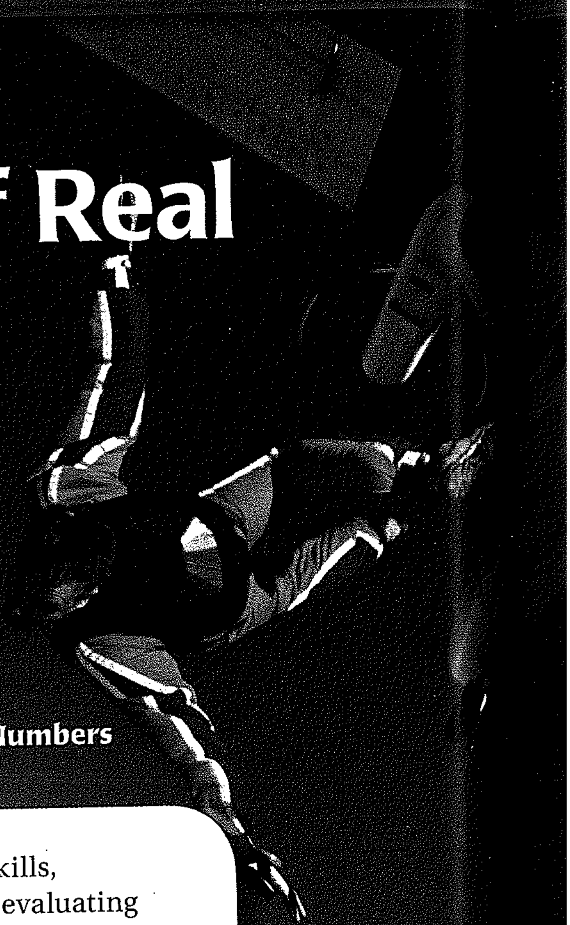
2 Properties of Real Numbers



Before

In previous courses and in Chapter 1, you learned the following skills, which you'll use in Chapter 2: comparing and ordering numbers, evaluating expressions, and applying the order of operations.

Prerequisite Skills

VOCABULARY CHECK

In Exercises 1 and 2, copy and complete the statement.

1. The **least common denominator** of the fractions $\frac{3}{8}$ and $\frac{5}{12}$ is __?__.
2. The **variable** in the expression $5x - 3$ is __?__.
3. According to the **order of operations**, what is the first step in simplifying the expression $(3 + 4)^2 - 8$?

SKILLS CHECK

Copy and complete the statement using <, >, or =. ***(Review p. 909 for 2.1, 2.7.)***

4. 26.70 __?__ 29.69 5. 15.09 __?__ 15.1 6. 0.333 __?__ 0.34 7. 2.5 __?__ 2.500

Evaluate the expression when $x = 5$. ***(Review p. 2 for 2.2–2.4, 2.6.)***

8. $52 - x$ 9. $1.7x$ 10. $x + 39$ 11. $\frac{125}{x}$

Evaluate the expression. ***(Review p. 8 for 2.5.)***

12. $5m - 9$ when $m = 6$ 13. $16 - r - 3$ when $r = 10$

@HomeTutor Prerequisite skills practice at classzone.com

Now

In Chapter 2, you will apply the big ideas listed below and reviewed in the Chapter Summary on page 120. You will also use the key vocabulary listed below.

Big Ideas

1. **Performing operations with real numbers**
2. **Applying properties of real numbers**
3. **Classifying and reasoning with real numbers**

KEY VOCABULARY

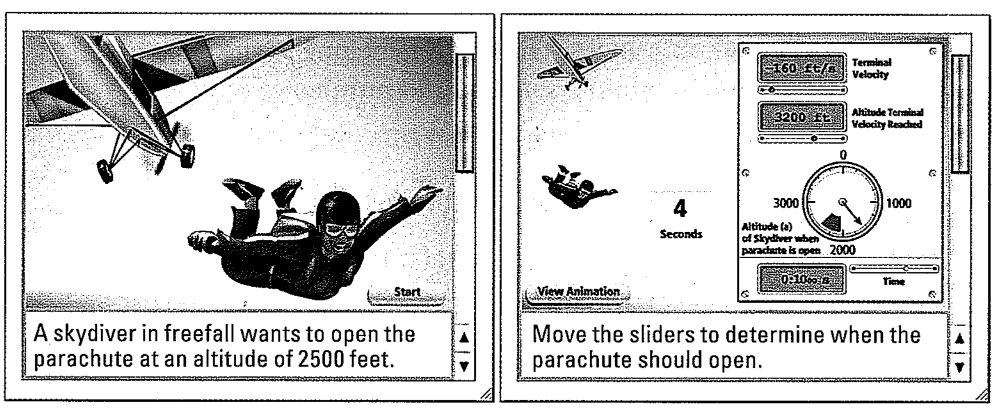
- whole numbers, integers, *p. 64*
- rational number, *p. 64*
- opposites, absolute value, *p. 66*
- conditional statement, *p. 66*
- additive identity, *p. 76*
- additive inverse, *p. 76*
- multiplicative identity, *p. 89*
- equivalent expressions, *p. 96*
- distributive property, *p. 96*
- term, coefficient, constant term, like terms, *p. 97*
- multiplicative inverse, *p. 103*
- square root, radicand, *p. 110*
- perfect square, *p. 111*
- irrational number, *p. 111*
- real numbers, *p. 112*

Why?

You can use multiple representations to solve a problem about a real-world situation. For example, you can write an equation and make a table to find a skydiver's altitude over time.

Animated Algebra

The animation illustrated below for Exercise 54 on page 93 helps you answer this question: How does the time spent in free fall after a skydiver reaches terminal velocity affect the altitude of the skydiver?



Animated Algebra at classzone.com

Other animations for Chapter 2: pages 73, 80, 90, and 98

EXAMPLE 6 Analyze a conditional statement

Identify the hypothesis and the conclusion of the statement "If a number is a rational number, then the number is an integer." Tell whether the statement is *true* or *false*. If it is false, give a counterexample.

Solution

Hypothesis: a number is a rational number

Conclusion: the number is an integer

The statement is false. The number 0.5 is a counterexample, because 0.5 is a rational number but not an integer.

✓ GUIDED PRACTICE for Examples 4, 5, and 6

For the given value of a, find $-a$ and $|a|$.

8. $a = 5.3$ **9.** $a = -7$ **10.** $a = -\frac{4}{9}$

Identify the hypothesis and the conclusion of the statement. Tell whether the statement is *true* or *false*. If it is false, give a counterexample.

11. If a number is a rational number, then the number is positive.

12. If the absolute value of a number is positive, then the number is positive.

2.1 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS3 for Exs. 7, 29, and 53

★ = **STANDARDIZED TEST PRACTICE** Exs. 3, 4, 39, 50, 56, and 59

SKILL PRACTICE

1. VOCABULARY Copy and complete: A number is a(n) _?_ if it can be written in the form $\frac{a}{b}$ where a and b are integers and $b \neq 0$.

2. VOCABULARY What is the opposite of −2?

3. ★ WRITING *Describe* the difference between whole numbers and positive integers.

4. ★ WRITING For a negative number x, is the absolute value of x a *positive number* or a *negative number*? *Explain.*

EXAMPLE 1 on p. 64 for Exs. 5–13

GRAPHING AND COMPARING INTEGERS Graph the numbers on a number line. Then tell which number is greater.

5. 0 and 7	**6.** 0 and −4	**(7.)** −5 and −6
8. −2 and −3	**9.** 5 and −2	**10.** −12 and 8
11. −1 and −5	**12.** 3 and −13	**13.** −20 and −2

EXAMPLES 2 and 3
on p. 65
for Exs. 14–22

CLASSIFYING AND ORDERING NUMBERS **Tell whether each number in the list is a whole number, an integer, or a rational number. Then order the numbers from least to greatest.**

14. 3, −5, −2.4, 1 **15.** 1.6, 1, −4, 0 **16.** 0.25, −0.5, 0.2, −2

17. $-\frac{2}{3}$, −0.6, −1, $\frac{1}{3}$ **18.** −0.01, 0.1, 0, $-\frac{1}{10}$ **19.** 16, −1.66, $\frac{5}{3}$, −1.6

20. −2.7, $\frac{1}{2}$, 0.3, −7 **21.** −4.99, 5, $\frac{16}{3}$, −5.1 **22.** $-\frac{3}{5}$, −0.4, −1, −0.5

EXAMPLES 4 and 5
on p. 66
for Exs. 23–34

FINDING OPPOSITES AND ABSOLUTE VALUES **For the given value of a, find $-a$ and $|a|$.**

23. $a = 6$ **24.** $a = -3$ **25.** $a = -18$ **26.** $a = 0$

27. $a = 13.4$ **28.** $a = 2.7$ **29.** $a = -6.1$ **30.** $a = -7.9$

31. $a = -1\frac{1}{9}$ **32.** $a = -\frac{5}{6}$ **33.** $a = \frac{3}{4}$ **34.** $a = 1\frac{1}{3}$

EXAMPLE 6
on p. 67
for Exs. 35–38

ANALYZING CONDITIONAL STATEMENTS **Identify the hypothesis and the conclusion of the conditional statement. Tell whether the statement is *true* or *false*. If it is false, give a counterexample.**

35. If a number is a positive integer, then the number is a whole number.

36. If a number is negative, then its absolute value is negative.

37. If a number is positive, then its opposite is positive.

38. If a number is an integer, then the number is a rational number.

39. ★ **MULTIPLE CHOICE** Which number is a whole number?

Ⓐ $\left|-\frac{18}{9}\right|$ Ⓑ $-\frac{4}{3}$ Ⓒ 1.6 Ⓓ −(−7.963)

ERROR ANALYSIS ***Describe*** **and correct the error in the statement.**

40. The numbers −(−2), −4, −|8|, and −0.3 are negative numbers.

41. The numbers |−3.4|, −(−8), −|−0.2|, and 0.87 are positive numbers.

EVALUATING EXPRESSIONS **Evaluate the expression when $x = -0.75$.**

42. $-x$ **43.** $|x| + 0.25$ **44.** $|x| - 0.75$ **45.** $1 + |-x|$

46. $2 \cdot (-x)$ **47.** $(-x) \cdot 3$ **48.** $|x| + |x|$ **49.** $-x + |x|$

50. ★ **MULTIPLE CHOICE** Which number is a solution of $|x| + 1 = 1.3$?

Ⓐ −2.3 Ⓑ −0.3 Ⓒ 1.3 Ⓓ 2.3

51. CHALLENGE What can you conclude about the opposite of the opposite of a number? *Explain* your reasoning.

52. CHALLENGE For what values of a is the opposite of a greater than a? less than a? equal to a?

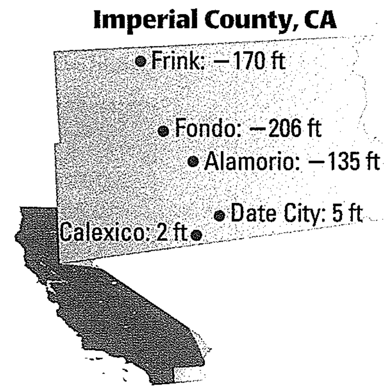
○ = **WORKED-OUT SOLUTIONS on p. WS1**

★ = **STANDARDIZED TEST PRACTICE**

PROBLEM SOLVING

EXAMPLE 3
on p. 65
for Exs. 53, 57

53. GEOGRAPHY The map shows various locations in Imperial County, California, and their elevations above or below sea level. Order the locations from lowest elevation to highest elevation.



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54. SPORTS In golf, the goal is to have the least score among all the players. Which golf score, −8 or −12, is the better score?

@HomeTutor for problem solving help at classzone.com

EXAMPLE 5
on p. 66
for Exs. 55–56

55. MUSIC A guitar tuner is a device that tunes a guitar string to its exact pitch. Some tuners use the measure *cents* to indicate how far above or below the exact pitch, marked as 0 cents, the string tone is. Suppose that one string tone measures −3.4 cents, and a second string tone measures −3.8 cents. Which string tone is closer to the exact pitch? *Explain.*

56. ★ MULTIPLE CHOICE The change in value of a share of a stock was −\$.45 on Monday, −\$1.32 on Tuesday, \$.27 on Wednesday, and \$1.03 on Thursday. On which day was the absolute value of the change the greatest?

(A) Monday (B) Tuesday (C) Wednesday (D) Thursday

57. MULTI-STEP PROBLEM An equalizer on a stereo system is used to increase or decrease the intensity of sounds at different frequencies. The intensity is measured in decibels (dB), and the frequencies are measured in hertz (Hz). The table shows the intensity at different frequencies on a stereo system.

Frequency (Hz)	32	64	125	250	500	1000	2000	4000	8000
Intensity (dB)	8.8	7.1	5.8	1.5	−2.8	−1.5	2.7	2.8	2.9

a. Which frequency has the least sound intensity?

b. *Describe* the change in sound intensity as the frequency increases from 32 hertz to 8000 hertz.

58. WEATHER A wind chill index describes how much colder it feels outside when wind speed is considered with air temperature. The table shows the wind chill temperatures for given pairs of air temperature and wind speed.

Wind Chill Temperatures (°F)

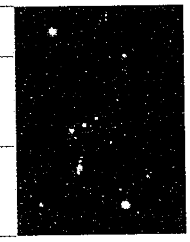
Wind speed (mi/h)	Air temperature (°F)				
	20	**10**	**0**	**−10**	**−20**
0	20	10	0	−10	−20
10	9	−4	−16	−28	−41
20	4	−9	−22	−35	−48
30	1	−12	−26	−39	−53

a. Compare Which feels colder, an air temperature of 0°F with a wind speed of 30 miles per hour, or an air temperature of −10°F with a wind speed of 10 miles per hour?

b. Analyze How does the wind chill temperature change under constant wind speed and decreasing air temperature? under constant air temperature and increasing wind speed?

59. ★ **EXTENDED RESPONSE** A star's apparent magnitude measures how bright the star appears to a person on Earth. A star's absolute magnitude measures its brightness if it were a distance of 33 light-years, or about 194 trillion miles, from Earth. The greater the magnitude, the dimmer the star.

