

LESSON

6.6

Rational Numbers

BEFORE

Now

WHY?

You performed operations on positive fractions and decimals.

You'll perform operations on rational numbers.

So you can find the area of a volleyball court, as in Ex. 28.

Word Watch

rational number, p. 283

additive inverse, p. 285

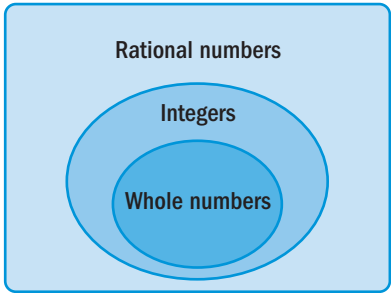
multiplicative inverse, p. 285

additive identity, p. 285

multiplicative identity, p. 285

A **rational number** is a number that can be written as $\frac{a}{b}$ where a and b are integers and $b \neq 0$.

The Venn diagram at the right shows the relationship among rational numbers, integers, and whole numbers. Notice that integers include whole numbers and rational numbers include integers.



EXAMPLE 1 Identifying Rational Numbers

Show that the number is rational by writing it in $\frac{a}{b}$ form.

a. $6 = \frac{6}{1}$

b. $-\frac{3}{5} = \frac{3}{-5}$

c. $0.75 = \frac{3}{4}$

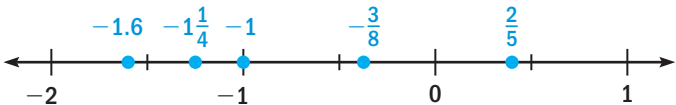
d. $-2\frac{1}{3} = \frac{-7}{3}$

The negative sign in a negative fraction usually appears in front of the fraction bar. However, it can also appear in the numerator, as in part (d), or in the denominator, as in part (b).

EXAMPLE 2 Ordering Rational Numbers

Order -1 , -1.6 , $\frac{2}{5}$, $-1\frac{1}{4}$, and $-\frac{3}{8}$ from least to greatest.

Graph each number on a number line.



ANSWER From least to greatest, the numbers are: -1.6 , $-1\frac{1}{4}$, -1 , $-\frac{3}{8}$, $\frac{2}{5}$.

Your turn now Show that each number is rational by writing it in $\frac{a}{b}$ form. Then order the numbers from least to greatest.

1. 2.5 , -1 , $-\frac{5}{8}$, -0.8

2. $4\frac{1}{5}$, -3.6 , $-3\frac{8}{9}$, 0

Commutative and Associative Properties The commutative and associative properties can help you add or multiply rational numbers.

Commutative and Associative Properties

Commutative Property of Addition

Words In a sum, you can add terms in any order.

Numbers $5 + (-6) = -6 + 5$

Algebra $a + b = b + a$

Commutative Property of Multiplication

Words In a product, you can multiply factors in any order.

Numbers $4(-7) = -7(4)$

Algebra $ab = ba$

Associative Property of Addition

Words Changing the grouping of terms will not change the sum.

Numbers
 $(9 + 8) + 6 = 9 + (8 + 6)$

Algebra
 $(a + b) + c = a + (b + c)$

Associative Property of Multiplication

Words Changing the grouping of factors will not change the product.

Numbers
 $(2 \cdot 3) \cdot 4 = 2 \cdot (3 \cdot 4)$

Algebra
 $(ab)c = a(bc)$

HELP

with Vocabulary

To remember the commutative property, remember that *commuters* are people who *move* or travel. To remember the associative property, remember that the people you *associate* with are the friends in your *group*.

HELP

with Notetaking

Remember that recording the steps you take in a multi-step calculation can help you perform similar calculations.

EXAMPLE 3 Using Commutative, Associative Properties

Evaluate the expression. Justify each step you take.

a. $-10.6 + 3 + (-4.4)$

$= 3 + (-10.6) + (-4.4)$

$= 3 + [-10.6 + (-4.4)]$

$= 3 + (-15) = -12$

Commutative property of addition

Associative property of addition

Add -10.6 and -4.4 , then 3 and -15 .

b. $-25(7)(-4)$

$= 7(-25)(-4)$

$= 7[(-25)(-4)]$

$= 7(100) = 700$

Commutative property of multiplication

Associative property of multiplication

Multiply -25 and -4 , then 7 and 100.

Your turn now Evaluate the expression. Justify each step you take.

3. $3.5 + [(-3) + 6.5]$

4. $5(-9)(-4)$

5. $-6(3)(-5)$

6. $2.8 + 7 + (-1.8)$

7. $0.5(7)(8)$

8. $0.9 + [9.1 + (-2)]$

Inverse and Identity Properties The inverse and identity properties can help you use mental math to evaluate expressions.



Inverse and Identity Properties

Inverse Property of Addition

Words The sum of a number and its **additive inverse**, or opposite, is 0.

Numbers $5 + (-5) = 0$

Algebra $a + (-a) = 0$

Inverse Property of Multiplication

Words The product of a nonzero number and its **multiplicative inverse**, or reciprocal, is 1.

Numbers $\frac{3}{4} \cdot \frac{4}{3} = 1$

Algebra For nonzero integers a and b ,
 $\frac{a}{b} \cdot \frac{b}{a} = 1$.

Identity Property of Addition

Words The sum of a number and the **additive identity**, 0, is the number.

Numbers $-7 + 0 = -7$

Algebra $a + 0 = a$

Identity Property of Multiplication

Words The product of a number and the **multiplicative identity**, 1, is the number.

Numbers $9 \cdot 1 = 9$

Algebra $a(1) = a$

EXAMPLE 4 Using Inverse and Identity Properties

Evaluate the expression. Justify each step you take.

