Inverse Properties

There exists a unique real number $-a$ such that

$$a + (-a) = 0 \text{ and } -a + a = 0.$$

If $a \neq 0$, there exists a unique real number $\frac{1}{a}$ such that

$$a \cdot \frac{1}{a} = 1 \quad \text{and} \quad \frac{1}{a} \cdot a = 1.$$

The sum of any real number and its negative is 0, and the product of any nonzero real number and its reciprocal is 1.

Distributive Properties

$$a(b + c) = ab + ac$$
$$a(b - c) = ab - ac$$

The product of a real number and the sum (or difference) of two real numbers equals the sum (or difference) of the products of the first number and each of the other numbers.

ercises

all odd-numbered
d complete solutions
ses denoted with
the back of the book
ent.
F 2. A, B, C, D, F
A, B, C, D, F
D, F 9. Answers
hree examples are
d $\frac{21}{2}$. 10. Answers
hree examples are -1,
. 11. 1, 3 12. 0,
$-6, -\frac{12}{4}$ (or -3), 0, 1,
, $-\frac{12}{4}$ (or -3), $-\frac{5}{8}$,
15. -81 16. -243
. -64 19. -243
21. -162 22. 500

Concept Check *Match each number from Column I with the letter or letters of the sets of numbers from Column II to which the number belongs. There may be more than one choice, so give all choices. See Example 1.*

I	II
1. 0	**A.** Natural numbers
2. 34	**B.** Whole numbers
3. $-\frac{9}{4}$	**C.** Integers
4. $\sqrt{36}$	**D.** Rational numbers
5. $\sqrt{13}$	**E.** Irrational numbers
6. 2.16	**F.** Real numbers

7. Explain why no answer in Exercises 1–6 can contain both D and E as choices.

8. The number π is irrational. Yet 3.14 and $\frac{22}{7}$ are often used as values for π. The first is a terminating decimal and the second is a quotient of integers, so both are rational. How is this possible?

9. *Concept Check* Give three examples of rational numbers that are not integers.

10. *Concept Check* Give three examples of integers that are not natural numbers.

Let set $B = \left\{-6, -\frac{12}{4}, -\frac{5}{8}, -\sqrt{3}, 0, \frac{1}{4}, 1, 2\pi, 3, \sqrt{12}\right\}$. *List all the elements of B that belong to each set. See Example 1.*

11. Natural numbers

12. Whole numbers

13. Integers

14. Rational numbers

Evaluate each expression. See Example 2.

15. -3^4

16. -3^5

17. $(-3)^4$

18. -2^6

19. $(-3)^5$

20. $(-2)^5$

21. $-2 \cdot 3^4$

22. $-4(-5)^3$

9 **25.** −148 **26.** −6
3 **28.** −60 **29.** 18
00 **31.** −12 **32.** 28
$\frac{25}{36}$ **34.** $-\frac{5}{8}$ **35.** $-\frac{6}{7}$
37. 36 **38.** $-\frac{4}{5}$
40. 38 **41.** $-\frac{1}{2}$
43. $-\frac{23}{20}$ **44.** 2
3/3 **46.** 2 **47.** 92.9
6 **49.** 86.0 **50.** 88.9
1

23. Why does $-5^2 = -25$, not 25? Is $(-5)^2$ positive or negative? What about $-(-5)^2$? Explain your answers.

Evaluate each expression. See Example 3.

24. $8^2 - (-4) + 11$

25. $16(-9) - 4$

26. $-2 \cdot 5 + 12 \div 3$

27. $9 \cdot 3 - 16 \div 4$

28. $-4(9 - 8) + (-7)(2)^3$

29. $6(-5) - (-3)(2)^4$

30. $-(-5)^3 - (-5)^2$

31. $(4 - 2^3)(-2 + \sqrt{25})$

32. $[-3^2 - (-2)][\sqrt{16} - 2^3]$

33. $\left(-\frac{2}{9} - \frac{1}{4}\right) - \left[-\frac{5}{18} - \left(-\frac{1}{2}\right)\right]$

34. $\left[-\frac{5}{8} - \left(-\frac{2}{5}\right)\right] - \left(\frac{3}{2} - \frac{11}{10}\right)$

35. $\dfrac{-8 + (-4)(-6) \div 12}{4 - (-3)}$

36. $\dfrac{15 \div 5 \cdot 4 \div 6 - 8}{-6 - (-5) - 8 \div 2}$

Evaluate each expression if $p = -4$, $q = 8$, and $r = -10$. See Example 4.

