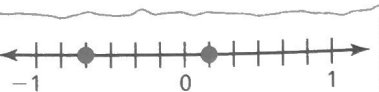



9.1 Exercises

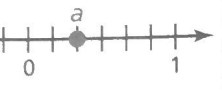
1. **Writing a Solution Key** Write a solution key for the activity on page 328. Describe a rubric for grading a student's work.

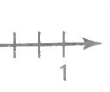
2. **Grading the Activity** In the activity on page 328, a student gave the answers below. Each question is worth 10 points. Assign a grade to each answer. For those that are incorrect, why do you think the student erred?

Sample Student Work

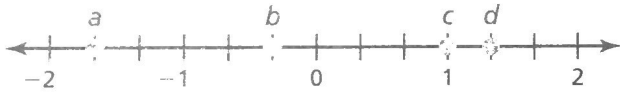
5. $-4/6 < 1/6$ 

6. $5/6 > 1/6$ 

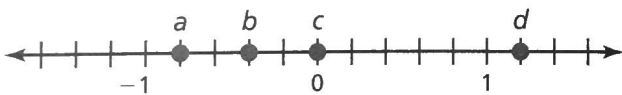
7. $-a = -2$ 
 $-a + a = -2 + 2 = 0$

8. $-b = 2$ 
 $-b + b = 2 + 1/2 = 0$

3. **Identifying Rational Numbers** Identify the rational numbers on the number line.



4. **Identifying Rational Numbers** Identify the rational numbers on the number line.



5. **Graphing Rational Numbers** Graph each rational number on a number line.

- a. $\frac{1}{4}$ b. $-\frac{3}{8}$ c. $-\frac{5}{4}$ d. $\frac{3}{2}$

6. **Graphing Rational Numbers** Graph each rational number on a number line.

- a. $\frac{7}{6}$ b. $-\frac{2}{3}$ c. 0 d. $-\frac{11}{6}$

7. **Definition of Rational Numbers** Show that each number is rational by writing it in the form $\frac{a}{b}$, where a and b are integers and $b \neq 0$.

- a. 1.5 b. $-\sqrt{4}$ c. $1\frac{3}{4}$ d. $-0.\bar{3}$

8. **Definition of Rational Numbers** Show that each number is rational by writing it in the form $\frac{a}{b}$, where a and b are integers and $b \neq 0$.

- a. -1.9 b. 0 c. $2.\bar{6}$ d. $-3\frac{1}{5}$

9. **Writing Rational Numbers** Which of the following rational numbers are equal to -5 ?

- $\frac{1}{5}, \frac{-5}{1}, \frac{5}{-1}, \frac{-5}{-1}, \frac{-5}{1}, \frac{-5}{-1}, \frac{5}{-1}, \frac{-5}{-1}$

10. **Writing Rational Numbers** Which of the following rational numbers are equal to $\frac{1}{4}$?

- $-\frac{1}{4}, \frac{1}{-4}, \frac{-1}{-4}, \frac{1}{4}, \frac{-1}{4}, \frac{1}{-4}, \frac{-1}{-4}, \frac{-1}{4}$

11. **Cross Products** Use cross products to determine whether the rational numbers are equal.

- a. $\frac{5}{8}$ and $\frac{7}{12}$ b. $-\frac{1}{6}$ and $\frac{-7}{42}$
 c. $\frac{20}{-36}$ and $\frac{-5}{9}$ d. $\frac{3}{-13}$ and $\frac{9}{-36}$

12. **Cross Products** Use cross products to determine whether the rational numbers are equal.

- a. $\frac{-7}{21}$ and $\frac{6}{-18}$ b. $\frac{3}{15}$ and $\frac{5}{20}$
 c. $\frac{-12}{26}$ and $\frac{-18}{39}$ d. $\frac{33}{-55}$ and $\frac{-6}{11}$

13. **Comparing Rational Numbers** Place the correct symbol ($<$, $=$, or $>$) between the two rational numbers.

- a. $-\frac{2}{3}$ $-\frac{3}{5}$ b. $-\frac{1}{4}$ $\frac{1}{6}$
 c. $\frac{-4}{6}$ $\frac{-8}{12}$ d. $\frac{8}{7}$ $-\frac{8}{7}$

14. **Comparing Rational Numbers** Place the correct symbol ($<$, $=$, or $>$) between the two rational numbers.