Star	Arcturus	Achernar	Canopus	Capella	Sirius	Sun
Apparent magnitude	−0.04	0.46	−0.72	0.08	−1.46	−26.72
Absolute magnitude	0.2	−1.3	−2.5	0.4	1.4	4.8


Orion Constellation

a. **Order** Order the stars in the table from brightest to dimmest when viewed from Earth. Then order the stars from brightest to dimmest if they were 33 light-years from Earth.

b. **Compare** The star Rigel has an apparent magnitude of 0.12 and an absolute magnitude of −8.1. *Compare* its brightness with the Sun's brightness using both apparent magnitude and absolute magnitude.

c. **Analyze** Can you use the apparent magnitudes of two stars to predict which star is brighter in terms of absolute magnitude? *Explain* your answer using a comparison of the apparent and absolute magnitudes of two stars in the table.

60. **CHALLENGE** In an academic contest, the point values of the questions are given by the expression $50x$ where $x = 1, 2, 3,$ and 4. You earn $50x$ points for a correct answer to a question and $-(50x)$ points for an incorrect answer. Order from least to greatest all the possible points you can earn when answering a question.

MIXED REVIEW

PREVIEW
Prepare for Lesson 2.2 in Exs. 61–66.

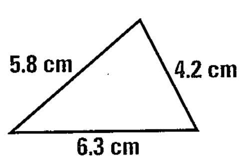
Add. *(p. 914)*

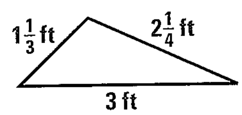
61. $\frac{1}{2} + \frac{1}{3}$

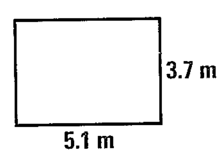
62. $\frac{5}{6} + \frac{1}{6}$

63. $2\frac{1}{2} + 1\frac{3}{4}$

Find the perimeter of the triangle or rectangle. *(p. 924)*

64.


65.


66.


Check whether the given number is a solution of the inequality. *(p. 21)*

67. $x + 2 < 3$; 2

68. $y - 8 < 6$; 13

69. $9 - 2z \leq 3$; 3

70. $2y + 3 \geq 14$; 5

71. $3 < 7x - 4$; 1

72. $2a \geq 15$; 7

Make a table for the function. Identify the range of the function. *(p. 43)*

73. $y = x - 3$
Domain: 5, 8, 14, 30

74. $y = 1.5x$
Domain: 0, 2, 6, 10

75. $y = 2x - 3$
Domain: 2, 4, 7, 11

Extension
Use after Lesson 2.1

Apply Sets to Numbers and Functions

GOAL Apply set theory to numbers and functions.

Key Vocabulary
- set
- element
- empty set
- universal set
- union
- intersection

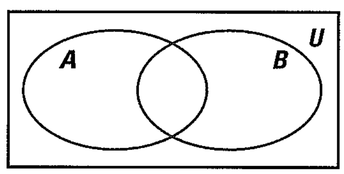
A **set** is a collection of distinct objects. Each object in a set is called an **element** or *member* of the set. You can use *set notation* to write a set by enclosing the elements of the set in braces. For example, if A is the set of whole numbers less than 6, then $A = \{0, 1, 2, 3, 4, 5\}$.

Two special sets are the *empty set* and the *universal set*. The set with no elements is called the **empty set** and is written as $\emptyset$. The set of all elements under consideration is called the **universal set** and is written as U.

KEY CONCEPT *For Your Notebook*

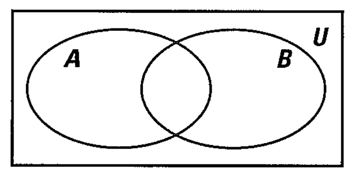
Union and Intersection of Two Sets

The **union** of two sets A and B is the set of all elements in *either* A or B and is written as $A \cup B$.



$A \cup B$

The **intersection** of two sets A and B is the set of all elements in *both* A and B and is written as $A \cap B$.



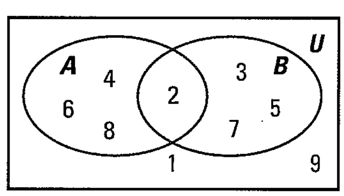
$A \cap B$

EXAMPLE 1 Find the union and intersection of two sets

Let U be the set of integers from 1 to 9. Let $A = \{2, 4, 6, 8\}$ and $B = \{2, 3, 5, 7\}$. Find (a) $A \cup B$ and (b) $A \cap B$.

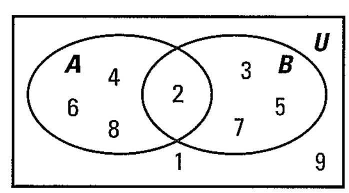
Solution

a. The union of A and B consists of the elements that are in either set.



▶ $A \cup B = \{2, 3, 4, 5, 6, 7, 8\}$

b. The intersection of A and B consists of the elements that are in both sets.

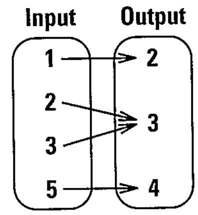


▶ $A \cap B = \{2\}$

FUNCTIONS AND SETS You can write the domain and range of a function as sets of input values and output values and the function as a set of ordered pairs, as illustrated for the mapping diagram below.

Function

Domain
$D = \{1, 2, 3, 5\}$



Range
$R = \{2, 3, 4\}$

$f = \{(1, 2), (2, 3), (3, 3), (5, 4)\}$

EXAMPLE 2 Write a function and its range as sets

Consider the function $y = x + 2$ with domain $D = \{0, 1, 2, 3\}$. Write the range and function using set notation.

Solution

x	0	1	2	3
y	$0 + 2 = 2$	$1 + 2 = 3$	$2 + 2 = 4$	$3 + 2 = 5$

▶ The range is $R = \{2, 3, 4, 5\}$.
The function is $f = \{(0, 2), (1, 3), (2, 4), (3, 5)\}$.

PRACTICE

EXAMPLE 1
on p. 71
for Exs. 1–4

Let U be the set of whole numbers from 0 to 10. Find $A \cup B$ and $A \cap B$ for the specified sets A and B.

1. $A = \{1, 3, 5, 7, 9\}$ and $B = \{3, 6, 9\}$
2. $A = \{1, 2, 3, 4, 5, 6\}$ and $B = \{4, 5, 6, 7, 8\}$
3. $A = \{0, 2, 4, 6, 8, 10\}$ and $B = \{1, 3, 5, 7, 9\}$
4. $A = \{0, 5, 10\}$ and $B = \{1, 4, 7, 10\}$

EXAMPLE 2
on p. 72
for Exs. 5–8

In Exercises 5–8, consider the specified function and domain. Write the range and function using set notation.

5. $y = 2x$ with domain $D = \{1, 2, 3, 4, 5\}$
6. $y = x - 1$ with domain $D = \{2, 4, 6, 8, 10\}$
7. $y = x + 3$ with domain $D = \{1, 5, 9, 13, 17\}$
8. $y = 3x + 2$ with domain $D = \{1, 2, 3, 4, 5\}$
9. Let A be the set of positive integers, and let B be the set of negative integers and 0. Find $A \cup B$ and $A \cap B$.
10. Let A be the set of integers, and let B be the set of rational numbers. Find $A \cup B$ and $A \cap B$.

2.2 Addition of Integers

MATERIALS • algebra tiles

QUESTION **How can you use algebra tiles to find the sum of two integers?**

You can use algebra tiles to model addition of integers. Each + represents 1, and each − represents −1. Pairing a + with a − results in a sum of 0.

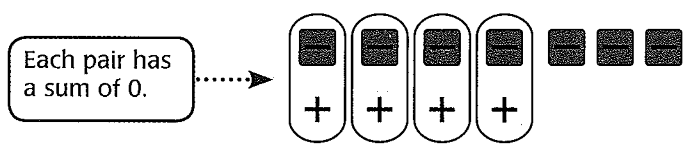
EXPLORE **Find the sum of two integers**

Find the sum −7 + 4.

STEP 1 Model −7 and 4 using algebra tiles.

−7 4

STEP 2 Group pairs of positive and negative tiles. Count the remaining tiles.



STEP 3 Copy and complete the statement: −7 + 4 = __?__.

DRAW CONCLUSIONS **Use your observations to complete these exercises**

Use algebra tiles to find the sum.

1. 3 + 8 **2.** 5 + (−1) **3.** −9 + 6 **4.** −2 + (−3)

5. −4 + 4 **6.** −7 + 5 **7.** 5 + (−7) **8.** −6 + 0

REASONING In Exercises 9–13, answer the question and give an example from Exercises 1–8 to support your answer.

9. Is the sum of two positive integers *positive* or *negative?*

10. Is the sum of two negative integers *positive* or *negative?*

11. Is the sum of a positive integer and a negative integer *always* positive?

12. What is the sum of an integer and its opposite?

13. What is the sum of an integer and 0?

14. In Exercises 6 and 7, the two integers being added are the same, but the order is reversed. What does this suggest about the sums $a + b$ and $b + a$ where a and b are integers?

2.2 EXERCISES

HOMEWORK KEY
◯ = **WORKED-OUT SOLUTIONS** on p. WS3 for Exs. 13, 35, and 55
★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 50, 56, 57, and 58

SKILL PRACTICE

1. **VOCABULARY** What number is called the additive identity?

2. ★ **WRITING** Without actually adding, how can you tell if the sum of two numbers will be zero?

EXAMPLE 1 on p. 74 for Exs. 3–11

USING A NUMBER LINE Use a number line to find the sum.

3. $-11 + 3$
4. $-1 + 6$
5. $13 + (-7)$
6. $5 + (-10)$
7. $-9 + (-4)$
8. $-8 + (-2)$
9. $-14 + 8$
10. $6 + (-12)$
11. $-11 + (-9)$

EXAMPLE 2 on p. 75 for Exs. 12–25

FINDING SUMS Find the sum.

12. $-2.4 + 3.9$
13. (circled) $-8.7 + 4.2$
14. $4.3 + (-10.2)$
15. $9.1 + (-2.5)$
16. $-6.5 + (-7.1)$
17. $-11.4 + (-3.8)$
18. $4\frac{1}{5} + \left(-9\frac{1}{2}\right)$
19. $8\frac{2}{3} + \left(-1\frac{3}{5}\right)$
20. $-12\frac{3}{4} + 6\frac{9}{10}$
21. $-\frac{4}{9} + 1\frac{4}{5}$
22. $-3\frac{3}{7} + \left(-14\frac{3}{4}\right)$
23. $-7\frac{1}{12} + \left(-13\frac{7}{8}\right)$

ERROR ANALYSIS *Describe* and correct the error in finding the sum.

24. $-13 + (-15) = 28$ ✗

25. $17 + (-31) = -48$ ✗

EXAMPLE 3 on p. 76 for Exs. 26–31

IDENTIFYING PROPERTIES Identify the property being illustrated.

26. $-3 + 3 = 0$
27. $(-6 + 1) + 7 = -6 + (1 + 7)$
28. $9 + (-1) = -1 + 9$
29. $-8 + 0 = -8$
30. $(x + 2) + 3 = x + (2 + 3)$
31. $y + (-4) = -4 + y$

EXAMPLE 4 on p. 76 for Exs. 32–37

FINDING SUMS Find the sum.

32. $-13 + 5 + (-7)$
33. $-18 + (-12) + (-19)$
34. $0.47 + (-1.8) + (-3.8)$
35. (circled) $-2.6 + (-3.4) + 7.6$
36. $-3\frac{1}{2} + \left(-7\frac{2}{5}\right) + \left(-9\frac{3}{10}\right)$
37. $8\frac{2}{3} + \left(-6\frac{3}{5}\right) + 3\frac{1}{4}$

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

38. $3 + x + (-7); x = 6$
39. $x + (-5) + 5; x = -3$
40. $9.6 + (-x) + 2.3; x = -8.5$
41. $-1.7 + (-5.4) + (-x); x = 2.4$
42. $1\frac{1}{4} + |x| + \left(-3\frac{1}{2}\right); x = -8\frac{2}{5}$
43. $|x| + \left(-3\frac{1}{4}\right) + \left(7\frac{3}{10}\right); x = -3\frac{1}{3}$

FINDING SOLUTIONS **Solve the equation using mental math.**

44. $x + (-9) + 9 = 8$

45. $(-8) + x + (-2) = -10$

46. $x + (-2.8) + 9.2 = 0$

47. $-8.7 + x + 1.3 = 0$

TRANSLATING PHRASES **In Exercises 48 and 49, translate the verbal phrase into an addition expression. Then find the sum.**

48. The sum of the absolute value of −4 and the additive identity

49. The sum of the opposite of −18 and its additive inverse

50. ★ **MULTIPLE CHOICE** If $a + b$ is negative, which statement must be true?

(A) $a < 0, b < 0$ (B) $a < 0$ (C) $a < 0, b > 0$ (D) $a < -b$

51. **CHALLENGE** Consider the expression $|x| + (-x)$. Write a simplified expression for the sum if x is positive. Then write a simplified expression for the sum if x is negative. Give examples to support your answers.

52. **CHALLENGE** Evaluate $-50 + (-49) + (-48) + \cdots + 48 + 49 + 50$. *Explain* how you can use the properties of addition to obtain the sum.

PROBLEM SOLVING

EXAMPLE 1 on p. 74 for Ex. 53

53. **WEATHER** The temperature in your city at 6 A.M. was −8°F and increased by 15°F by noon. What was the temperature at noon?

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EXAMPLE 2 on p. 75 for Exs. 54–55

54. **PARKING GARAGES** The bottom level of a parking garage has an elevation of −45 feet. The top level of the garage is 100 feet higher. What is the elevation of the top level?

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(55.) **MULTI-STEP PROBLEM** In optometry, the strength of an eyeglass lens is measured in diopters. Two lenses can be combined to create a new lens, and the sum of their strengths is the strength of the new lens.

a. A lens of −4.75 diopters is combined with a lens of 6.25 diopters to form a new lens. What is the strength of the new lens?

b. A lens of −2.5 diopters is combined with a lens of −1.25 diopters to form a new lens. What is the strength of the new lens?

c. The greater the absolute value of the strength of a lens, the stronger the lens. Which new lens is stronger, the one in part (a) or in part (b)?

EXAMPLE 4 on p. 76 for Exs. 56–57

56. ★ **MULTIPLE CHOICE** The table shows the profits for a company from 1999 to 2004. Which three-year period had the greatest total profit?

