EXAMPLE 8 USING THE ORDER OF OPERATIONS

Simplify: $(-6)^2 - (5 - 7)^2(-3)$.

SOLUTION Because grouping symbols appear, we perform the operation within parentheses first.

$$(-6)^2 - (5 - 7)^2(-3)$$

$$= (-6)^2 - (-2)^2(-3)$$ Work inside parentheses first: $5 - 7 = 5 + (-7) = -2$.

$$= 36 - 4(-3)$$ Evaluate exponential expressions: $(-6)^2 = (-6)(-6) = 36$ and $(-2)^2 = (-2)(-2) = 4$.

$$= 36 - (-12)$$ Multiply: $4(-3) = -12$.

$$= 48$$ Subtract: $36 - (-12) = 36 + 12 = 48$.

○

CHECK POINT 8 Simplify $(-8)^2 - (10 - 13)^2(-2)$.

EXERCISE SET 5.2

Practice Exercises

In Exercises 1–4, start by drawing a number line that shows integers from −5 to 5. Then graph each of the following integers on your number line.

1. 3 **2.** 5 **3.** −4 **4.** −2

In Exercises 5–12, insert either < or > in the shaded area between the integers to make the statement true.

5. −2 ▒ 7 **6.** −1 ▒ 13 **7.** −13 ▒ −2 **8.** −1 ▒ −13

9. 8 ▒ −50 **10.** 7 ▒ −9 **11.** −100 ▒ 0 **12.** 0 ▒ −300

In Exercises 13–18, find the absolute value.

13. $|-14|$ **14.** $|-16|$ **15.** $|14|$

16. $|16|$ **17.** $|-300{,}000|$ **18.** $|-1{,}000{,}000|$

In Exercises 19–30, find each sum.

19. $-7 + (-5)$ **20.** $-3 + (-4)$ **21.** $12 + (-8)$

22. $13 + (-5)$ **23.** $6 + (-9)$ **24.** $3 + (-11)$

25. $-9 + (+4)$ **26.** $-7 + (+3)$ **27.** $-9 + (-9)$

28. $-13 + (-13)$ **29.** $9 + (-9)$ **30.** $13 + (-13)$

In Exercises 31–42, perform the indicated subtraction.

31. $13 - 8$ **32.** $14 - 3$ **33.** $8 - 15$

34. $9 - 20$ **35.** $4 - (-10)$ **36.** $3 - (-17)$

37. $-6 - (-17)$ **38.** $-4 - (-19)$ **39.** $-12 - (-3)$

40. $-19 - (-2)$ **41.** $-11 - 17$ **42.** $-19 - 21$

In Exercises 43–52, find each product.

43. $6(-9)$ **44.** $5(-7)$ **45.** $(-7)(-3)$

46. $(-8)(-5)$ **47.** $(-2)(6)$ **48.** $(-3)(10)$

49. $(-13)(-1)$ **50.** $(-17)(-1)$ **51.** $0(-5)$

52. $0(-8)$

In Exercises 53–66, evaluate each exponential expression.

53. 5^2 **54.** 6^2 **55.** $(-5)^2$ **56.** $(-6)^2$

57. 4^3 **58.** 2^3 **59.** $(-5)^3$ **60.** $(-4)^3$

61. $(-5)^4$ **62.** $(-4)^4$ **63.** -3^4 **64.** -1^4

65. $(-3)^4$ **66.** $(-1)^4$

In Exercises 67–80, find each quotient, or, if applicable, state that the expression is undefined.

67. $\frac{-12}{4}$ **68.** $\frac{-40}{5}$ **69.** $\frac{21}{-3}$ **70.** $\frac{60}{-6}$

71. $\frac{-90}{-3}$ **72.** $\frac{-66}{-6}$ **73.** $\frac{0}{-7}$ **74.** $\frac{0}{-8}$

75. $\frac{-7}{0}$ **76.** $\frac{0}{0}$

77. $(-480) \div 24$ **78.** $(-300) \div 12$

79. $(465) \div (-15)$ **80.** $(-594) \div (-18)$

In Exercises 81–98, use the order of operations to find the value of each expression.

