

Directions:

Show all work.

Write each section on a separate sheet with the section title at the top and each problem clearly numbered and answer circled. See below.

Prime Factorization

Your Name

1. 1, 16
2, 8
4, 4

2.

3.

4.

etc.

Prime Factorization

Because 3 is a factor of 24 and $3 \cdot 8 = 24$, 8 is also a factor of 24. The pair 3, 8 is called a **factor pair** of 24.

The **prime factorization** of a composite number is the number written as a product of its prime factors. You can use factor pairs and a **factor tree** to help find the prime factorization of a number. The factor tree is complete when only prime factors appear in the product.

Example 1 A classroom has 42 students. The teacher arranges the students in rows. Each row has the same number of students. How many possible arrangements are there?

Use the factor pairs of 42 to find the number of arrangements.

$$42 = 1 \cdot 42 \quad \text{1 row of 42 or 42 rows of 1} \quad 42 = 2 \cdot 21 \quad \text{2 rows of 21 or 21 rows of 2}$$

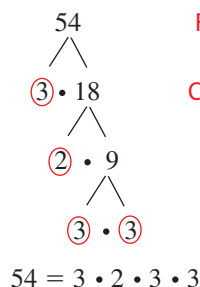
$$42 = 3 \cdot 14 \quad \text{3 rows of 14 or 14 rows of 3} \quad 42 = 6 \cdot 7 \quad \text{6 rows of 7 or 7 rows of 6}$$

► There are 8 possible arrangements: 1 row of 42, 42 rows of 1, 2 rows of 21, 21 rows of 2, 3 rows of 14, 14 rows of 3, 6 rows of 7, or 7 rows of 6.

Example 2 Write the prime factorization of 54.

Choose any factor pair of 54 to begin the factor tree.

Tree 1

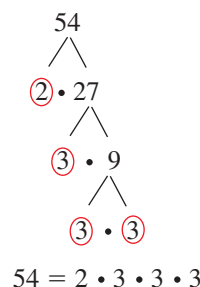


Find a factor pair and draw "branches."

Circle the prime factors as you find them.

Find factors until each branch ends at a prime factor.

Tree 2



► The prime factorization of 54 is $2 \cdot 3 \cdot 3 \cdot 3$, or $2 \cdot 3^3$.

Practice

Check your answers at BigIdeasMath.com.

List the factor pairs of the number.

1. 16

2. 30

3. 63

4. 100

5. 135

6. 275

Write the prime factorization of the number.

7. 24

8. 66

9. 50

10. 80

11. 98

12. 126

13. 154

14. 310

Find the greatest perfect square that is a factor of the number.

15. 117

16. 150

17. 539

18. 936

19. **EXERCISE** An exercise class has 28 participants. The instructor arranges the participants in rows. Each row has the same number of participants. How many possible arrangements are there?

Greatest Common Factor

Factors that are shared by two or more numbers are called **common factors**. The greatest of the common factors is called the **greatest common factor** (GCF). There are several different ways to find the GCF of two or more numbers.

Example 1 Find the greatest common factor (GCF) of 56 and 104.

Method 1 List the factors of each number. Then circle the common factors.

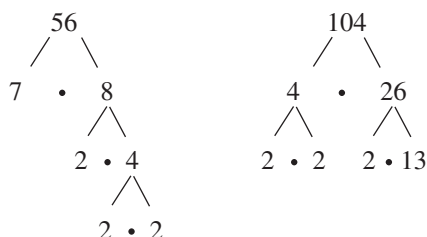
Factors of 56: ①, ②, ④, 7, ⑧, 14, 28, 56

Factors of 104: ①, ②, ④, ⑧, 13, 26, 52, 104

The common factors are 1, 2, 4, and 8. The greatest of these common factors is 8.

► So, the GCF of 56 and 104 is 8.

Method 2 Make a factor tree for each number.



Write the prime factorization of each number. Then circle the common prime factors. The GCF is the product of the common prime factors.

$$56 = 2 \cdot 2 \cdot 2 \cdot 7$$

$$104 = 2 \cdot 2 \cdot 2 \cdot 13$$

► So, the GCF of 56 and 104 is $2 \cdot 2 \cdot 2 = 8$.

Practice

Check your answers at BigIdeasMath.com.

Find the GCF of the numbers using the two methods shown above.