Year	1999	2000	2001	2002	2003	2004
Profit (millions of dollars)	−13.76	54.91	38.54	−21.33	123.90	−14.82

(A) 1999–2001 (B) 2000–2002 (C) 2001–2003 (D) 2002–2004

○ = **WORKED-OUT SOLUTIONS** on p. WS1 ★ = **STANDARDIZED TEST PRACTICE**

57. ★ **SHORT RESPONSE** In golf, your score on a hole is the number of strokes above or below an expected number of strokes needed to hit a ball into the hole. As shown in the table, each score has a name. When you compare two scores, the lesser score is the better score.

Name	Double eagle	Eagle	Birdie	Par	Bogey	Double bogey
Score	−3	−2	−1	0	1	2

a. **Compare** For three holes, you score an eagle, a double bogey, and a birdie. Your friend scores a double eagle, a bogey, and a par. Who has the better total score?

b. **Explain** Your friend scores a double eagle and an eagle for the next two holes. Is it possible for you to have a better score on all five holes after your next two holes? *Explain* your reasoning.

58. ★ **EXTENDED RESPONSE** Atoms consist of protons, electrons, and neutrons. A group of x protons has a charge of x. A group of x electrons has a charge of $-x$. Neutrons have a charge of 0.

a. **Calculate** The total charge of an atom is the sum of the charges of its protons and electrons. Find the total charge of an atom that has 13 protons, 10 electrons, and 14 neutrons.

b. **Interpret** An atom is an ion only when it has a positive or a negative total charge. Is the atom in part (a) an ion?

c. **Explain** In an atom, only the number of electrons can change. Suppose an atom has a total charge of 5. For the atom not to be an ion, how should the number of electrons change? Your answer should include an algebraic equation that models the situation and an explanation of how you solved the equation.

59. **CHALLENGE** You sold three items in an Internet auction. The table shows the profit earned for each item. You now plan to sell a floor lamp. What is the least profit that you can earn on the lamp and have a positive total profit for the four items? *Explain* your answer.

Item	Profit (dollars)
Mantel clock	4.13
Framed mirror	−10.65
Metal lunch box	−5.87

MIXED REVIEW

PREVIEW
Prepare for Lesson 2.3 in Exs. 60–63.

Evaluate the expression.

60. $t - 7$ when $t = 21$ *(p. 2)*

61. $1.7 - y$ when $y = 0.8$ *(p. 2)*

62. $-a$ when $a = -13.5$ *(p. 64)*

63. $|c|$ when $c = -9.6$ *(p. 64)*

State the formula that is needed to solve the problem. Then solve the problem. *(p. 28)*

64. What is the interest on $800 invested for 3 years in an account that earns simple interest at a rate of 1.5% per year?

65. Find the perimeter of a rectangle that is 28 feet wide and 40 feet long.

66. The temperature is 50°F. What is the temperature in degrees Celsius?

2.3 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 3, 21, and 43

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 38, 39, 40, and 46

◆ = **MULTIPLE REPRESENTATIONS** Ex. 45

SKILL PRACTICE

1. **VOCABULARY** Use the subtraction rule to rewrite the expression $-3 - 6$ as an addition expression.

2. ★ **WRITING** Without actually subtracting, how can you tell whether a change in a quantity will be negative?

EXAMPLE 1 on p. 80 for Exs. 3–14

FINDING DIFFERENCES Find the difference.

3. $13 - (-5)$
4. $16 - 32$
5. $-11 - (-3)$
6. $-15 - 29$
7. $-35.9 - (-50)$
8. $14.7 - (-2.3)$
9. $-3.6 - 22.2$
10. $-18.2 - (-15.4)$
11. $\frac{1}{2} - \frac{5}{6}$
12. $-\frac{5}{3} - \frac{8}{3}$
13. $\frac{1}{2} - \left(-\frac{1}{4}\right)$
14. $-\frac{7}{10} - \left(-\frac{2}{5}\right)$

EXAMPLE 2 on p. 80 for Exs. 15–25

ERROR ANALYSIS ***Describe*** **and correct the error in evaluating the expression when $x = 3$ and $y = -8$.**

15.
$$x - y + 2 = 3 - 8 + 2$$
$$= 3 + (-8) + 2$$
$$= -5 + 2$$
$$= -3$$
✗

16.
$$x - (-4 + y) = 3 - [-4 + (-8)]$$
$$= 3 - (-12)$$
$$= 3 - 12$$
$$= -9$$
✗

EVALUATING EXPRESSIONS **Evaluate the expression when $x = 7.1$ and $y = -2.5$.**

17. $x - (-y)$
18. $y - x - 12$
19. $x - (-6) + y$
20. $x - (y - 13)$
21. $-y - (1.9 - x)$
22. $-y - x$
23. $x - y - 2$
24. $5.3 - (y - x)$
25. $x + y - 2.8$

EXAMPLE 3 on p. 81 for Exs. 26–31

EVALUATING CHANGE **Find the change in temperature or elevation.**

26. From −5°C to −13°C
27. From −45°F to 62°F
28. From −300 feet to −100 feet
29. From 1200 meters to −80 meters
30. From 4.8°F to −12.6°F
31. From −90.7 miles to 36.4 miles

EVALUATING EXPRESSIONS **Evaluate the expression when $x = 3.6$, $y = 6.6$, and $z = -11$.**

32. $(x - y) - |z|$
33. $(x - |-y|) - z$
34. $x - |y - z|$
35. $(-x - y) - z - 5$
36. $x + y - z + 12.9$
37. $-z + y - x - (-2.4)$

38. ★ **MULTIPLE CHOICE** If the value of the expression $a - b$ is negative, which statement must be true?

Ⓐ $a > b$ Ⓑ $a = 0$ Ⓒ $a < b$ Ⓓ $b = 0$

39. ★ **OPEN-ENDED** Write a real-world problem that can be modeled by the expression $-23 - 14 - 8$. Then solve the problem.

40. ★ **WRITING** Tell whether the associative property and the commutative property hold for subtraction. Give examples to support your answers.

41. **CHALLENGE** Let a and b be negative numbers. Tell whether the value of the expression is positive or negative. *Explain* your reasoning.

a. $|a + b|$ **b.** $-a - b$ **c.** $-|a| - |b|$ **d.** $a + b$

PROBLEM SOLVING

EXAMPLE 3 on p. 81 for Exs. 42–43

42. **VOLCANOES** Mahukona is a Hawaiian volcano whose summit has an elevation of −3600 feet. The summit once had an elevation of 800 feet. What was the change in elevation of the volcano's summit?

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43. **CAVES** The temperature inside Mammoth Cave in Kentucky is about 12.2°C year round. If the temperature outside the cave is −2.4°C, what is the change in temperature from outside to inside the cave?

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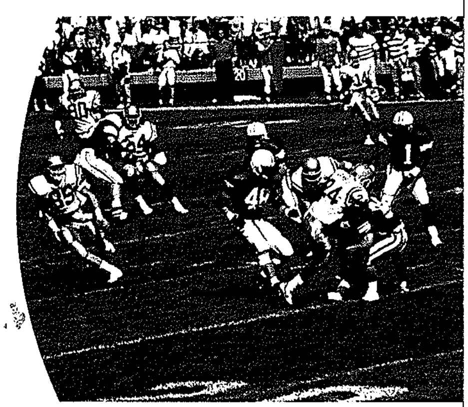
44. **FOOTBALL** In four plays a football team gains 3 yards, loses 7 yards, loses 2 yards, and gains 15 yards. How many yards did the team gain after four plays?



45. **MULTIPLE REPRESENTATIONS** In order to qualify for a girls' regional 1500 meter race, an athlete's personal best time for the season must be under the qualifying time of 5 minutes 42 seconds.

a. Writing an Equation Write an equation that expresses d as the difference of the athlete's personal best time t (in seconds) and the qualifying time (in seconds).

b. Making a Table Make a table that gives the values of d for $t = 341.7$, 343.8, 340.9, and 342.7. Which values of t in the table are under the qualifying time? How can you tell from the differences?

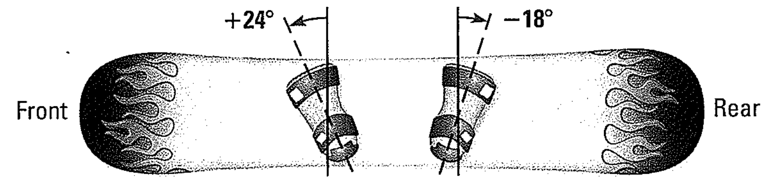
46. ★ **SHORT RESPONSE** A trade surplus or deficit is the difference of the value of all exports and the value of all imports. A positive difference is a surplus, and a negative difference is a deficit. The table shows the values of the United States' imports and exports for the period 2000–2003.

Year	2000	2001	2002	2003
Value of exports (trillions of dollars)	1.071	1.007	0.976	1.021
Value of imports (trillions of dollars)	1.449	1.369	1.398	1.517

a. Calculate Find the trade surplus or deficit for each year.

b. Describe *Describe* any trends in the surplus or deficit over the years.

47. **SNOWBOARDS** Snowboarders can rotate the shoe bindings on their snowboards. The binding setup shown below is written $+24°/-18°$. This means that the front angle is 24° counterclockwise from vertical, and the rear angle is 18° clockwise from vertical.



a. An instructor suggests a binding setup of $+30°/+15°$ for beginners. Your setup is initially $+24°/-4°$. Find the changes in angle measures needed to match the instructor's suggestion.

b. A mirror setup is a setup of $+n°/-n°$ where n is between 0 and 90. Your setup is initially $+13°/-6°$. You change the front angle measure by $-3°$. Find the change in the rear angle measure needed for a mirror setup.

48. **CHALLENGE** Greenwich Mean Time (GMT) is the time at the Royal Observatory in Greenwich, England. A location that is $+n$ hours from GMT is n hours ahead of GMT, and a location that is $-n$ hours from GMT is n hours behind GMT. Costa Rica is -6 hours from GMT, and India is $+5.5$ hours from GMT. If it is 7:45 A.M. in India, what time is it in Costa Rica?

MIXED REVIEW

Evaluate the expression.

49. $20x$ when $x = 15$ *(p. 2)*

50. $3x + 8$ when $x = 12$ *(p. 8)*

51. $15.5 + x$ when $x = -30.2$ *(p. 74)*

52. $-x + 19.4$ when $x = 8.2$ *(p. 74)*

PREVIEW
Prepare for Lesson 2.4 in Exs. 53–56.

Identify the property illustrated. *(p. 74)*

53. $1 + 7 = 7 + 1$

54. $-4.8 + 4.8 = 0$

55. $0 + (-9) = -9$

56. $(2 + 3) + 4 = 2 + (3 + 4)$

QUIZ *for Lessons 2.1–2.3*

1. Tell whether each of the following numbers is a whole number, an integer, or a rational number: $-\frac{5}{6}$, -8.2, 0, -9. Then order the numbers from least to greatest. *(p. 64)*

Find the sum or difference.

2. $5 + (-36)$ *(p. 74)*

3. $-8.2 + (-2.3)$ *(p. 74)*

4. $3\frac{1}{2} + (-2)$ *(p. 74)*

5. $-18 - (-9)$ *(p. 80)*

6. $-11.2 - 21.7$ *(p. 80)*

7. $4\frac{1}{2} - \left(-\frac{1}{5}\right)$ *(p. 80)*

Evaluate the expression when $x = 2.5$ and $y = -3.4$. *(p. 80)*

8. $x + y - 9$

9. $x - (y - 5.1)$

10. $12.1 - (y - x)$

EXTRA PRACTICE for Lesson 2.3, p. 939

ONLINE QUIZ at classzone.com

Spreadsheet ACTIVITY *Use after Lesson 2.3*

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Keystrokes

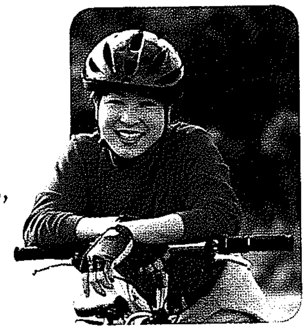
2.3 Subtract Real Numbers

QUESTION **How can you use a spreadsheet to subtract the same number from various numbers?**

In a spreadsheet, the columns are identified by letters, and the rows are identified by numbers. Each cell has a name that is made up of a letter and a number. For example, B2 is the cell in column B and row 2. A cell can contain a label, a number, or a formula.

	A	B
1		
2		

EXAMPLE **Find the difference of two numbers**



A manufacturing company is making foam hand grips for bicycles and jump ropes. The ideal length of a hand grip is 5 inches. In a batch of ten hand grips, the actual lengths (in inches) are 4.878, 4.902, 5.115, 5.13, 4.877, 4.874, 4.799, 4.819, 4.879, and 5.124. Create a spreadsheet to find the difference of the actual length and the ideal length for each hand grip.

Solution

STEP 1 ***Enter data***
Enter the labels in the first row of the spreadsheet. Then enter the grip numbers and grip lengths in successive rows.

	A	B	C
1	Grip	Length (inches)	Difference
2	1	4.878	
3	2	4.902	

STEP 2 ***Calculate differences***
For each hand grip, enter the formula for the difference of the actual and ideal lengths in the appropriate cell in column C.

	A	B	C
1	Grip	Length (inches)	Difference
2	1	4.878	=B2−5
3	2	4.902	=B3−5

After you enter a formula, the cell should display the difference of the length of the grip and the ideal length. For example, C2 should display −0.122, and C3 should display −0.098.

DRAW CONCLUSIONS

1. The manufacturer will consider a hand grip acceptable if the absolute value of the difference of the actual length and the ideal length is at most 0.125 inch. How many hand grips from the batch are acceptable?
2. What are the least and greatest possible lengths that a hand grip can have and still be acceptable? *Explain* your reasoning.
3. For which of the ten hand grips is the length closest to the ideal length? How can you tell from the differences in column C?
4. In another batch of ten hand grips, the actual lengths (in inches) are 4.871, 5.019, 5.112, 4.987, 5.067, 4.899, 4.859, 5.132, 5.126, and 5.093. Create a spreadsheet to find the difference of the actual length and the ideal length for each hand grip.

Lessons 2.1–2.3

1. **MULTI-STEP PROBLEM** The table shows the record low temperatures for several states in the United States.