81. $7 + 6 \cdot 3$ **82.** $-5 + (-3) \cdot 8$

83. $(-5) - 6(-3)$ **84.** $-8(-3) - 5(-6)$

85. $6 - 4(-3) - 5$ **86.** $3 - 7(-1) - 6$

87. $3 - 5(-4 - 2)$ **88.** $3 - 9(-1 - 6)$

89. $(2 - 6)(-3 - 5)$ **90.** $9 - 5(6 - 4) - 10$

91. $3(-2)^2 - 4(-3)^2$ **92.** $5(-3)^2 - 2(-2)^3$

93. $(2 - 6)^2 - (3 - 7)^2$ **94.** $(4 - 6)^2 - (5 - 9)^3$

95. $6(3 - 5)^3 - 2(1 - 3)^3$

96. $-3(-6 + 8)^3 - 5(-3 + 5)^3$

97. $8^2 - 16 \div 2^2 \cdot 4 - 3$

98. $10^2 - 100 \div 5^2 \cdot 2 - (-3)$

• Practice Plus

In Exercises 99–104, use the order of operations to find the value of each expression.

99. $8 - 3[-2(2 - 5) - 4(8 - 6)]$

100. $8 - 3[-2(5 - 7) - 5(4 - 2)]$

101. $-2^2 + 4[16 \div (3 - 5)]$

102. $-3^2 + 2[20 \div (7 - 11)]$

103. $4|10 - (8 - 20)|$

104. $-5|7 - (20 - 8)|$

In Exercises 105–108, express each sentence as a single numerical expression. Then use the order of operations to simplify the expression.

105. Cube −2. Subtract this exponential expression from −10.

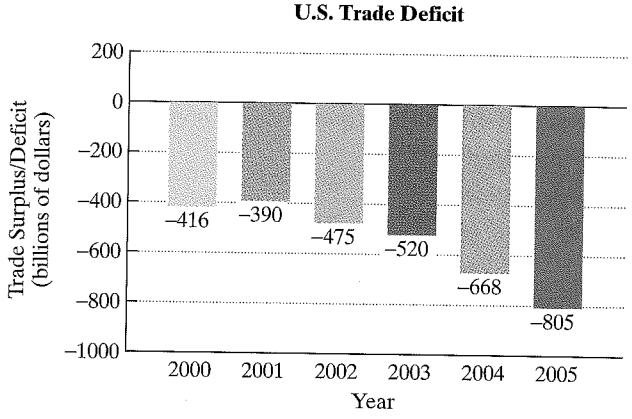
106. Cube −5. Subtract this exponential expression from −100.

107. Subtract 10 from 7. Multiply this difference by 2. Square this product.

108. Subtract 11 from 9. Multiply this difference by 2. Raise this product to the fourth power.

• Application Exercises

The bar graph shows the U.S. trade balance in goods and services, in billions of dollars, from 2000 through 2005. The most complete scorecard of the U.S. international trade performance deteriorated to a record $805 billion deficit in 2005. Use the information shown by the graph to solve Exercises 109–112. Express answers in billions of dollars.



Source: Bureau of Economic Analysis

109. Find the difference between the 2000 trade deficit and the 2005 trade deficit.

110. Find the difference between the 2001 trade deficit and the 2005 trade deficit.

111. By how much did the 2005 deficit exceed twice the 2001 deficit?

112. Find the average trade deficit for 2003 and 2004 combined. By how much did the 2005 deficit exceed this average?

113. The peak of Mount Kilimanjaro, the highest point in Africa, is 19,321 feet above sea level. Qattara Depression, Egypt, the lowest point in Africa, is 436 feet below sea level. What is the difference in elevation between the peak of Mount Kilimanjaro and the Qattara Depression?

114. The peak of Mount Everest is 8848 meters above level. The Marianas Trench, on the floor of the Pac Ocean, is 10,915 meters below sea level. What is difference in elevation between the peak of Mo Everest and the Marianas Trench?