1. 30, 45

2. 12, 54

3. 16, 96

4. 42, 98

5. 27, 66

6. 50, 160

7. 21, 70

8. 76, 95

9. 60, 84

10. 60, 120, 210

11. 44, 64, 100

12. 15, 28, 70

13. Write a set of two numbers that have a GCF of 20. Explain how you found your answer.

14. Write a set of three numbers that have a GCF of 25. Explain how you found your answer.

15. **BOUQUETS** A florist is making identical bouquets using 90 white roses, 60 red roses, and 45 pink roses. What is the greatest number of bouquets that the florist can make if no roses are left over? How many of each color are in each bouquet?

16. **FABRIC** You have two pieces of fabric. One piece is 6 feet wide and the other piece is 7.5 feet wide. You want to cut both pieces into strips of equal width that are as wide as possible. How wide should you cut the strips of fabric?

Least Common Multiple

Multiples that are shared by two or more numbers are called **common multiples**. The least of the common multiples is called the **least common multiple** (LCM). There are several different ways to find the LCM of two or more numbers.

Example 1 Find the least common multiple (LCM) of 18 and 30.

Method 1 List the multiples of each number. Then circle the common multiples.

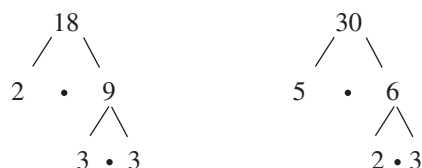
Multiples of 18: 18, 36, 54, 72, 90, 108, 126, 144, 162, 180

Multiples of 30: 30, 60, 90, 120, 150, 180, 210

Some common multiples of 18 and 30 are 90 and 180. The least of these common multiples is 90.

► So, the LCM of 18 and 30 is 90.

Method 2 Make a factor tree for each number.



Write the prime factorization of each number. Circle each different factor where it appears the greatest number of times.

$$18 = 2 \cdot 3 \cdot 3$$

2 appears once in both factorizations, so circle it here.

3 appears more often here, so circle all 3s.

$$30 = 2 \cdot 3 \cdot 5$$

5 appears once. Do not circle the 2s or 3s again.

$$2 \cdot 3 \cdot 3 \cdot 5 = 90$$

Find the product of the circled factors.

► So, the LCM of 18 and 30 is 90.

Practice

Check your answers at BigIdeasMath.com.

Find the LCM of the numbers using the two methods shown above.

1. 6, 10

2. 12, 16

3. 15, 25

4. 20, 50

5. 9, 24

6. 10, 22

7. 25, 35

8. 12, 14

9. 4, 6, 10

10. 6, 9, 12

11. 10, 18, 20

12. 16, 24, 30

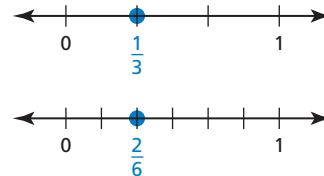
13. **SPOTLIGHTS** A spotlight at a dance club flashes every 25 seconds. Another spotlight flashes every 30 seconds. Both lights just flashed. After how many minutes will both lights flash at the same time again?

14. **CLOCKS** A clock chimes every 15 minutes. Another clock chimes every half hour. Both clocks just chimed at midnight. How many times will both clocks chime at the same time over the next 24 hours?

15. **SUBWAYS** Three subway lines arrive at a station at the same time. Line A arrives at the station every 20 minutes, Line B arrives every 24 minutes, and Line C arrives every 25 minutes. How long must you wait until all three lines arrive at the station at the same time again?

Equivalent Fractions and Simplifying Fractions

The number lines show the graphs of two fractions, $\frac{1}{3}$ and $\frac{2}{6}$. These fractions represent the same number. Two fractions that represent the same number are called **equivalent fractions**. To write equivalent fractions, you can multiply or divide the numerator and the denominator by the same nonzero number.



Example 1 Write two fractions that are equivalent to $\frac{8}{12}$.

Multiply the numerator and denominator by 2.

$$\frac{8}{12} = \frac{8 \cdot 2}{12 \cdot 2} = \frac{16}{24}$$

Divide the number and denominator by 2.

$$\frac{8}{12} = \frac{8 \div 2}{12 \div 2} = \frac{4}{6}$$

► Two equivalent fractions are $\frac{16}{24}$ and $\frac{4}{6}$.

A fraction is in **simplest form** when its numerator and its denominator have no common factors besides 1.

Example 2 Write the fraction $\frac{18}{24}$ in simplest form.

Divide the numerator and denominator by 6, the greatest common factor of 18 and 24.

$$\frac{18}{24} = \frac{18 \div 6}{24 \div 6} = \frac{3}{4}$$

► $\frac{18}{24}$ in simplest form is $\frac{3}{4}$.

Practice

Check your answers at BigIdeasMath.com.

Write two fractions that are equivalent to the given fraction.