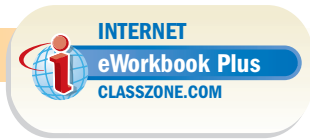
$$\begin{aligned} \frac{2}{3} + \frac{7}{10} + \left(-\frac{2}{3}\right) &= \frac{2}{3} + \left(-\frac{2}{3}\right) + \frac{7}{10} && \text{Commutative property of addition} \\ &= 0 + \frac{7}{10} && \text{Inverse property of addition} \\ &= \frac{7}{10} && \text{Identity property of addition} \end{aligned}$$

Your turn now Evaluate the expression. Justify each step you take.

9. $94 + 87 + (-94)$ 10. $-\frac{3}{4} + \frac{5}{6} + \frac{3}{4}$ 11. $\frac{1}{9} \cdot 91 \cdot 9$
 12. $\frac{1}{3} \cdot \frac{5}{6} \cdot 3$ 13. $-53 + (-25) + 53$ 14. $\frac{1}{6} \cdot 310 \cdot 6$

6.6

Exercises
More Practice, p. 710



Getting Ready to Practice

Vocabulary Write the number described.

1. The multiplicative identity of 23
2. The additive inverse of -2
3. The additive identity of -17
4. The multiplicative inverse of 3

Show that the number is rational by writing it in $\frac{a}{b}$ form.

5. 0.4
6. $-3\frac{5}{8}$
7. $-\frac{7}{9}$
8. -12

Mental Math Evaluate the expression. Justify each step you take.

9. $3 \cdot \frac{1}{2} \cdot \frac{1}{3}$
10. $-\frac{3}{4} + \frac{5}{6} + \frac{3}{4}$
11. $7 \cdot 13 \cdot \frac{1}{7}$
12. $4 + 17 + (-4)$

13. **Rainfall** The table shows the amount of rainfall, in inches, above or below the mean for four regions of Oklahoma during a recent drought. Order the numbers from least to greatest to determine which region's rainfall was the most above the mean and which region's rainfall was the most below the mean.

Region	Departure from Mean
Panhandle	-5.87
Northeast	$-\frac{631}{100}$
Southwest	$-8\frac{4}{25}$
Southeast	1.97

Practice and Problem Solving



Example Exercises

- 1 14-17
2 18-21
3 22-27
4 22-27



- More Examples
- eTutorial Plus

Show that the number is rational by writing it in $\frac{a}{b}$ form. Then give the multiplicative inverse and the additive inverse of the number.

14. $-\frac{2}{3}$
15. $5\frac{3}{7}$
16. 0.7
17. 21

Order the rational numbers from least to greatest.

18. $-3.1, -4, -\frac{10}{3}, -3\frac{3}{4}, -3.7$
19. $3, -2\frac{2}{3}, 0, -\frac{5}{4}, -0.85$
20. $\frac{3}{10}, -1\frac{1}{3}, 0.02, 1, -0.5$
21. $-4.25, 1, -\frac{22}{5}, -4\frac{7}{8}, -3$

Mental Math Evaluate the expression. Justify each step you take.

22. $43 + 68 + 57$
23. $7(-8)(5)$
24. $-2.4 + [7 + (-0.6)]$
25. $\frac{1}{2} + \frac{4}{7} + \left(-\frac{1}{2}\right)$
26. $14 \cdot \frac{2}{3} \cdot \frac{1}{14}$
27. $2(3)(35)$



- 28. Volleyball Court** A volleyball court is a rectangle that is 9 m wide and 18 m long. Which property allows you to find the area using either the product 18×9 or the product 9×18 ? What is the area of the court?

Algebra Evaluate the expression for the given values of the variables. Justify each step you take.

29. $a + (4.8 + b)$ when $a = -2.5$ and $b = -6.5$

30. $x \cdot \left(-\frac{2}{3}\right) \cdot y$ when $x = -\frac{8}{9}$ and $y = -\frac{9}{8}$

Copy and complete the statement using $<$, $>$, or $=$.

31. $-\frac{9}{11} + \frac{9}{11} \underline{\hspace{1cm}} 1$

32. $-0.85 \underline{\hspace{1cm}} -\frac{3}{4}$

33. $7 \cdot \frac{1}{7} \underline{\hspace{1cm}} -1$

- 34. Critical Thinking** Use the properties of addition to show that the expression $a + b + (-a) + (-b)$ is equal to 0. Justify each step you take.

- 35. Challenge** Copy and complete the following statement:
The multiplicative inverse of 0.25 is $\underline{\hspace{1cm}}$.

Mixed Review

Evaluate the expression. (Lesson 1.4)

36. $\frac{32}{4 + 4}$

37. $54 + 3 \cdot 9$

38. $35 - 28 \div 4$

39. $5(23 - 11)$

Find the quotient. (Lesson 6.5)

40. $-180 \div 12$

41. $-112 \div 7$

42. $84 \div (-14)$

43. $-220 \div (-11)$

Basic Skills Use compatible numbers to estimate the product.

44. 6429×43

45. 27×13

46. 386×293

47. 252×53

Test-Taking Practice

- 48. Multiple Choice** What is the multiplicative inverse of $1\frac{1}{3}$?

A. $\frac{3}{4}$

B. $\frac{4}{3}$

C. $\frac{3}{1}$

D. 4

- 49. Multiple Choice** Which equation illustrates the associative property of addition?

F. $5 + 22 = 22 + 5$

G. $(15 + 3) + 67 = 15 + (3 + 67)$

H. $5(-17) = -17(5)$

I. $(6 \cdot 8) \cdot 10 = 6 \cdot (8 \cdot 10)$