State	Temperature (°F)
Alaska	−80
Arkansas	−29
California	−45
Hawaii	12
Kentucky	−37

   a. Order the temperatures from least to greatest.

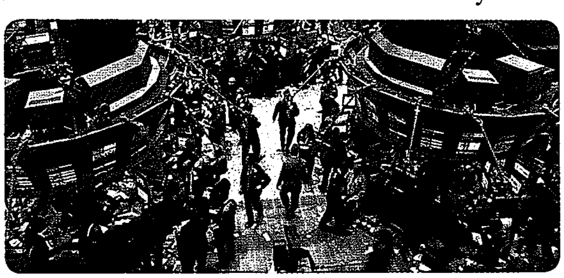
   b. The record low temperature in Arizona is −40°F. Which states in the table have record low temperatures less than −40°F?

2. **MULTI-STEP PROBLEM** Your bank account incurs a \$35 fee for each withdrawal that either results in a negative balance or occurs while your account balance is negative. You have a balance of \$150. You withdraw \$165.

   a. What will the balance in your account be after the fee is charged?

   b. How much money do you need to deposit into the account so that the balance is \$0?

3. **GRIDDED ANSWER** At the close of trading on the New York Stock Exchange on Monday, the value of a share of a certain stock was \$10.65. Over the next three days, the change in value of a share was −\$.56, then −\$1.09, and then \$.89. What was the value of a share of the stock at the end of the three days?



4. **OPEN-ENDED** *Describe* a real-world situation that can be modeled by the expression $-35.50 + (-12.43) + 50.43$. Then find the value of the expression.

5. **SHORT RESPONSE** Net migration flow is the difference of the number of people migrating into a place and the number of people migrating out of a place. The table shows the number of people who migrated into and out of a certain city during the period 2001–2005.

Year	Number migrating into city	Number migrating out of city
2001	3302	3316
2002	3179	3623
2003	3053	3632
2004	3180	3695
2005	3174	3396

Find the net migration flow for each year. Then describe any trends in the city's net migration flow during this period.

6. **EXTENDED RESPONSE** In meteorology, the lifted index measures the likelihood of a thunderstorm. The greater the lifted index, the less likely a storm will occur. The table shows the lifted index for two cities at various times during a day.

Time	Lifted index for city A	Lifted index for city B
12 A.M.	−5.6	−0.8
4 A.M.	−4.3	−1.8
8 A.M.	−3.8	−2.3
12 P.M.	−2.5	−2.6
4 P.M.	−3.0	−1.4
8 P.M.	−4.5	0.8

   a. At what time during that day is a storm least likely to occur in city A?

   b. Compare the likelihood of a storm between 12 A.M. and 8 P.M. for the two cities on that day.

   c. Would you expect a storm in city B but not in city A at 8 P.M. that day? *Explain.*

2.4 Multiplication by −1

MATERIALS • paper and pencil

QUESTION **What is the product of any integer *a* and −1?**

You can rewrite a multiplication expression as repeated addition. For example, 3 • 8 can be rewritten as 8 + 8 + 8. Because the sum is 24, you can conclude that 3 • 8 = 24.

EXPLORE **Find the product of an integer and −1**

STEP 1 Copy and complete the table.

Multiplication Expression	Addition Expression	Sum
5 • (−1)	−1 + (−1) + (−1) + (−1) + (−1)	−5
4 • (−1)	?	?
3 • (−1)	?	?
2 • (−1)	?	?

STEP 2 Copy and complete the multiplication equations below.

5 • (−1) = ?
4 • (−1) = ?
3 • (−1) = ?
2 • (−1) = ?

Complete using the table from Step 1.

1 • (−1) = ?
0 • (−1) = ?
−1 • (−1) = ?
−2 • (−1) = ?
−3 • (−1) = ?

Complete by extending the pattern in the first four products.

DRAW CONCLUSIONS **Use your observations to complete these exercises**

1. Copy and complete: For any integer *a*, *a* • (−1) = ?.

Find the product.

2. 12 • (−1)
3. 10 • (−1)
4. −23 • (−1)
5. −47 • (−1)
6. −18 • (−1)
7. 15 • (−1)

2.4 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 11, 31, and 51

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 48, 52, 53, and 55

◈ = **MULTIPLE REPRESENTATIONS** Ex. 54

SKILL PRACTICE

1. **VOCABULARY** What number is called the multiplicative identity?

2. ★ **WRITING** *Describe* the difference between the identity property of multiplication and the multiplicative property of -1.

EXAMPLE 1 on p. 88 for Exs. 3–18

FINDING PRODUCTS Find the product.

3. $-4(7)$
4. $11(-2)$
5. $-9(-10)$
6. $-8(-11)$
7. $5(-7.2)$
8. $(-2.5)(-1.3)$
9. $-42\left(-\frac{1}{6}\right)$
10. $-\frac{1}{2}(-32)$
11. $-1.9(3.3)(7)$
12. $0.5(-20)(-3)$
13. $-\frac{5}{6}(-12)(-4)$
14. $-\frac{3}{4}(2)(-6)$
15. $-8(-4)(-2.5)$
16. $-1.6(-2)(-10)$
17. $18\left(-\frac{2}{3}\right)\left(-\frac{1}{5}\right)$
18. $-\frac{3}{4}\left(-\frac{1}{3}\right)\left(-\frac{8}{9}\right)$

EXAMPLE 2 on p. 89 for Exs. 19–27

IDENTIFYING PROPERTIES Identify the property illustrated.

19. $-\frac{2}{5} \cdot 0 = 0$
20. $0.3 \cdot (-3) = -3 \cdot 0.3$
21. $-143 \cdot 1 = -143$
22. $-1 \cdot (-6) = 6$
23. $(-2 \cdot 5) \cdot 4 = -2 \cdot (5 \cdot 4)$
24. $0 \cdot (-76.3) = 0$
25. $1 \cdot (ab) = ab$
26. $(3x)y = 3(xy)$
27. $s \cdot (-1) = -s$

EXAMPLE 3 on p. 90 for Exs. 28–36

USING PROPERTIES Find the product. *Justify* your steps.

28. $y(-2)(-8)$
29. $-18(-x)$
30. $\frac{3}{5}(-5q)$
31. $-2(-6)(-7z)$
32. $-5(-4)(-2.1)(-z)$
33. $-\frac{1}{5}(-10)(4)(-5c)$
34. $-5t(-t)$
35. $-6r(-2.8r)$
36. $\frac{1}{3}\left(-\frac{9}{10}\right)(-m)(-m)$

EVALUATING EXPRESSIONS Evaluate the expression when $x = -2$ and $y = 3.6$.

37. $2x + y$
38. $-x - 3y$
39. $xy - 5.4$
40. $|y| - 4x$
41. $1.5x - |-y|$
42. $x^2 - y^2$

ERROR ANALYSIS *Describe* and correct the error in finding the product.

43.
$$\begin{aligned} -1(7)(-3)(-2x) &= 7(-3)(-2x) \\ &= -21(-2x) \\ &= [-21 \cdot (-2)]x \\ &= 42x \end{aligned}$$

44.
$$\begin{aligned} (-5z)(-8)(z) &= (-8)(-5z)(z) \\ &= (-8)(-5)(z)(z) \\ &= -40(z \cdot z) \\ &= -40z^2 \end{aligned}$$

REASONING **In Exercises 45–47, tell whether the statement is *true* or *false*. If it is false, give a counterexample.**

45. If x is negative, then x^2 is positive.

46. If the product of three numbers is positive, then all three numbers are positive.

47. If the product of four numbers is 0, then at least one of the numbers is 0.

48. ★ **MULTIPLE CHOICE** Let a be a negative number. If the product abc is positive, which statement must be true?

Ⓐ $bc > 0$ Ⓑ $bc < 0$ Ⓒ $ac > 0$ Ⓓ $ab < 0$

49. **CHALLENGE** The product of n factors is negative. What is the greatest possible number of negative factors if n is even? if n is odd? Give several examples to support your answers.

PROBLEM SOLVING

EXAMPLE 4 on p. 90 for Exs. 50–53

50. **DEAD SEA** In 1940 the surface area of the Dead Sea was about 980 square kilometers. From 1940 to 2001, the average rate of change in surface area was about −5.7 square kilometers per year. Find the surface area of the Dead Sea in 2001.

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51. **STOCKS** An investor purchases 50 shares of a stock at \$3.50 per share. The next day, the change in value of a share of the stock is −\$.25. What is the total value of the shares the next day?

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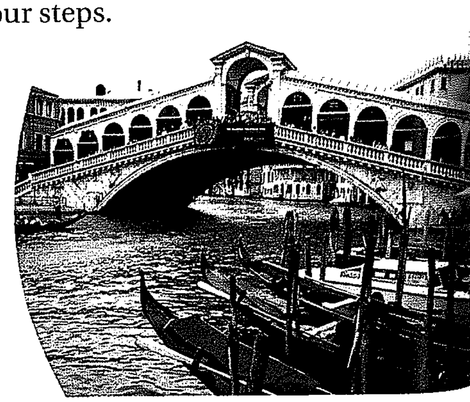
52. ★ **SHORT RESPONSE** In 1913 the total volume of the glaciers on Mount Rainier was 5.62 cubic kilometers. The table shows the average rate of change in the volume for two periods of time.

Time period	Rate of change (km^3/yr)
1913–1971	−0.02241
1971–1994	−0.00565

a. Find the total volume of the glaciers in 1971 and in 1994.

b. About one third of the change in volume during the period 1913–1994 took place in the northeastern glaciers. Find the change in the volume of the northeastern glaciers. *Explain* your steps.

53. ★ **MULTIPLE CHOICE** The Rialto Bridge in Venice, Italy, is a footbridge built in the late 16th century. The maximum clearance between the water and the bridge is about 7.32 meters. Because of a rising sea level and a gradual sinking of the city, the clearance changes at an average rate of about −2 millimeters per year. Approximate the clearance after 15 years.

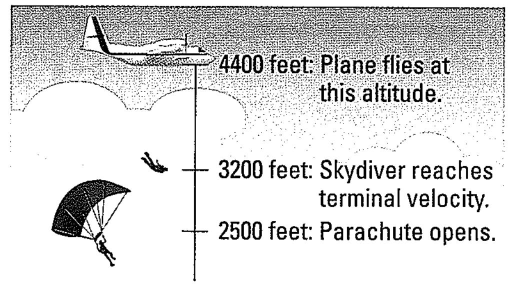


Ⓐ 5.32 meters Ⓑ 7.02 meters

Ⓒ 7.29 meters Ⓓ 7.318 meters

◯ = **WORKED-OUT SOLUTIONS** on p. WS1 ★ = **STANDARDIZED TEST PRACTICE** ◈ = **MULTIPLE REPRESENTATIONS**

54. **MULTIPLE REPRESENTATIONS** A skydiver in free fall will eventually reach a constant velocity, called terminal velocity. A skydiver reaches a terminal velocity of −160 feet per second at an altitude of 3200 feet.



a. **Writing an Equation** Write an equation for the altitude a (in feet) of the skydiver as a function of the time t (in seconds) after reaching terminal velocity.

b. **Making a Table** Make a table of values for $t = 1, 2, 3, 4,$ and 5 seconds. The skydiver wants to open the parachute after reaching an altitude of about 2500 feet. After how many seconds should the skydiver open the parachute?

Animated Algebra at classzone.com

55. ★ **EXTENDED RESPONSE** The table shows the fuel capacities of two ferries in Puget Sound, Washington, and the average rates of change in tank fuel when the ferries are burning fuel.

Ferry	Fuel capacity (gal)	Rate of change (gal/h)
Rhododendron	11,250	−30
Spokane	135,000	−240

a. **Model** For each ferry, write an equation that gives the amount of tank fuel f (in gallons) as a function of the time t (in hours) that fuel is burned.

b. **Calculate** Both ferries start with a full tank. How many gallons of fuel will each ferry have left after 3 hours?

c. **Explain** If both ferries continue to burn fuel without refueling, which ferry will run out of fuel first? How many gallons will the other ferry have at that time? Your answer should include the following:

- the number of hours that each ferry will take to burn all of its fuel
- an explanation of how you used the equations in part (a)

56. **CHALLENGE** Due to soil erosion, the surface area of Dongting Lake in China is decreasing. Its surface area was about 2626.5 square kilometers in 1995. From 1950 to 1995, the average rate of change in surface area was about −38.3 square kilometers per year. From 1825 to 1950, the average rate of change was about −13.2 square kilometers per year. Approximate the surface area in 1825.

MIXED REVIEW

PREVIEW Prepare for Lesson 2.5 in Exs. 57–60.

Evaluate the expression for the given value of the variable. *(p. 8)*

57. $1 + 9y^2$ when $y = 3$

58. $z^2 \cdot 2$ when $z = 6$

59. $2(x - 19)$ when $x = 24$

60. $9(17 + w)$ when $w = 8$

Find the sum or difference.

61. $-3 + (-6)$ *(p. 74)*

62. $7.8 + (-6.4) + (-9.4)$ *(p. 74)*

63. $-19.4 - (-6.4)$ *(p. 80)*

64. $-\frac{4}{7} - \frac{3}{14}$ *(p. 80)*

Extension
Use after Lesson 2.4

Perform Matrix Addition, Subtraction, Scalar Multiplication

GOAL Perform operations on matrices.

Key Vocabulary
- matrix
- dimensions of a matrix
- element
- scalar multiplication
- scalar

A **matrix** is a rectangular arrangement of numbers in rows and columns. If a matrix has m rows and n columns, the **dimensions of the matrix** are written as $m \times n$. For example, matrix A below has two rows and three columns. The dimensions of matrix A are 2×3 (read "2 by 3"). Each number in a matrix is called an **element**, or *entry*. In matrix A, the element in the first row and second column is 4.

$$A = \begin{bmatrix} 0 & 4 & -1 \\ -3 & 2 & 5 \end{bmatrix} \text{ 2 rows}$$

3 columns

MATRIX ADDITION AND SUBTRACTION To add or subtract matrices (the plural of *matrix*), you add or subtract corresponding elements. You can add or subtract matrices only if they have the same dimensions.

