}{9}$

68.  $7\frac{9}{10} - 5\frac{3}{7}$

69.  $\frac{5}{12} - \frac{3}{16}$

**VARIABLE EXPRESSIONS** Evaluate the expression. (Review 1.3)

70.  $a^4 + 8$  when  $a = 10$

71.  $79 - v^3$  when  $v = 4$

72.  $t^2 - 7t + 12$  when  $t = 8$

73.  $2x^2 + 8x - 5$  when  $x = 3$

**CHECKING SOLUTIONS** Check whether the given number is a solution of the equation. (Review 1.4)

74.  $x + 5 = 11$ ; 7

75.  $12 - 2a = 18$ ; 4

76.  $7y - 15 = 6$ ; 3

77.  $3 + 2d = 9 + d$ ; 6

78.  $3w - 7 = w + 1$ ; 5

79.  $6z + 5 = 8z - 12$ ; 8.5

**PIZZA** In Exercises 80–82, use the following information. A pizzeria charges \$6.00 for a large cheese pizza, and \$.85 for each additional topping. The total cost  $C$  of a large cheese pizza with  $n$  additional toppings is given by  $C = 6 + 0.85n$ . (Review 1.7)

80. Write an input-output table that shows the total cost of a pizza with 0, 1, 2, 3, 4, and 5 additional toppings.

81. Describe the domain and range of the function.

82. Graph the data in the input-output table.