The following table shows the amount of money, in billions dollars, collected and spent by the U.S. government from 2 through 2005. Use the information from the table to so Exercises 115–118. Express answers in billions of dollars.

Year	Money Collected (billions of dollars)	Money Spent (billions of dollars)
2001	$1991	$1863
2002	$1853	$2011
2003	$1782	$2160
2004	$1880	$2292
2005	$2053	$2479

Source: Budget of the U.S. Government

115. In 2002, what was the difference between the amount money collected and the amount spent? Was there budget surplus or deficit in 2002?

116. In 2003, what was the difference between the amount money collected and the amount spent? Was there budget surplus or deficit in 2003?

117. What is the difference between the 2001 surplus and t 2005 deficit?

118. What is the difference between the 2001 surplus and t 2004 deficit?

The way that we perceive the temperature on a cold d depends on both air temperature and wind speed. The windch is what the air temperature would have to be with no wind achieve the same chilling effect on the skin. In 2002, the Nation Weather Service issued new windchill temperatures, shown the table below. Use the information from the table to so Exercises 119–122.

New Windchill Temperature Index

Wind Speed (miles per hour) \ Air Temperature (°F)	30	25	20	15	10	5	0	−5	−10	−15	−20	−25
5	25	19	13	7	1	−5	−11	−16	−22	−28	−34	−40
10	21	15	9	3	−4	−10	−16	−22	−28	−35	−41	−47
15	19	13	6	0	−7	−13	−19	−26	−32	−39	−45	−51
20	17	11	4	−2	−9	−15	−22	−29	−35	−42	−48	−55
25	16	9	3	−4	−11	−17	−24	−31	−37	−44	−51	−58
30	15	8	1	−5	−12	−19	−26	−33	−39	−46	−53	−60
35	14	7	0	−7	−14	−21	−27	−34	−41	−48	−55	−62
40	13	6	−1	−8	−15	−22	−29	−36	−43	−50	−57	−64
45	12	5	−2	−9	−16	−23	−30	−37	−44	−51	−58	−65
50	12	4	−3	−10	−17	−24	−31	−38	−45	−52	−60	−67
55	11	4	−3	−11	−18	−25	−32	−39	−46	−54	−61	−68
60	10	3	−4	−11	−19	−26	−33	−40	−48	−55	−62	−69

Frostbite occurs in 15 minutes or less.

Source: National Weather Service

EXERCISE SET 5.5

• Practice Exercises

In Exercises 1–4, list all numbers from the given set that are

a. *natural numbers.* **b.** *whole numbers.* **c.** *integers.*

d. *rational numbers.* **e.** *irrational numbers.* **f.** *real numbers.*

1. $\left\{-9, -\frac{4}{5}, 0, 0.25, \sqrt{3}, 9.2, \sqrt{100}\right\}$

2. $\left\{-7, -0.\overline{6}, 0, \sqrt{49}, \sqrt{50}\right\}$

3. $\left\{-11, -\frac{5}{6}, 0, 0.75, \sqrt{5}, \pi, \sqrt{64}\right\}$

4. $\left\{-5, -0.\overline{3}, 0, \sqrt{2}, \sqrt{4}\right\}$

5. Give an example of a whole number that is not a natural number.

6. Give an example of an integer that is not a whole number.

7. Give an example of a rational number that is not an integer.

8. Give an example of a rational number that is not a natural number.

9. Give an example of a number that is an integer, a whole number, and a natural number.

10. Give an example of a number that is a rational number, an integer, and a real number.

11. Give an example of a number that is an irrational number and a real number.

12. Give an example of a number that is a real number, but not an irrational number.

Complete each statement in Exercises 13–15 to illustrate the commutative property.

13. $3 + (4 + 5) = 3 + (5 + \_\_\_\_)$

14. $\sqrt{5} \cdot 4 = 4 \cdot \_\_\_\_$

15. $9 \cdot (6 + 2) = 9 \cdot (2 + \_\_\_\_)$

Complete each statement in Exercises 16–17 to illustrate the associative property.