EXAMPLE 1 Add or subtract two matrices

Perform the indicated operation, if possible.

a. $$\begin{bmatrix} 0 & 4 & -1 \\ -3 & 2 & 5 \end{bmatrix} + \begin{bmatrix} 2 & 1 & 3 \\ -2 & -6 & 4 \end{bmatrix} = \begin{bmatrix} 0+2 & 4+1 & -1+3 \\ -3+(-2) & 2+(-6) & 5+4 \end{bmatrix}$$
$$= \begin{bmatrix} 2 & 5 & 2 \\ -5 & -4 & 9 \end{bmatrix}$$

b. $$\begin{bmatrix} -10 & 2 \\ -4 & 7 \\ 7 & -13 \end{bmatrix} - \begin{bmatrix} 9 & -2 \\ 4 & 8 \\ -5 & -11 \end{bmatrix} = \begin{bmatrix} -10-9 & 2-(-2) \\ -4-4 & 7-8 \\ 7-(-5) & -13-(-11) \end{bmatrix}$$
$$= \begin{bmatrix} -10+(-9) & 2+2 \\ -4+(-4) & 7+(-8) \\ 7+5 & -13+11 \end{bmatrix}$$
$$= \begin{bmatrix} -19 & 4 \\ -8 & -1 \\ 12 & -2 \end{bmatrix}$$

c. You can't perform the subtraction $\begin{bmatrix} 6 & -4 & -8 \end{bmatrix} - \begin{bmatrix} 1 \\ 12 \\ -6 \end{bmatrix}$ because the first matrix is a 1×3 matrix and the second matrix is a 3×1 matrix.

SCALAR MULTIPLICATION In **scalar multiplication**, every element in a matrix is multiplied by a real number called a **scalar.**

EXAMPLE 2 Perform scalar multiplication

Perform the indicated operation.

a. $6\begin{bmatrix} -7 & -\frac{1}{3} \\ \frac{1}{2} & 11 \end{bmatrix} = \begin{bmatrix} 6(-7) & 6\left(-\frac{1}{3}\right) \\ 6\left(\frac{1}{2}\right) & 6(11) \end{bmatrix}$

$= \begin{bmatrix} -42 & -2 \\ 3 & 66 \end{bmatrix}$

b. $-2\begin{bmatrix} 0.5 \\ -3.2 \\ 8.1 \end{bmatrix} = \begin{bmatrix} -2(0.5) \\ -2(-3.2) \\ -2(8.1) \end{bmatrix}$

$= \begin{bmatrix} -1 \\ 6.4 \\ -16.2 \end{bmatrix}$

PRACTICE

EXAMPLES 1 and 2 on pp. 94–95 for Exs. 1–10

Perform the indicated operation, if possible.

1. $\begin{bmatrix} 7 & 6 \\ 3 & 2 \end{bmatrix} + \begin{bmatrix} 9 & -2 \\ 5 & 10 \end{bmatrix}$

2. $\begin{bmatrix} -8 \\ -4 \\ 1 \end{bmatrix} + \begin{bmatrix} 11 \\ -9 \\ -6 \end{bmatrix}$

3. $\begin{bmatrix} -8 & -1 & -9 \\ -4 & -3 & 2 \end{bmatrix} - \begin{bmatrix} 7 & 3 & 0 \\ -2 & -5 & 7 \end{bmatrix}$

4. $\begin{bmatrix} 11 & -12 \\ 15 & -22 \end{bmatrix} - \begin{bmatrix} 7 \\ 8 \end{bmatrix}$

5. $\begin{bmatrix} -9.1 & 5.4 & 3.7 \end{bmatrix} + \begin{bmatrix} 1.3 & -6.7 \end{bmatrix}$

6. $\begin{bmatrix} \frac{3}{4} & -2 \\ 6 & -3 \end{bmatrix} - \begin{bmatrix} 8 & -2 \\ 6 & -\frac{5}{6} \end{bmatrix}$

7. $7\begin{bmatrix} -4 & -7 \\ \frac{1}{2} & \frac{4}{9} \end{bmatrix}$

8. $2\begin{bmatrix} 1.5 & -6 \\ -4.5 & 0. \end{bmatrix}$

9. $-6\begin{bmatrix} 12 \\ -3.4 \\ -0.7 \end{bmatrix}$

10. $-\frac{1}{2}\begin{bmatrix} 18 & -26 & \frac{7}{4} \\ -\frac{2}{3} & 20 & -2 \end{bmatrix}$

11. NUTRITION The matrix shows the amounts (in milligrams) of calcium and potassium in one ounce of different types of milk. Write a matrix for the amounts of calcium and potassium in 8 ounces of each type of milk.

	Calcium (mg)	Potassium (mg)
Lowfat milk	32.940	36.295
Reduced fat milk	33.855	42.700
Whole milk	30.805	40.565

CHALLENGE Perform the indicated operations.

12. $9\left(\begin{bmatrix} 1 & -12 & 8 \\ -7 & 10 & -4 \end{bmatrix} + \begin{bmatrix} 3 & -3 & -7 \\ -5 & -21 & -12 \end{bmatrix}\right)$

13. $\begin{bmatrix} -6 & -8 \\ 8 & 14 \end{bmatrix} - 7\begin{bmatrix} 5 & 13 \\ -10 & -11 \end{bmatrix}$

2.5 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 9, 23, and 51

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 27, 52, and 54

SKILL PRACTICE

1. **VOCABULARY** What are the coefficients of the expression $4x + 8 - 9x + 2$?

2. ★ **WRITING** Are the expressions $2(x + 1)$ and $2x + 1$ equivalent? *Explain.*

ERROR ANALYSIS ***Describe*** **and correct the error in simplifying the expression.**

3. $5y - (2y - 8) = 5y - 2y - 8$
$= 3y - 8$ ✗

4. $8 + 2(4 + 3x) = 8 + 8 + 6x$
$= 22x$ ✗

EXAMPLES 1 and 2 on pp. 96–97 for Exs. 5–20

USING THE DISTRIBUTIVE PROPERTY **Use the distributive property to write an equivalent expression.**

5. $4(x + 3)$
6. $8(y + 2)$
7. $(m + 5)5$
8. $(n + 6)3$
9. $(p - 3)(-8)$
10. $-4(q - 4)$
11. $2(2r - 3)$
12. $(s - 9)9$
13. $6v(v + 1)$
14. $-w(2w + 7)$
15. $-2x(3 - x)$
16. $3y(y - 6)$
17. $\frac{1}{2}\left(\frac{1}{2}m - 4\right)$
18. $-\frac{3}{4}(p - 1)$
19. $\frac{2}{3}(6n - 9)$
20. $\frac{5}{6}r(r - 1)$

EXAMPLE 3 on p. 97 for Exs. 21–26

IDENTIFYING PARTS OF AN EXPRESSION **Identify the terms, like terms, coefficients, and constant terms of the expression.**

21. $-7 + 13x + 2x + 8$
22. $9 + 7y - 2 - 5y$
23. $7x^2 - 10 - 2x^2 + 5$
24. $-3y^2 + 3y^2 - 7 + 9$
25. $2 + 3xy - 4xy + 6$
26. $6xy - 11xy + 2xy - 4xy + 7xy$

27. ★ **MULTIPLE CHOICE** Which two terms are like terms?

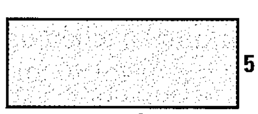
Ⓐ $-2, -5x$ Ⓑ $4x, -x$ Ⓒ $-2, -2y$ Ⓓ $5x, -3y$

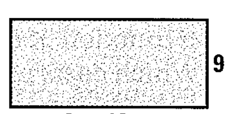
EXAMPLE 4 on p. 98 for Exs. 28–39

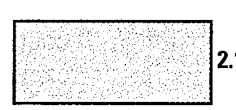
SIMPLIFYING EXPRESSIONS **Simplify the expression.**

28. $7x + (-11x)$
29. $6y - y$
30. $5 + 2n + 2$
31. $(4a - 1)2 + a$
32. $3(2 - c) - c$
33. $6r + 2(r + 4)$
34. $15t - (t - 4)$
35. $3(m + 5) - 10$
36. $-6(v + 1) + v$
37. $7(w - 5) + 3w$
38. $6(5 - z) + 2z$
39. $(s - 3)(-2) + 17s$

GEOMETRY **Find the perimeter and area of the rectangle.**

40. 

41. 

42. 

USING MENTAL MATH In Exercises 43–46, use the example below to find the total cost.

EXAMPLE **Use the distributive property and mental math**

Use the distributive property and mental math to find the total cost of 5 picture frames at $1.99 each.

Total cost $= 5(1.99)$	**Write expression for total cost.**
$= 5(2 - 0.01)$	**Rewrite 1.99 as 2 − 0.01.**
$= 5(2) - 5(0.01)$	**Distributive property**
$= 10 - 0.05$	**Multiply using mental math.**
$= 9.95$	**Subtract. The total cost is $9.95.**

43. 3 CDs at $12.99 each

44. 5 magazines at $3.99 each

45. 6 pairs of socks at $1.98 per pair

46. 25 baseballs at $2.98 each

TRANSLATING PHRASES In Exercises 47 and 48, translate the verbal phrase into an expression. Then simplify the expression.

47. Twice the sum of 6 and x, increased by 5 less than x

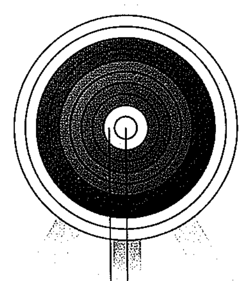
48. Three times the difference of x and 2, decreased by the sum of x and 10

49. CHALLENGE How can you use $a(b + c) = ab + ac$ to show that $(b + c)a = ba + ca$ is also true? *Justify* your steps.

PROBLEM SOLVING

EXAMPLE 5 on p. 98 for Exs. 50–52

50. SPORTS An archer shoots 6 arrows at a target. Some arrows hit the 9 point ring, and the rest hit the 10 point bull's-eye. Write an equation that gives the score s as a function of the number a of arrows that hit the 9 point ring. Then find the score if 2 arrows hit the 9 point ring.



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51. MOVIES You have a coupon for $2 off the regular cost per movie rental. You rent 3 movies, and the regular cost of each rental is the same. Write an equation that gives the total cost C (in dollars) as a function of the regular cost r (in dollars) of a rental. Then find the total cost if a rental regularly costs $3.99.

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52. ★ SHORT RESPONSE Each day you use your pay-as-you-go cell phone you pay $.25 per minute for the first 10 minutes and $.10 per minute for any time over 10 minutes. Write an equation that gives the daily cost C (in dollars) as a function of the time t (in minutes) when usage exceeds 10 minutes. Which costs more, using the phone for 10 minutes today and 15 minutes tomorrow, or using the phone for 25 minutes today? *Explain.*

○ = **WORKED-OUT SOLUTIONS on p. WS1**

★ = **STANDARDIZED TEST PRACTICE**

53. **DIVING** In a diving competition, a diver's score is the product of the difficulty level d of a dive and the sum of the scores x, y, and z of 3 judges. Write a simplified expression that represents the diver's score.

54. ★ **EXTENDED RESPONSE** During the summer you give one hour saxophone lessons to 20 students each week. Use the information in the advertisement.

   a. **Model** Write an equation that gives your weekly earnings y (in dollars) as a function of the number x of beginning students that you teach.

   b. **Calculate** Find your weekly earnings if 15 of your 20 students are beginners.

   c. **Explain** Suppose that you plan to teach for 10 weeks and want to earn \$4000 for the summer. How many advanced students should you teach? Your answer should include the following:

   - a table of values generated by the equation in part (a)
   - an explanation of your method for answering the question

55. **CHALLENGE** A drama club plans to sell 100 tickets to a school musical. An adult ticket costs \$6, and a student ticket costs \$4. Students who attend the school get a \$1 discount. The club expects two thirds of the student tickets to be discounted. Write an equation that gives the total revenue r (in dollars) as a function of the number a of adult tickets sold.

MIXED REVIEW

PREVIEW
Prepare for Lesson 2.6 in Exs. 56–61.

Multiply or divide. *(p. 915)*

56. $\frac{1}{2} \cdot \frac{2}{5}$ 57. $\frac{4}{7} \cdot \frac{1}{8}$ 58. $1\frac{2}{3} \cdot 2\frac{3}{10}$

59. $\frac{1}{5} \div \frac{3}{10}$ 60. $\frac{2}{3} \div \frac{4}{9}$ 61. $2\frac{3}{4} \div 1\frac{5}{8}$

Find the sum, difference, or product.

62. $-7 + (-4)$ *(p. 74)* 63. $8 + (-11)$ *(p. 74)* 64. $12 - 23$ *(p. 80)*

65. $-9 - 6$ *(p. 80)* 66. $(-11)(-2.1)$ *(p. 88)* 67. $15(3.5)$ *(p. 88)*

QUIZ for Lessons 2.4–2.5

Find the product. *(p. 88)*

1. $-5 \cdot (-5)$ 2. $18 \cdot \left(-\frac{7}{6}\right)$ 3. $8 \cdot \frac{4}{5} \cdot (-10)$ 4. $9 \cdot (-7) \cdot (-1.2)$

5. $(-3x) \cdot (-4)$ 6. $-\frac{2}{3}x \cdot 15$ 7. $x \cdot 1.5 \cdot (-6.4)$ 8. $(-2)(13x)$

Use the distributive property to write an equivalent expression. *(p. 96)*

9. $7(x + 14)$ 10. $-4(5x + 9)$ 11. $-5(2x - 6)$ 12. $(3 - x)6$

PROBLEM SOLVING WORKSHOP
LESSON 2.5

Using ALTERNATIVE METHODS

Another Way to Solve Example 5, page 98

MULTIPLE REPRESENTATIONS In Example 5 on page 98, you saw how to solve a problem about exercising using a verbal model and an equation. You can also solve the problem by breaking it into parts.

PROBLEM

EXERCISING Your daily workout plan involves a total of 50 minutes of running and swimming. You burn 15 calories per minute when running and 9 calories per minute when swimming. Find the number of calories you burn in your 50 minute workout if you run for 20 minutes.

METHOD

Breaking into Parts You can solve the problem by breaking it into parts.

STEP 1 **Find** the number of calories you burn when running.

15 calories per minute • 20 minutes = 300 calories

Your running time is 20 minutes, so your swimming time is 50 − 20 = 30 minutes.

STEP 2 **Find** the calories you burn when swimming.