- a. $\frac{-5}{6}$ $\frac{1}{6}$ b. $\frac{-15}{40}$ $\frac{6}{-16}$
 c. $\frac{-3}{9}$ $\frac{-4}{7}$ d. $\frac{8}{-11}$ $\frac{11}{-14}$

15. **Ordering Rational Numbers** Use a number line to order the rational numbers 0, $-\frac{5}{2}$, -2 , $\frac{3}{2}$, and $\frac{5}{4}$ from least to greatest.

16. **Ordering Rational Numbers** Use a number line to order the rational numbers $\frac{2}{3}$, $-\frac{1}{3}$, $-\frac{5}{3}$, $-\frac{5}{6}$, and $\frac{1}{6}$ from least to greatest.
17. **Finding Inverses** Find the additive and multiplicative inverses of each rational number.
- a. $\frac{1}{5}$ b. $-\frac{7}{3}$ c. 6 d. $-\frac{13}{16}$
18. **Finding Inverses** Find the additive and multiplicative inverses of each rational number.
- a. -4 b. $\frac{9}{10}$ c. $\frac{15}{8}$ d. $-\frac{1}{12}$
19. **Identifying Properties of Rational Numbers** Identify the property of rational numbers that makes each equation true.
- a. $\frac{3}{2} + 0 = \frac{3}{2}$ b. $-4 \cdot -\frac{1}{4} = 1$
- c. $(-\frac{1}{4} \cdot \frac{3}{4}) \cdot \frac{2}{5} = -\frac{1}{4} \cdot (\frac{3}{4} \cdot \frac{2}{5})$
- d. $-\frac{1}{2}(\frac{2}{9} + \frac{4}{3}) = -\frac{1}{2} \cdot \frac{2}{9} + (-\frac{1}{2}) \cdot \frac{4}{3}$
20. **Identifying Properties of Rational Numbers** Identify the property of rational numbers that makes each equation true.
- a. $-\frac{1}{7} \cdot 0 = 0$ b. $\frac{5}{8} + (-\frac{3}{8}) = -\frac{3}{8} + \frac{5}{8}$
- c. $\frac{3}{11} + (-\frac{3}{11}) = 0$ d. $\frac{9}{5} \cdot 1 = \frac{9}{5}$
21. **Using Properties of Rational Numbers** Use the given property of rational numbers to complete each equation.
- a. **Associative Property of Addition**
 $(\frac{1}{3} + \frac{1}{5}) + \frac{3}{13} =$
- b. **Zero Multiplication Property**
 $\frac{9}{2} \cdot 0 =$
- c. **Commutative Property of Addition**
 $-\frac{4}{6} + \frac{2}{5} =$
- d. **Additive Identity Property**
 $-\frac{10}{11} + 0 =$
- e. **Commutative Property of Multiplication**
 $-\frac{6}{12} \cdot \frac{4}{3} =$

22. **Using Properties of Rational Numbers** Use the given property of rational numbers to complete each equation.
- a. **Additive Inverse Property**
 $-\frac{5}{12} + \frac{5}{12} =$
- b. **Distributive Property of Multiplication Over Subtraction**
 $\frac{3}{4}(\frac{1}{8} - \frac{1}{9}) =$
- c. **Multiplicative Identity Property**
 $-\frac{1}{14} \cdot 1 =$
- d. **Associative Property of Multiplication**
 $\frac{5}{7} \cdot [(-\frac{2}{8}) \cdot \frac{1}{2}] =$
- e. **Multiplicative Inverse Property**
 $\frac{11}{3} \cdot \frac{3}{11} =$
23. **Operations with Rational Numbers** Evaluate each expression. Write your answer in simplest form.
- a. $\frac{1}{4} + \frac{7}{4}$ b. $-\frac{3}{5} - \frac{4}{5}$
- c. $-\frac{2}{3} + \frac{1}{9}$ d. $\frac{7}{2} + \frac{3}{4} - \frac{5}{2}$
- e. $\frac{5}{6} \cdot \frac{1}{2}$ f. $\frac{1}{4} \div \frac{3}{8}$
- g. $-\frac{5}{3} \div \frac{7}{6}$ h. $\frac{1}{12} \cdot \frac{3}{2} \cdot (-\frac{4}{5})$
24. **Operations with Rational Numbers** Evaluate each expression. Write your answer in simplest form.
- a. $-\frac{2}{9} + \frac{4}{9}$ b. $\frac{8}{3} - (-\frac{5}{3})$
- c. $\frac{7}{10} - \frac{4}{15}$ d. $-\frac{3}{4} + \frac{1}{6} + \frac{5}{8}$
- e. $\frac{3}{5} \div (-\frac{1}{10})$ f. $-\frac{7}{3} \cdot \frac{2}{9}$
- g. $\frac{5}{12} \div \frac{3}{4}$ h. $-\frac{10}{27} \cdot \frac{9}{5} \div (-\frac{4}{7})$
25. **True or False?** Tell whether each statement is *true* or *false*. Justify your answer.
- a. Every natural number is a rational number.
- b. Every rational number can be written as a terminating decimal.
- c. Every rational number can be written as the ratio of an integer to an integer.