16. $(3 + 7) + 9 = \_\_\_\_ + (7 + \_\_\_\_)$

17. $(4 \cdot 5) \cdot 3 = \_\_\_\_ \cdot (5 \cdot \_\_\_\_)$

Complete each statement in Exercises 18–20 to illustrate the distributive property.

18. $3 \cdot (6 + 4) = 3 \cdot 6 + 3 \cdot \_\_\_\_$

19. $\_\_\_\_ \cdot (4 + 5) = 7 \cdot 4 + 7 \cdot 5$

20. $2 \cdot (\_\_\_\_ + 3) = 2 \cdot 7 + 2 \cdot 3$

Use the distributive property to simplify the radical expressions in Exercises 21–28.

21. $5\left(6 + \sqrt{2}\right)$

22. $4\left(3 + \sqrt{5}\right)$

23. $\sqrt{7}\left(3 + \sqrt{2}\right)$

24. $\sqrt{6}\left(7 + \sqrt{5}\right)$

25. $\sqrt{3}\left(5 + \sqrt{3}\right)$

26. $\sqrt{7}\left(9 + \sqrt{7}\right)$

27. $\sqrt{6}\left(\sqrt{2} + \sqrt{6}\right)$

28. $\sqrt{10}\left(\sqrt{2} + \sqrt{10}\right)$

In Exercises 29–38, state the name of the property illustrated.

29. $6 + (-4) = (-4) + 6$

30. $11 \cdot (7 + 4) = 11 \cdot 7 + 11 \cdot 4$

31. $6 + (2 + 7) = (6 + 2) + 7$

32. $6 \cdot (2 \cdot 3) = 6 \cdot (3 \cdot 2)$

33. $(2 + 3) + (4 + 5) = (4 + 5) + (2 + 3)$

34. $7 \cdot (11 \cdot 8) = (11 \cdot 8) \cdot 7$

35. $2(-8 + 6) = -16 + 12$

36. $-8(3 + 11) = -24 + (-88)$

37. $\left(2\sqrt{3}\right) \cdot \sqrt{5} = 2\left(\sqrt{3} \cdot \sqrt{5}\right)$

38. $\sqrt{2}\pi = \pi\sqrt{2}$

In Exercises 39–43, use two numbers to show that

39. the natural numbers are not closed with respect to subtraction.

40. the natural numbers are not closed with respect to division.

41. the integers are not closed with respect to division.

42. the irrational numbers are not closed with respect to subtraction.

43. the irrational numbers are not closed with respect to multiplication.

• Practice Plus

In Exercises 44–47, determine if each statement is true or false. Do not use a calculator.

44. $468(787 + 289) = 787 + 289(468)$

45. $468(787 + 289) = 787(468) + 289(468)$

46. $58 \cdot 9 + 32 \cdot 9 = (58 + 32) \cdot 9$

47. $58 \cdot 9 \cdot 32 \cdot 9 = (58 \cdot 32) \cdot 9$

In Exercises 48–49, name the property used to go from step to step each time that (why?) *occurs.*

48. $7 + 2(x + 9)$

$= 7 + (2x + 18)$ (why?)

$= 7 + (18 + 2x)$ (why?)

$= (7 + 18) + 2x$ (why?)

$= 25 + 2x$

$= 2x + 25$ (why?)

49. $5(x + 4) + 3x$

$= (5x + 20) + 3x$ (why?)

$= (20 + 5x) + 3x$ (why?)

$= 20 + (5x + 3x)$ (why?)

$= 20 + (5 + 3)x$ (why?)

$= 20 + 8x$

$= 8x + 20$ (why?)

• Application Exercises

In Exercises 50–53, use the definition of vampire numbers from the Blitzer Bonus on page 273 to determine which products are vampires.

50. $15 \times 93 = 1395$

51. $80 \times 86 = 6880$

52. $20 \times 51 = 1020$

53. $146 \times 938 = 136{,}948$