9 calories per minute • 30 minutes = 270 calories

STEP 3 **Add** the calories you burn when doing each activity. You burn a total of 570 calories.

300 calories + 270 calories = 570 calories

PRACTICE

1. **VACATIONING** Your family is taking a vacation for 10 nights. You will spend some nights at a campground and the rest of the nights at a motel. A campground stay costs \$15 per night, and a motel stay costs \$60 per night. Find the total cost of lodging if you stay at a campground for 6 nights. Solve this problem using two different methods.

2. **WHAT IF?** In Exercise 1, suppose the vacation lasts 12 days. Find the total cost of lodging if you stay at the campground for 6 nights. Solve this problem using two different methods.

3. **FLORIST** During the summer, you work 35 hours per week at a florist shop. You get paid \$8 per hour for working at the register and \$9.50 per hour for making deliveries. Find the total amount you earn this week if you spend 5 hours making deliveries. Solve this problem using two different methods.

4. **ERROR ANALYSIS** *Describe* and correct the error in solving Exercise 3.

\$8 per hour • 5 hours = \$40
\$9.50 per hour • 30 hours = \$285
\$40 + \$285 = \$325 ✗

2.6 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS4 for Exs. 13, 35, and 53

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 23, 48, 49, 55, 56, and 57

SKILL PRACTICE

1. **VOCABULARY** Copy and complete: The product of a nonzero number and its _?_ is 1.

2. ★ **WRITING** How can you tell whether the mean of n numbers is negative without actually dividing the sum of the numbers by n? *Explain.*

EXAMPLE 1 on p. 103 for Exs. 3–10, 23

FINDING INVERSES **Find the multiplicative inverse of the number.**

3. -18 4. -9 5. -1 6. $-\frac{1}{2}$

7. $-\frac{3}{4}$ 8. $-\frac{5}{9}$ 9. $-4\frac{1}{3}$ 10. $-2\frac{2}{5}$

EXAMPLE 2 on p. 104 for Exs. 11–22

FINDING QUOTIENTS **Find the quotient.**

11. $-21 \div 3$ 12. $-18 \div (-6)$ (13.) $-1 \div \left(-\frac{7}{2}\right)$ 14. $15 \div \left(-\frac{3}{4}\right)$

15. $13 \div \left(-4\frac{1}{3}\right)$ 16. $-\frac{2}{3} \div 2$ 17. $-\frac{1}{2} \div \frac{1}{5}$ 18. $-\frac{1}{5} \div (-6)$

19. $-\frac{4}{7} \div (-2)$ 20. $-1 \div \left(-\frac{6}{5}\right)$ 21. $8 \div \left(-\frac{4}{11}\right)$ 22. $-\frac{1}{3} \div \frac{5}{3}$

23. ★ **MULTIPLE CHOICE** If $-\frac{5}{7}x = 1$, what is the value of x?

Ⓐ $-1\frac{2}{5}$ Ⓑ $\frac{5}{7}$ Ⓒ 1 Ⓓ $\frac{12}{5}$

EXAMPLE 3 on p. 104 for Exs. 24–32

FINDING MEANS **Find the mean of the numbers.**

24. $-10, -8, 3$ 25. $12, -8, -9$ 26. $18, -9, 0, -5$

27. $-2, 9, -3, 5$ 28. $-1, -4, -5, 10$ 29. $7, -4, 1, -9, -6$

30. $-5.3, -2, 1.3$ 31. $0.25, -4, -0.75, -1, 6$ 32. $-0.6, 0.18, -2, 5, -0.5$

EXAMPLE 4 on p. 105 for Exs. 33–43

SIMPLIFYING EXPRESSIONS **Simplify the expression.**

33. $\frac{6x - 14}{2}$ 34. $\frac{12y - 8}{-4}$ (35.) $\frac{9z - 6}{-3}$

36. $\frac{-6p + 15}{6}$ 37. $\frac{5 - 25q}{10}$ 38. $\frac{-18 - 21r}{-12}$

39. $\frac{-24a - 10}{-8}$ 40. $\frac{-20b + 12}{-5}$ 41. $\frac{36 - 27c}{9}$

ERROR ANALYSIS ***Describe*** **and correct the error in simplifying the expression.**

42.

$$\frac{12 - 18x}{6} = (12 - 18x) \cdot \left(-\frac{1}{6}\right)$$
$$= 12\left(-\frac{1}{6}\right) - 18x\left(-\frac{1}{6}\right)$$
$$= -2 + 3x$$

43.

$$\frac{-15x - 10}{-5} = (-15x - 10) \cdot \left(-\frac{1}{5}\right)$$
$$= -15x\left(-\frac{1}{5}\right) - 10\left(-\frac{1}{5}\right)$$
$$= 3x - 2$$

EVALUATING EXPRESSIONS **Evaluate the expression.**

44. $\frac{2y - x}{x}$ when $x = 1$ and $y = -4$

45. $\frac{4x}{3y + x}$ when $x = 6$ and $y = -8$

46. $\frac{-9x}{y^2 - 1}$ when $x = -3$ and $y = -2$

47. $\frac{y - x}{xy}$ when $x = -6$ and $y = -2$

48. ★ **WRITING** Tell whether division is commutative and associative. Give examples to support your answer.

49. ★ **MULTIPLE CHOICE** Let a and b be positive numbers, and let c and d be negative numbers. Which quotient has a value that is always negative?

Ⓐ $\frac{a}{b} \div \frac{c}{d}$ Ⓑ $\frac{a}{c} \div \frac{b}{d}$ Ⓒ $\frac{c^2}{a} \div \frac{b}{d}$ Ⓓ $\frac{a}{cd} \div b$

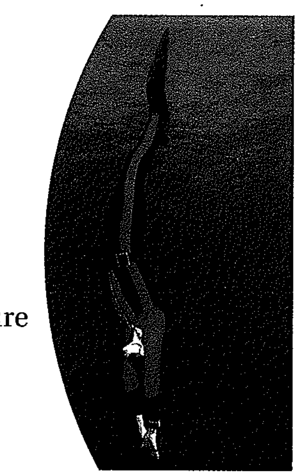
50. **CHALLENGE** Find the mean of the integers from −410 to 400. *Explain* how you got your answer.

51. **CHALLENGE** What is the mean of a number and three times its opposite? *Explain* your reasoning.

PROBLEM SOLVING

EXAMPLE 2
on p. 104
for Ex. 52

52. **SPORTS** Free diving means diving without the aid of breathing equipment. Suppose that an athlete free dives to an elevation of −42 meters in 60 seconds. Find the average rate of change in the diver's elevation.



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EXAMPLE 3
on p. 104
for Exs. 53–54

53. **WEATHER** The daily mean temperature is the mean of the high and low temperatures for a given day. The high temperature for Boston, Massachusetts, on January 10, 2004, was −10.6°C. The low temperature was −18.9°C. Find the daily mean temperature for that day.

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54. **MULTI-STEP PROBLEM** The table shows the changes in the values of one share of stock A and one share of stock B over 5 days.

Day of week	Monday	Tuesday	Wednesday	Thursday	Friday
Change in share value for stock A (dollars)	−0.45	−0.32	0.66	−1.12	1.53
Change in share value for stock B (dollars)	−0.37	0.14	0.59	−0.53	1.02

a. Find the average daily change in share value for each stock.

b. Which stock performed better over the 5 days? How much more money did the better performing stock earn, on average, per day?

c. Can you conclude that the stock that performed better over all 5 days also performed better over the first 4 days of the week? *Explain* your reasoning.

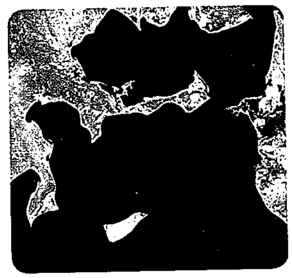
55. ★ **MULTIPLE CHOICE** In a trivia competition, your team earned 60, −100, 300, 120, and −80 points on 5 questions. The sixth question has a value of 300 points. By how many points will your team's mean score per question change if you answer the sixth question correctly?

(A) 40 points (B) 50 points (C) 60 points (D) 100 points

56. ★ **SHORT RESPONSE** The South Aral Sea in Russia was about 57 meters above sea level in 1965. Scientists once predicted that the elevation would be about 34 meters above sea level in 2002.

a. Estimate the average rate of change in elevation for the period 1965–2002 using the scientists' prediction. Round to the nearest hundredth of a meter per year.

b. More recent research suggests that the elevation decreased to about 30.5 meters above sea level in 2002. Use this information to predict the elevation in 2010. *Explain* the steps of your solution.



South Aral Sea, 1973

South Aral Sea, 2000

57. ★ **EXTENDED RESPONSE** In volleyball, an ace is a serve that the opponent doesn't hit. Ace efficiency is a measure of a player's ability to hit aces while minimizing service errors. The ace efficiency f is given by the formula $f = \frac{a - e}{s}$ where a is the number of aces, e is the number of service errors, and s is the total number of serves.

a. **Calculate** Find the ace efficiency for a player who has 108 aces and 125 service errors in 500 serves.

b. **Compare** If the player makes 30 more aces and 20 more service errors in the next 100 serves, will the ace efficiency improve? *Explain.*

c. **Justify** Under what conditions would a player's ace efficiency be 0? 1? −1? *Justify* your answers algebraically.

58. **CHALLENGE** The average daily balance of a checking account is the sum of the daily balances in a given period divided by the number of days in the period. Suppose that a period has 30 days. Find the average daily balance of an account that has a balance of \$110 for 18 days, −\$300 for 10 days, and \$100 for the rest of the period.

MIXED REVIEW

Evaluate the expression.

59. $6x$ when $x = 15$ *(p. 2)*

60. $4x + 2y$ when $x = 3$ and $y = 7$ *(p. 8)*

61. $x - y - 2$ when $x = 3$ and $y = -4$ *(p. 80)*

62. $-4xy$ when $x = -2$ and $y = -1.4$ *(p. 88)*

PREVIEW
Prepare for Lesson 2.7 in Exs. 63–64.

Identify the hypothesis and the conclusion of the statement. Tell whether the statement is *true* or *false*. If it is false, give a counterexample. *(p. 64)*

63. If a number is a whole number, then the number is a rational number.

64. If a number is a rational number, then the number is an integer.

2.7 Writing Statements in If-Then Form

MATERIALS • paper and pencil

QUESTION **How can you write an *all* or *none* statement in if-then form?**

EXPLORE **Tell whether certain statements are true about a group**

STEP 1 ***Answer questions*** Copy the questions below and write your answers beside them.

1. Do you play an instrument?
2. Do you participate in a school sport?
3. Are you taking an art class?
4. Do you walk to school?

STEP 2 ***Write if-then statements*** Each of the *all* or *none* statements below can be written in if-then form. Copy each statement and complete its equivalent if-then form. The first one is done for you as an example.

1. All of the students in our group play an instrument.
   If a student is in our group, then the student plays an instrument.
2. None of the students in our group participates in a school sport.
   If _?_, then _?_.
3. None of the students in our group is taking an art class.
   If _?_, then _?_.
4. All of the students in our group walk to school.
   If _?_, then _?_.

STEP 3 ***Analyze statements*** Form a group with 2 or 3 classmates. Tell whether each if-then statement in Step 2 is *true* or *false* for your group. If the statement is false, give a counterexample.

DRAW CONCLUSIONS **Use your observations to complete these exercises**

1. *Describe* the similarity and difference in the if-then forms of the following statements:

   All of the students in our group listen to rock music.

   None of the students in our group listens to rock music.

Rewrite the given conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.

2. All of the positive numbers are integers.
3. All of the rational numbers can be written as fractions.
4. None of the negative numbers is a whole number.
5. None of the rational numbers has an opposite equal to itself.

CONDITIONAL STATEMENTS In the activity on page 109, you saw that a conditional statement not in if-then form can be written in that form.

EXAMPLE 5 Rewrite a conditional statement in if-then form

Rewrite the given conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.

Solution

a. Given: No fractions are irrational numbers.

If-then form: If a number is a fraction, then it is not an irrational number.

The statement is true.

b. Given: All real numbers are rational numbers.

If-then form: If a number is a real number, then it is a rational number.

The statement is false. For example, $\sqrt{2}$ is a real number but *not* a rational number.

✓ **GUIDED PRACTICE** for Example 5

Rewrite the conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.

10. All square roots of perfect squares are rational numbers.

11. All repeating decimals are irrational numbers.

12. No integers are irrational numbers.

2.7 EXERCISES

HOMEWORK KEY

○ = **WORKED-OUT SOLUTIONS** on p. WS5 for Exs. 9, 19, and 49

★ = **STANDARDIZED TEST PRACTICE** Exs. 2, 23, 42, 43, 44, 50, and 53

◆ = **MULTIPLE REPRESENTATIONS** Ex. 54

SKILL PRACTICE

1. VOCABULARY Copy and complete: The set of all rational and irrational numbers is called the set of __?__.

2. ★ **WRITING** Without calculating, how can you tell whether the square root of a whole number is rational or irrational?

EXAMPLE 1 on p. 110 for Exs. 3–14

EVALUATING SQUARE ROOTS **Evaluate the expression.**

3. $\sqrt{4}$	**4.** $-\sqrt{49}$	**5.** $-\sqrt{9}$	**6.** $\pm\sqrt{1}$
7. $\sqrt{196}$	**8.** $\pm\sqrt{121}$	**9.** $\pm\sqrt{2500}$	**10.** $-\sqrt{256}$
11. $-\sqrt{225}$	**12.** $\sqrt{361}$	**13.** $\pm\sqrt{169}$	**14.** $-\sqrt{1600}$

EXAMPLE 2
on p. 111
for Exs. 15–22

APPROXIMATING SQUARE ROOTS **Approximate the square root to the nearest integer.**

15. $\sqrt{10}$
16. $-\sqrt{18}$
17. $-\sqrt{3}$
18. $\sqrt{150}$
19. $-\sqrt{86}$
20. $\sqrt{40}$
21. $\sqrt{200}$
22. $-\sqrt{65}$

23. ★ **MULTIPLE CHOICE** Which number is between -30 and -25?