26. **True or False?** Tell whether each statement is *true* or *false*. Justify your answer.
- Every whole number is a rational number.
 - Every rational number can be written as a terminating or repeating decimal.
 - Every rational number can be written as the ratio of a whole number to a whole number.

27. **Algebra** Complete the solution of the equation. Then write the property that justifies each step in the solution.

$$\frac{6}{5}x = -3 \quad \text{Write original equation.}$$

$$\left(\frac{6}{5}x\right) = \cdot (-3) \quad \text{Multiply each side by the multiplicative inverse of } \frac{6}{5}.$$

$$\left(\frac{6}{5}x\right) = \cdot (-3)$$

$$(1)x = \cdot (-3)$$

$$x =$$

28. **Algebra** Complete the solution of the equation. Then write the property that justifies each step in the solution.

$$\frac{3}{8} + x = -\frac{1}{8} \quad \text{Write original equation.}$$

$$\frac{3}{8} + x + \quad = -\frac{1}{8} + \quad \text{Add } \frac{5}{8} \text{ to both sides.}$$

$$\frac{3}{8} + \quad + x = -\frac{1}{8} + \quad$$

$$(1) - x = -\frac{1}{8} + \quad$$

$$x =$$

29. **Closure Under Subtraction** Show that the set of natural numbers is not closed under subtraction by finding two natural numbers whose difference is not a natural number. Which number set(s) contain all possible differences of natural numbers?

30. **Closure Under Subtraction** Show that the set of positive fractions is not closed under subtraction by finding two positive fractions whose difference is not a positive fraction. Which number set(s) contain all possible differences of positive fractions?

31. **Closure Under Division** Show that the set of whole numbers is not closed under division by finding two whole numbers whose quotient is not a whole number. Which number set(s) contain all possible quotients of whole numbers?

32. **Closure Under Division** Show that the set of integers is not closed under division by finding two integers whose quotient is not an integer. Which number set(s) contain all possible quotients of integers?

33. **River Depth: In Your Classroom** The table shows the changes (in feet) of the depth of a river over five weeks.

Week	Change (feet)
1	$3\frac{5}{6}$
2	$-1\frac{1}{3}$
3	$-\frac{5}{6}$
4	$-\frac{7}{12}$
5	$2\frac{1}{6}$

- During which week did the depth increase the most?
- During which week did the depth decrease the most?
- Describe a homework project that would involve data about river depth. Include a description of how you would ask your students to order and perform operations with rational numbers.

34. **Snow Depth: In Your Classroom** The table shows the changes (in inches) of the depth of snow in a town over five days.

Day	Change (inches)
1	$1\frac{3}{8}$
2	$6\frac{1}{4}$
3	$-\frac{3}{4}$
4	$1\frac{1}{2}$
5	$-1\frac{1}{4}$

- On which day did the depth increase the most?
 - On which day did the depth decrease the most?
 - Describe a homework project that would involve data about snow depth. Include a description of how you would ask your students to order and perform operations with rational numbers.
35. **Snorkeling** The initial elevation of a snorkeler is $-4\frac{3}{5}$ meters. The snorkeler dives to three times the initial elevation and then swims $8\frac{1}{2}$ meters upward. What is the snorkeler's final elevation?

36. **Giant Squid** The initial elevation of a giant squid is $-\frac{7}{12}$ kilometer. The squid swims upward to $\frac{2}{3}$ of its initial elevation and then swims $\frac{1}{2}$ kilometer downward. What is the squid's final elevation?