37. $2(q - r)$

38. $\frac{p}{q} + \frac{3}{r}$

39. $2p - 7q + r^2$

40. $-p^3 - 2q + r$

41. $\dfrac{q + r}{q + p}$

42. $\dfrac{3q}{3p - 2r}$

43. $\frac{3q}{r} - \frac{5}{p}$

44. $\dfrac{\frac{q}{4} - \frac{r}{5}}{\frac{p}{2} + \frac{q}{2}}$

45. $\dfrac{-(p + 2)^2 - 3r}{2 - q}$

46. $\dfrac{5q + 2(1 + p)^3}{r + 3}$

Passing Rating for NFL Quarterbacks *Use the formula*

$$\text{Passing Rating} \approx 85.68\left(\frac{C}{A}\right) + 4.31\left(\frac{Y}{A}\right) + 326.42\left(\frac{T}{A}\right) - 419.07\left(\frac{I}{A}\right),$$

where A = number of passes attempted, C = number of passes completed, Y = total number of yards gained passing, T = number of touchdown passes, and I = number of interceptions, to approximate the passing rating for each NFL quarterback. (The formula is exact to one decimal place in Exercises 47–49 and in Exercise 50 differs by only .1.) See Example 5. (Source: www.NFL.com*)*

NFL Quarterback/Team	*A*	*C*	*Y*	*T*	*I*
47. Brad Johnson/Buccaneers	451	281	3049	22	6
48. Trent Green/Chiefs	470	287	3690	26	13
49. Drew Bledsoe/Bills	610	375	4359	24	15
50. Peyton Manning/Colts	591	392	4200	27	19

Blood Alcohol Concentration *The Blood Alcohol Concentration (BAC) of a person who has been drinking is given by the expression*

number of oz × % alcohol × .075 ÷ body weight in lb − hr of drinking × .015.

(Source: Lawlor, J., *Auto Math Handbook: Mathematical Calculations, Theory, and Formulas for Automotive Enthusiasts,* HP Books, 1991.*)*

51. Suppose a policeman stops a 190-lb man who, in 2 hr, has ingested four 12-oz beers (48 oz), each having a 3.2% alcohol content. Calculate the man's BAC to the nearest thousandth. Follow the order of operations.

3. .024; .023;
ight results in lower
Decreased weight
higher BACs; .040;
stributive
ative **57.** inverse
59. identity

$p = -6p$
$)x = 5x$
y **66.** $-2m - 2n$
$-9r$ **69.** $m + 8$
$a + 9$
$z - \frac{5}{3}$
$2y + 8z$ **73.** 65.25

52. Find the BAC to the nearest thousandth for a 135-lb woman who, in 3 hr, has drunk three 12-oz beers (36 oz), each having a 4.0% alcohol content.

53. Calculate the BACs in Exercises 51 and 52 if each person weighs 25 lb more and the rest of the variables stay the same. How does increased weight affect a person's BAC?

54. Predict how decreased weight would affect the BAC of each person in Exercises 51 and 52. Calculate the BACs if each person weighs 25 lb less and the rest of the variables stay the same.

Identify the property illustrated in each statement. Assume all variables represent real numbers. See Examples 6 and 7.

55. $6 \cdot 12 + 6 \cdot 15 = 6(12 + 15)$

56. $8(m + 4) = (m + 4) \cdot 8$

57. $(x + 6) \cdot \left(\frac{1}{x + 6}\right) = 1, \quad \text{if } x + 6 \neq 0$

58. $\frac{2 + m}{2 - m} \cdot \frac{2 - m}{2 + m} = 1, \quad \text{if } m \neq 2 \text{ or } -2$

59. $(7 + y) + 0 = 7 + y$

60. $5 + \pi$ is a real number.

61. Is there a commutative property for subtraction? That is, in general, is $a - b$ equal to $b - a$? Support your answer with examples.

62. Is there an associative property for subtraction? That is, does $(a - b) - c$ equal $a - (b - c)$ in general? Support your answer with examples.

Use the distributive property to rewrite sums as products and products as sums. See Example 7.

63. $8p - 14p$

64. $15x - 10x$

65. $-3(z - y)$

66. $-2(m + n)$

Simplify each expression. See Examples 6 and 7.

67. $\frac{10}{11}(22z)$

68. $\left(\frac{3}{4}r\right)(-12)$

69. $(m + 5) + 3$

70. $2 + (a + 7)$

71. $\frac{3}{8}\left(\frac{16}{9}y + \frac{32}{27}z - \frac{40}{9}\right)$

72. $-\frac{1}{4}(20m + 8y - 32z)$

Solve each problem.

73. *Average Golf Score* To find the average of n real numbers, we add the numbers and then divide the sum by n. Ernie Els broke the record for the lowest score on the PGA Tour by winning the 2003 Mercedes Open with a score of 31 under par. His scores for the four rounds were 64, 65, 65, and 67. What was his average score per round? (*Source:* www.kapaluamaui.com/golf)