(A) $-\sqrt{1610}$ (B) $-\sqrt{680}$ (C) $-\sqrt{410}$ (D) $-\sqrt{27}$

EXAMPLES 3 and 4
on p. 112
for Exs. 24–29

CLASSIFYING AND ORDERING REAL NUMBERS **Tell whether each number in the list is a real number, a rational number, an irrational number, an integer, or a whole number. Then order the numbers from least to greatest.**

24. $\sqrt{49}, 8, -\sqrt{4}, -3$
25. $-\sqrt{12}, -3.7, \sqrt{9}, 2.9$
26. $-11.5, -\sqrt{121}, -10, \frac{25}{2}, \sqrt{144}$
27. $\sqrt{8}, -\frac{2}{5}, -1, 0.6, \sqrt{6}$
28. $-\frac{8}{3}, -\sqrt{5}, 2.6, -1.5, \sqrt{5}$
29. $-8.3, -\sqrt{80}, -\frac{17}{2}, -8.25, -\sqrt{100}$

EXAMPLE 5
on p. 113
for Exs. 30–33

ANALYZING CONDITIONAL STATEMENTS **Rewrite the conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.**

30. All whole numbers are real numbers.
31. All real numbers are irrational numbers.
32. No perfect squares are whole numbers.
33. No irrational numbers are whole numbers.

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

34. $3 + \sqrt{x}$ when $x = 9$
35. $11 - \sqrt{x}$ when $x = 81$
36. $4 \cdot \sqrt{x}$ when $x = 49$
37. $-7 \cdot \sqrt{x}$ when $x = 36$
38. $-3 \cdot \sqrt{x} - 7$ when $x = 121$
39. $6 \cdot \sqrt{x} + 3$ when $x = 100$
40. $\frac{\sqrt{x}}{x}$ when $x = 4$
41. $\frac{\sqrt{x}}{5} - 17$ when $x = 25$

42. ★ **OPEN-ENDED** Without using a calculator, find three rational numbers between $-\sqrt{26}$ and $-\sqrt{15}$. *Explain* how you found the numbers.

43. ★ **MULTIPLE CHOICE** If $x = 36$, the value of which expression is a perfect square?

(A) $\sqrt{x} + 17$ (B) $87 - \sqrt{x}$ (C) $5 \cdot \sqrt{x}$ (D) $8 \cdot \sqrt{x} + 2$

44. ★ **WRITING** Simplify $(\sqrt{x})^2$ for $x \geq 0$ using the definition of square root. Then verify your answer using several values of x that are perfect squares.

45. **CHALLENGE** Find the first five perfect squares x such that $2 \cdot \sqrt{x}$ is also a perfect square. *Describe* your method.

46. **CHALLENGE** Let n be any whole number from 1 to 1000. For how many values of n is $\sqrt{n}$ a rational number? *Explain* your reasoning.

○ = **WORKED-OUT SOLUTIONS on p. WS1**

★ = **STANDARDIZED TEST PRACTICE**

PROBLEM SOLVING

EXAMPLE 1 on p. 110 for Exs. 47, 49

47. ART The area of a square painting is 3600 square inches. Find the side length of the painting.

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EXAMPLE 2 on p. 111 for Exs. 48, 50

48. SOCCER Some soccer drills are practiced in a square section of a field. If the section of a field for a soccer drill is 1620 square yards, find the side length of the section. Round your answer to the nearest yard.

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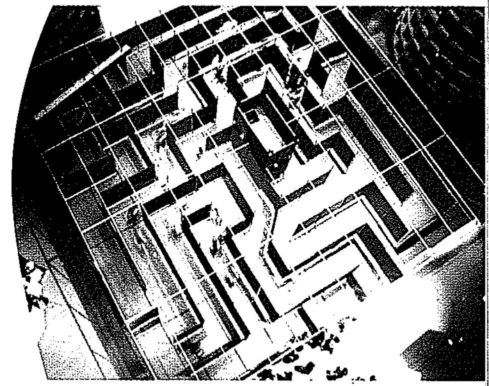
49. MAZES The table shows the locations and areas of various life-size square mazes. Find the side lengths of the mazes. Then tell whether the side lengths are *rational* or *irrational* numbers.

Location of maze	Area (ft^2)
Dallas, Texas	1225
San Francisco, California	576
Corona, New York	2304
Waterville, Maine	900



Maze at Corona, New York

50. ★ SHORT RESPONSE You plan to use a square section of a park for a small outdoor concert. The section should have an area of 1450 square feet. You have 150 feet of rope to use to surround the section. Do you have enough rope? *Explain* your reasoning.

51. MATH HISTORY To calculate the value of the irrational number π, the Greek mathematician Archimedes first estimated the square root of a certain integer x. He found that $\sqrt{x}$ was between $\frac{265}{153}$ and $\frac{1351}{780}$. Find the value of x. *Explain* how you got your answer.

52. MULTI-STEP PROBLEM The Kelvin temperature scale was invented by Lord Kelvin in the 19th century and is often used for scientific measurements. To convert a temperature from degrees Celsius (°C) to kelvin (K), you add 273 to the temperature in degrees Celsius.

a. Convert 17°C to kelvin.

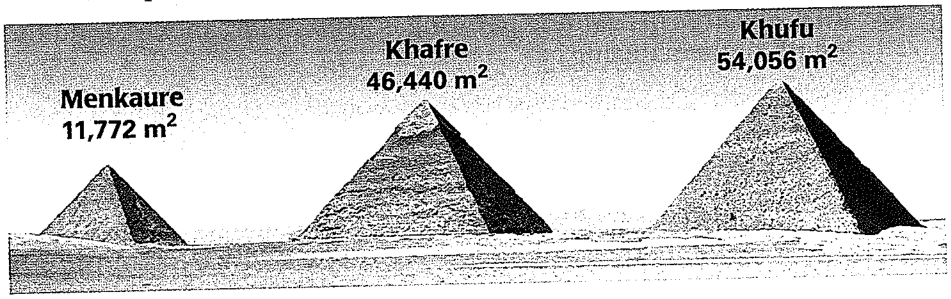
b. The speed s (in meters per second) of sound in air is given by the formula $s = 20.1 \cdot \sqrt{K}$ where K is the temperature in kelvin. Find the speed of sound in air at 17°C. Round your answer to the nearest meter per second.

53. ★ SHORT RESPONSE A homeowner is building a square patio and will cover the patio with square tiles. Each tile has an area of 256 square inches and costs $3.45. The homeowner has $500 to spend on tiles.

a. Calculate How many tiles can the homeowner buy?

b. Explain Find the side length (in feet) of the largest patio that the homeowner can build. *Explain* how you got your answer.

54. **MULTIPLE REPRESENTATIONS** The diagram shows the approximate areas (in square meters) of the square bases for the pyramids of Giza.



a. **Making a Table** Make a table that gives the following quotients (rounded to the nearest tenth) for each of the 3 pairs of pyramids:
- (area of larger base) ÷ (area of smaller base)
- (side length of larger base) ÷ (side length of smaller base)

For each pair of pyramids, how are the two quotients related?

b. **Writing an Equation** Write an equation that gives the quotient q of the side lengths as a function of the quotient r of the areas.

55. **CHALLENGE** Write an equation that gives the edge length ℓ of a cube as a function of the surface area A of the cube.

MIXED REVIEW

Evaluate the expression. *(p. 8)*

56. $11 + 6 - 3$	57. $18 - 3^2$	58. $9 \cdot 2^2 - 1$	59. $6(4^2 + 4)$
60. $12 \cdot 3 + 15$	61. $6 \cdot 4 + 7 \cdot 5$	62. $9(15 - 2 \cdot 4)$	63. $5^2 - 2^3$

PREVIEW Prepare for Lesson 3.1 in Exs. 64–71.

Solve the equation using mental math. *(p. 21)*

64. $8 + x = 13$	65. $x - 20 = 15$	66. $4x = 32$	67. $\frac{x}{7} = 5$
68. $x - 14 = 30$	69. $x + 11 = 27$	70. $\frac{x}{9} = 10$	71. $6x = 48$

QUIZ for Lessons 2.6–2.7

Find the quotient. *(p. 103)*

1. $-20 \div (-5)$	2. $-12 \div \frac{2}{3}$	3. $\frac{4}{5} \div \left(-\frac{3}{10}\right)$	4. $-18.2 \div (-3)$

5. Simplify the expression $\frac{15x - 6}{3}$. *(p. 103)*

6. Tell whether each of the following numbers is a real number, a rational number, an irrational number, an integer, or a whole number: -3, $-\sqrt{5}$, -3.7, $\sqrt{3}$. Then order the numbers from least to greatest. *(p. 110)*

7. Rewrite the following conditional statement in if-then form: "No irrational numbers are negative numbers." Tell whether the statement is *true* or *false*. If it is false, give a counterexample. *(p. 110)*

EXTRA PRACTICE for Lesson 2.7, p. 939

ONLINE QUIZ at classzone.com

Extension

Use after Lesson 2.7

Use Logical Reasoning

GOAL Use inductive and deductive reasoning.

Key Vocabulary
- **inductive reasoning**
- **conjecture**
- **deductive reasoning**

When you make a conclusion based on several examples, you are using **inductive reasoning**. A conclusion reached using inductive reasoning is an example of a *conjecture*. A **conjecture** is a statement that is believed to be true but not yet shown to be true.

EXAMPLE 1 Use inductive reasoning

Your friend asks you to perform the following number trick: *Choose any number. Then double the number. Then add 8. Then multiply by 3. Then divide by 6. Then subtract 4.* Perform the number trick for three different numbers. Then make a conjecture based on the results.

Solution

Step 1: Choose any number.	Choose 5.	Choose 14.	Choose −6.
Step 2: Double the number.	10	28	−12
Step 3: Add 8.	18	36	−4
Step 4: Multiply by 3.	54	108	−12
Step 5: Divide by 6.	9	18	−2
Step 6: Subtract 4.	5	14	−6

Conjecture: The result in Step 6 is the same as the number in Step 1.

EXAMPLE 2 Show that a conjecture is true

Show that the conjecture made in Example 1 is true for all numbers x.

Solution

Step 1: Choose any number.	Choose x.
Step 2: Double the number.	$2x$
Step 3: Add 8.	$2x + 8$
Step 4: Multiply by 3.	$3(2x + 8) = 6x + 24$
Step 5: Divide by 6.	$\frac{6x + 24}{6} = x + 4$
Step 6: Subtract 4.	$(x + 4) - 4 = x$

The result in Step 6 is the same as the number chosen in Step 1. So, the conjecture made in Example 1 is true for all numbers x.

DEDUCTIVE REASONING In Example 2, you simplified the expression at each step. Had you not done this, you would have obtained the expression $\frac{3(2x+8)}{6} - 4$. You can still show that $\frac{3(2x+8)}{6} - 4 = x$ by applying *deductive reasoning*. When you make a conclusion based on statements that are assumed or shown to be true, you are using **deductive reasoning**.

EXAMPLE 3 Use deductive reasoning

Show that $\frac{3(2x+8)}{6} - 4 = x$. Justify each step.

Solution

Step	Justification
$\frac{3(2x+8)}{6} - 4 = \frac{6x+24}{6} - 4$	Distributive property
$= (x+4) - 4$	Divide $(6x + 24)$ by 6.
$= (x+4) + (-4)$	Subtraction rule
$= x + [4 + (-4)]$	Associative property of addition
$= x + 0$	Inverse property of addition
$= x$	Identity property of addition

PRACTICE

EXAMPLES 1, 2, and 3 on pp. 117–118 for Exs. 1–3

In Exercises 1 and 2, perform the given number trick for three numbers. Make a conjecture based on the results. Then show that your conjecture is true for all numbers.

1. Choose any number. Then subtract 5. Then multiply by 6. Then divide by 3. Then add 10.

2. Choose any number. Then double it. Then add 12. Then multiply by 4. Then divide by 8. Then subtract the number you chose.

3. The steps below show that $\frac{4(3x+5)-20}{12} = x$. *Justify* each step.

$\frac{4(3x+5)-20}{12} = \frac{(12x+20)-20}{12}$	?
$= \frac{(12x+20)+(-20)}{12}$	?
$= \frac{12x+[20+(-20)]}{12}$	?
$= \frac{12x+0}{12}$	?
$= \frac{12x}{12}$	?
$= x$	?

Lessons 2.4–2.7

1. **MULTI-STEP PROBLEM** The modern pentathlon consists of 5 events, including a distance run. For the men's run, every athlete starts with 1000 points. The athlete earns 2 points for every 0.5 second under a finishing time of 10 minutes and -2 points for every 0.5 second over 10 minutes.
   a. An athlete finishes the race in 9 minutes 34 seconds. How many points does he have now?
   b. His competitor finishes in 11 minutes 2.5 seconds. How many more points than his competitor does he have?

2. **MULTI-STEP PROBLEM** The troposphere is the lowest layer of the atmosphere. It extends to a height of 11,000 meters. On average, the temperature is 15°C at the bottom of the troposphere and changes by about -0.0065°C for every meter of increase in elevation.
   a. Write an equation that gives the temperature T (in degrees Celsius) as a function of the elevation e (in meters) within the troposphere.
   b. Find the temperature at the top of the troposphere.

3. **GRIDDED ANSWER** The table shows the areas of two square rugs that a store sells. How many inches longer is the sorrel rug than the shaw rug?

Type of rug	Area (in.^{2})
Sorrel rug	8281
Shaw rug	7744

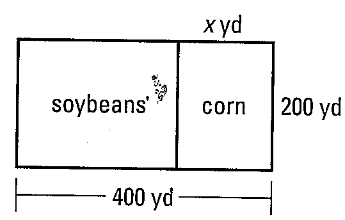
4. **SHORT RESPONSE** Your friend is comparing two 6-sided cubic storage bins. The yellow bin has a surface area of 9600 square centimeters and costs $25. The blue bin has a surface area of 7350 square centimeters and costs $20.
   a. Find the edge length of each bin.
   b. Which bin costs less per cubic centimeter? *Explain* your reasoning.

5. **SHORT RESPONSE** The table shows the costs of three items at a baseball stadium in 2002 and 2004.