37. **Mental Math** Use the properties of rational numbers and mental math to evaluate each expression. List the properties that you used to make calculations simpler.

a. $\frac{6}{7} + (-\frac{1}{4}) + \frac{1}{7}$

b. $\frac{2}{5} \cdot (-\frac{9}{8}) \cdot \frac{5}{2}$

c. $\frac{1}{6} \cdot \frac{5}{8} + \frac{1}{6} \cdot \frac{3}{8}$

d. $-\frac{1}{12} + (\frac{5}{12} + \frac{2}{3})$

38. **Mental Math** Use the properties of rational numbers and mental math to evaluate each expression. List the properties that you used to make calculations simpler.

a. $\frac{4}{5} \cdot [\frac{5}{8} \cdot (-\frac{12}{13})]$

b. $(\frac{7}{9} - 7) \frac{9}{7}$

c. $\frac{10}{3} + \frac{1}{3} + (-\frac{10}{3})$

d. $\frac{4}{15} \cdot \frac{1}{6} + (-\frac{4}{15}) \cdot \frac{1}{6}$

39. **writing** Find the sum of two arbitrary rational numbers, $\frac{a}{b}$ and $\frac{c}{d}$. How does this show that the set of rational numbers is closed under addition?

40. **writing** Explain why it is easier to show that a set of numbers is not closed under an operation than it is to show that a set of numbers is closed under an operation. Give an example of each case.

41. **Grading Student Work** On a diagnostic test, one of your students does the following work. Explain what the student did wrong. Which topics would you encourage the student to review?

$$\frac{4}{6} \quad \frac{3}{2}$$

$$4 \cdot 3 \stackrel{?}{=} 6 \cdot 2$$

$$12 = 12 \Rightarrow \frac{4}{6} = \frac{3}{2}$$

42. **Grading Student Work** On a diagnostic test, one of your students does the following work. Explain what the student did wrong. Which topics would you encourage the student to review?

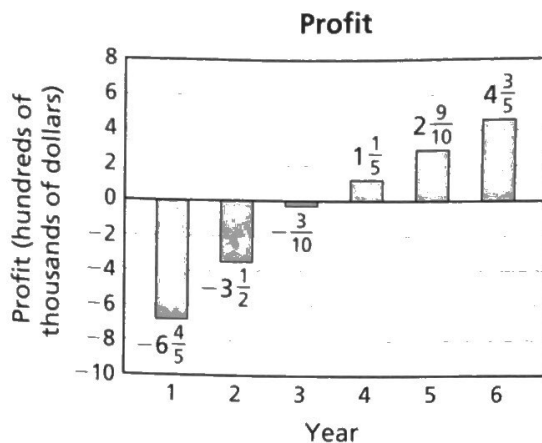
$$\frac{10}{13} \quad \frac{7}{9}$$

$$10 > 7 \Rightarrow \frac{10}{13} > \frac{7}{9}$$

43. **Reasoning** What rational number is its own additive inverse? Justify your answer.

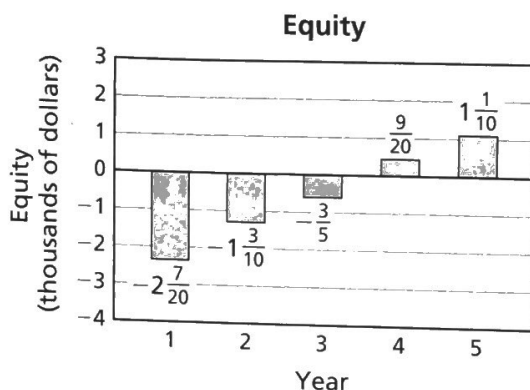
44. **Reasoning** What two rational numbers are their own multiplicative inverses? Justify your answer.

45. **Profit** The bar graph shows the profit, in hundreds of thousands of dollars, of a new business for each of its first six years.



- What was the difference in profit from Year 3 to Year 4?
- How many times greater was the Year 1 profit than the Year 3 profit?
- What is the total profit over the first six years?

46. **Equity** The bar graph shows the equity, in thousands of dollars, of a used car for each of the first five years after its purchase.



- What was the difference in equity from Year 1 to Year 3?
- How many times greater was the Year 5 equity than the Year 4 equity?
- On average, how much did the equity increase each year?

47. **Problem Solving** A man started college $\frac{1}{4}$ of the way through his life, was unmarried for the next $\frac{1}{6}$ of his life, and then had a child six years after his marriage. The child's birth coincided with the half-way point of his life. How old did the man live to be?

48. **Problem Solving** A woman earned a master's degree $\frac{5}{16}$ of the way through her life, worked professionally for the next half of her life, and then spent the last 15 years of her life in retirement. How old did the woman live to be?