Item	Cost in 2002	Cost in 2004
Ticket	$20.44	$17.90
Soda	$2.75	$2.00
Hot dog	$2.75	$2.75

   a. Write an equation that gives the change c in the total amount spent from 2002 to 2004 when buying x of each item. Then find the value of c when $x = 4$.
   b. Suppose that from 2004 to 2006 the cost of a ticket decreases, and the costs of the other two items increase. Can you conclude that the change in the total amount spent from 2004 to 2006 is positive? *Explain.*

6. **EXTENDED RESPONSE** A farmer is planting corn and soybeans in the rectangular field shown. The farmer spends $.09 per square yard to plant corn and $.07 per square yard to plant soybeans.



   a. Write an equation that gives the cost C of planting the field as a function of the length x (in yards) of the corn section.
   b. How much money will the farmer spend on planting the field if the corn section has a length of 100 yards?
   c. Suppose that the farmer has $6500 to plant the entire field. Will the farmer have enough money if the soybean section has a length of 250 yards? *Explain.*

7. **OPEN-ENDED** *Describe* a real-world situation that can be modeled by the expression $\frac{8.90 + (-2.34) + (-1.15)}{3}$. Then find the value of the expression.

2 CHAPTER SUMMARY

BIG IDEAS *For Your Notebook*

Big Idea 1

Performing Operations with Real Numbers

To add or multiply two real numbers a and b, you can use the following rules:

Expression	Rule when a and b have the same sign	Rule when a and b have different signs
$a + b$	Add $\lvert a \rvert$ and $\lvert b \rvert$. The sum has the same sign as a and b.	Subtract the lesser absolute value from the greater absolute value. The sum has the same sign as the number with the greater absolute value.
ab	The product is positive.	The product is negative.

You can use these rules to subtract or divide numbers, but first you rewrite the difference or quotient using the subtraction rule or the division rule.

Big Idea 2

Applying Properties of Real Numbers

You can apply the properties of real numbers to evaluate and simplify expressions. Many of the properties of addition and multiplication are similar.

Property	Addition	Multiplication
Commutative property	$a + b = b + a$	$ab = ba$
Associative property	$(a + b) + c = a + (b + c)$	$(ab)c = a(bc)$
Identity property	$a + 0 = 0 + a = a$	$a \cdot 1 = 1 \cdot a = a$
Inverse property	$a + (-a) = -a + a = 0$	$a \cdot \frac{1}{a} = \frac{1}{a} \cdot a = 1, a \neq 0$
Distributive property	$a(b + c) = ab + ac$ (and three variations)	

Big Idea 3

Classifying and Reasoning with Real Numbers

Being able to classify numbers can help you tell whether a conditional statement about real numbers is true or false. For example, the following statement is false: "All real numbers are integers." A counterexample is 3.5.

Numbers	Description
Whole numbers	The numbers 0, 1, 2, 3, 4, . . .
Integers	The numbers . . . , −3, −2, −1, 0, 1, 2, 3, . . .
Rational numbers	Numbers of the form $\frac{a}{b}$ where a and b are integers and $b \neq 0$
Irrational numbers	Numbers that cannot be written as a quotient of two integers
Real numbers	All rational and irrational numbers

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• Multi-Language Glossary
• Vocabulary practice

REVIEW KEY VOCABULARY

- whole numbers, integers, positive integer, negative integer, *p. 64*
- rational number, *p. 64*
- opposites, absolute value, *p. 66*
- conditional statement, *p. 66*
- if-then statement, *p. 66*
- counterexample, *p. 66*
- additive identity, *p. 76*
- additive inverse, *p. 76*
- multiplicative identity, *p. 89*
- equivalent expressions, *p. 96*
- distributive property, *p. 96*
- term, coefficient, constant term, like terms, *p. 97*
- multiplicative inverse, *p. 103*
- square root, radicand, *p. 110*
- perfect square, *p. 111*
- irrational number, *p. 111*
- real numbers, *p. 112*

VOCABULARY EXERCISES

Identify the terms, coefficients, constant terms, and like terms of the expression.

1. $-3x - 5 - 7x - 9$ **2.** $-10c - 6 + c$

Tell whether the number is a real number, a rational number, an irrational number, an integer, or a whole number.

3. 0.3 **4.** $-\sqrt{8}$ **5.** -15 **6.** $\sqrt{49}$

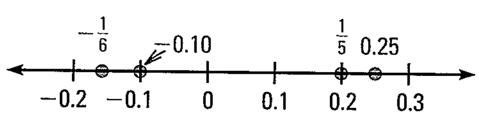
REVIEW EXAMPLES AND EXERCISES

Use the review examples and exercises below to check your understanding of the concepts you have learned in each lesson of Chapter 2.

2.1 Use Integers and Rational Numbers *pp. 64–67*

EXAMPLE

Order the following numbers from least to greatest: $\frac{1}{5}$, −0.10, 0.25, $-\frac{1}{6}$.



From least to greatest, the numbers are $-\frac{1}{6}$, −0.10, $\frac{1}{5}$, and 0.25.

EXERCISES

EXAMPLES 3, 4, and 5 on pp. 65–66 for Exs. 7–12

Order the numbers in the list from least to greatest.

7. $-5.2, -\frac{3}{8}, -6, 0.3, -\frac{1}{4}$ **8.** $2.1, 0, -\frac{13}{10}, -1.38, \frac{3}{5}$

For the given value of *a*, find $-a$ and $|a|$.

9. $a = -0.2$ **10.** $a = 3$ **11.** $a = \frac{7}{8}$ **12.** $a = -\frac{6}{11}$

2 CHAPTER REVIEW

2.2 Add Real Numbers

pp. 74–76

EXAMPLE

Find the sum.

a. $-3.6 + (-5.5) = -(|-3.6| + |-5.5|)$ — **Rule of same signs**

$= -(3.6 + 5.5)$ — **Take absolute values.**

$= -9.1$ — **Add.**

b. $16.1 + (-9.3) = |16.1| - |-9.3|$ — **Rule of different signs**

$= 16.1 - 9.3$ — **Take absolute values.**

$= 6.8$ — **Subtract.**

EXERCISES

EXAMPLES 1, 2, and 4 on pp. 74–76 for Exs. 13–19

Find the sum.

13. $-2 + 5$ **14.** $-6 + (-4)$ **15.** $6.2 + (-9.7)$

16. $-4.61 + (-0.79)$ **17.** $-\frac{4}{7} + \left(-\frac{9}{14}\right)$ **18.** $-\frac{4}{5} + \frac{11}{12}$

19. BUSINESS A company has a profit of \$2.07 million in its first year, −\$1.54 million in its second year, and −\$.76 million in its third year. Find the company's total profit for the three years.

2.3 Subtract Real Numbers

pp. 80–81

EXAMPLE

Find the difference.

a. $12 - 19 = 12 + (-19)$ — **Add the opposite of 19.**

$= -7$ — **Simplify.**

b. $8.2 - (-1.6) = 8.2 + 1.6$ — **Add the opposite of −1.6.**

$= 9.8$ — **Simplify.**

EXERCISES

EXAMPLES 1 and 2 on p. 80 for Exs. 20–28

Find the difference.

20. $-8 - 3$ **21.** $1 - 11$ **22.** $7.7 - 16.3$

23. $-20.3 - (-14.2)$ **24.** $\frac{7}{3} - \frac{11}{3}$ **25.** $-\frac{4}{9} - \frac{5}{12}$

Evaluate the expression when $x = 2$ and $y = -3$.

26. $(x - 7) + y$ **27.** $\frac{3}{2} - x - y$ **28.** $y - (2.4 - x)$

2.4 Multiply Real Numbers

pp. 88–90

EXAMPLE

Find the product.

a. $-4(12) = -48$ — **Different signs; product is negative.**

b. $\frac{1}{2}(-6)(-3) = -3(-3)$ — **Multiply $\frac{1}{2}$ and -6.**

$= 9$ — **Same signs; product is positive.**

EXERCISES

EXAMPLES 1, 3, and 4 on pp. 88–90 for Exs. 29–35

Find the product.

29. $15(-4)$ **30.** $-7.5(-8)$ **31.** $-\frac{2}{5}(-5)(-9)$

Find the product. *Justify* your steps.

32. $-4(-y)(-7)$ **33.** $-\frac{1}{3}x \cdot (-18)$ **34.** $2.5(-4z)(-2)$

35. SWIMMING POOLS The water level of a swimming pool is 3.3 feet and changes at an average rate of -0.14 feet per day due to water evaporation. What will the water level of the pool be after 4 days?

2.5 Apply the Distributive Property

pp. 96–98

EXAMPLE

Use the distributive property to write an equivalent expression.

a. $5(x + 3) = 5(x) + 5(3)$ — **Distribute 5.**

$= 5x + 15$ — **Simplify.**

b. $(7 - y)(-2y) = 7(-2y) - y(-2y)$ — **Distribute $-2y$.**

$= -14y + 2y^2$ — **Simplify.**

EXERCISES

EXAMPLES 1, 2, 4, and 5 on pp. 96–98 for Exs. 36–42

Use the distributive property to write an equivalent expression.

36. $8(5 - x)$ **37.** $-3(y + 9)$ **38.** $(z - 4)(-z)$

Simplify the expression.

39. $3(x - 2) + 14$ **40.** $9.1 - 4(m + 3.2)$ **41.** $5n + \frac{1}{2}(8n - 7)$

42. PARTY COSTS You are buying 10 pizzas for a party. Cheese pizzas cost \$11 each, and single topping pizzas cost \$13 each. Write an equation that gives the total cost C (in dollars) as a function of the number p of cheese pizzas that you buy. Then find the total cost if you buy 4 cheese pizzas.

2 CHAPTER REVIEW

2.6 Divide Real Numbers

pp. 103–105

EXAMPLE

Find the quotient.

a. $196 \div (-7) = 196 \cdot \left(-\frac{1}{7}\right)$

$= -28$

b. $-\frac{14}{15} \div \left(-\frac{7}{3}\right) = -\frac{14}{15} \cdot \left(-\frac{3}{7}\right)$

$= \frac{2}{5}$

EXERCISES

EXAMPLES 2, 3, and 4 on pp. 104–105 for Exs. 43–49

Find the quotient.

43. $56 \div (-4)$

44. $-6 \div \frac{3}{13}$

45. $-\frac{4}{9} \div \left(-\frac{2}{3}\right)$

46. SCIENCE A scientist studies the diving abilities of three seals and records the elevations they reach before swimming back up to the surface. Find the mean of the following elevations (in meters) recorded: −380, −307, −354.

Simplify the expression.

47. $\frac{24x - 40}{8}$

48. $\frac{-36m + 18}{6}$

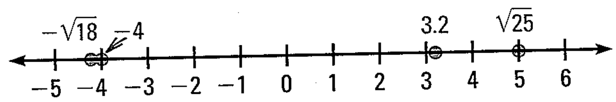
49. $\frac{-18n - 9}{-9}$

2.7 Find Square Roots and Compare Real Numbers

pp. 110–113

EXAMPLE

Order the following numbers from least to greatest: $\sqrt{25}$, $-\sqrt{18}$, −4, 3.2.



From least to greatest, the numbers are $-\sqrt{18}$, −4, 3.2, and $\sqrt{25}$.

EXERCISES

EXAMPLES 1, 2, 4, and 5 on pp. 110–113 for Exs. 50–60

Evaluate the expression.

50. $\sqrt{121}$

51. $-\sqrt{36}$

52. $\pm\sqrt{81}$

53. $\pm\sqrt{225}$

Approximate the square root to the nearest integer.

54. $\sqrt{97}$

55. $-\sqrt{48}$

56. $-\sqrt{142}$

57. $\sqrt{300}$

Order the numbers in the list from least to greatest.

58. $-\sqrt{49}$, −6.8, 2, $\sqrt{3}$, 1.58

59. 1.25, $\sqrt{11}$, −0.3, 0, $-\sqrt{4}$

60. Rewrite the following conditional statement in if-then form: "All real numbers are irrational numbers." Tell whether the statement is *true* or *false*. If it is false, give a counterexample.

2 CHAPTER TEST

Tell whether the number is a real number, a rational number, an irrational number, an integer, or a whole number.

1. $-\frac{1}{4}$ **2.** $\sqrt{90}$ **3.** $-\sqrt{144}$ **4.** 8.95

Order the numbers in the list from least to greatest.

5. $-\frac{5}{3}, -2, 3, \frac{1}{2}, -1.07$ **6.** $\sqrt{15}, -4.3, 4.2, 0, -\sqrt{25}$

Find the sum, difference, product, or quotient.

7. $-5 + 2$ **8.** $1.3 + (-10.4)$ **9.** $-\frac{1}{3} + \frac{1}{6}$ **10.** $-\frac{2}{7} - \frac{5}{14}$

11. $-41 - 32$ **12.** $7.2 - (-11.6)$ **13.** $-11(-7)$ **14.** $-4.5(20)(2)$

15. $-\frac{1}{5}(-20)(-5)$ **16.** $-36 \div (-6)$ **17.** $-\frac{3}{5} \div 12$ **18.** $5 \div \left(-\frac{10}{11}\right)$

Evaluate the expression when $x = -6$ and $y = -10$.

19. $-x$ **20.** $|y|$ **21.** $8 - (x - y)$ **22.** $-4x + y$

Simplify the expression.

23. $-9(y - 7)$ **24.** $8(x - 4) - 10x$ **25.** $\frac{-7w - 21}{7}$ **26.** $\frac{-16v + 8}{-4}$

In Exercises 27 and 28, rewrite the conditional statement in if-then form. Then tell whether the statement is *true* or *false*. If it is false, give a counterexample.

27. No rational numbers are integers.

28. All irrational numbers are real numbers.

29. MUSIC The revenue from sales of digital pianos in the United States was \$152.4 million in 2001 and \$149.0 million in 2002. Find the change in revenue from 2001 to 2002.

30. ELEVATORS An elevator moves at a rate of −5.8 feet per second from a height of 300 feet above the ground. It takes 3 seconds for the elevator to make its first stop. How many feet above the ground is the elevator now?

31. SUMMER JOBS You plan to work a total of 25 hours per week at two summer jobs. You will earn \$8.75 per hour working at a cafe and \$10.50 per hour working at an auto shop. Write an equation that gives your weekly pay p (in dollars) as a function of the time t (in hours) spent working at the cafe. Then find your weekly pay if you work 10 hours at the cafe.

32. TEMPERATURES The low temperatures for Montreal, Quebec, in Canada on February 12 for each year during the period 2000–2004 are −6.7°F, −4.2°F, 4.1°F, −3.6°F, and 0.3°F. Find the mean of the temperatures.