1. $\frac{4}{10}$

2. $\frac{3}{7}$

3. $\frac{10}{15}$

4. $\frac{16}{20}$

5. $\frac{9}{30}$

6. $\frac{1}{8}$

7. $\frac{9}{16}$

8. $\frac{12}{14}$

Write the fraction in simplest form.

9. $\frac{18}{27}$

10. $\frac{3}{18}$

11. $\frac{35}{50}$

12. $\frac{14}{32}$

13. $\frac{4}{36}$

14. $\frac{48}{80}$

15. $\frac{24}{63}$

16. $\frac{33}{88}$

17. $\frac{45}{100}$

18. $\frac{60}{150}$

19. $\frac{48}{96}$

20. $\frac{110}{170}$

21. Is the fraction $\frac{45}{61}$ in simplest form? Explain.

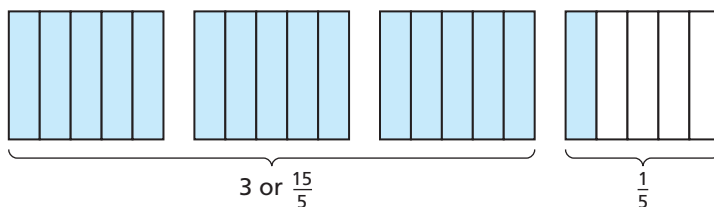
22. Write five fractions that each simplify to one-ninth.

23. **SLEEP** It is recommended that 10- to 17-year old students should sleep about 9 hours each night. What fraction of the day is this? Write your answer in simplest form.

Mixed Numbers and Improper Fractions

A **mixed number** is the sum of a whole number and a fraction. An **improper fraction** is a fraction with a numerator that is greater than or equal to the denominator.

The shaded part of the model represents the mixed number $3\frac{1}{5}$ and the improper fraction $\frac{16}{5}$.



Example 1 Write $4\frac{5}{8}$ as an improper fraction.

$$\begin{aligned}
 4\frac{5}{8} &= 4 + \frac{5}{8} && \text{Definition of mixed number} \\
 &= \frac{32}{8} + \frac{5}{8} && 1 \text{ whole} = \frac{8}{8}. \text{ So, } 4 \text{ wholes} = \frac{32}{8}. \\
 &= \frac{37}{8} && \text{Add.}
 \end{aligned}$$

► $4\frac{5}{8}$ written as an improper fraction is $\frac{37}{8}$.

Example 2 Write $\frac{19}{7}$ as a mixed number.

$$\begin{array}{r}
 2 \\
 7 \overline{)19} \\
 \underline{14} \\
 5
 \end{array}$$

Divide the numerator, 19, by the denominator, 7. The quotient is 2.

The remainder is 5. Write the remainder as a fraction, $\frac{\text{remainder}}{\text{divisor}}$.

► $\frac{19}{7}$ written as a mixed number is $2\frac{5}{7}$.

Practice

Check your answers at BigIdeasMath.com.

Write the mixed number as an improper fraction.

1. $1\frac{4}{5}$

2. $3\frac{1}{6}$

3. $10\frac{7}{10}$

4. $2\frac{12}{13}$

5. $6\frac{5}{9}$

6. $4\frac{3}{20}$

7. $7\frac{6}{7}$

8. $25\frac{2}{3}$

Write the improper fraction as a mixed number.

9. $\frac{9}{2}$

10. $\frac{13}{5}$

11. $\frac{25}{3}$

12. $\frac{31}{9}$

13. $\frac{59}{10}$

14. $\frac{43}{4}$

15. $\frac{35}{8}$

16. $\frac{67}{11}$

17. Find the improper fraction with a denominator of 8 that is equivalent to $3\frac{1}{2}$.

18. Find the improper fraction with a denominator of 12 that is equivalent to $5\frac{3}{4}$.

Adding and Subtracting Fractions

To add or subtract two fractions with *like denominators*, write the sum or difference of the numerators over the denominator.

Adding or Subtracting Fractions with Like Denominators

$$\frac{a}{c} + \frac{b}{c} = \frac{a+b}{c}, \text{ where } c \neq 0 \quad \frac{a}{c} - \frac{b}{c} = \frac{a-b}{c}, \text{ where } c \neq 0$$

Example 1 Find $\frac{7}{12} + \frac{1}{12}$.

$$\begin{aligned} \frac{7}{12} + \frac{1}{12} &= \frac{7+1}{12} && \text{Add the numerators.} \\ &= \frac{8}{12}, \text{ or } \frac{2}{3} && \text{Simplify.} \end{aligned}$$

Example 2 Find $\frac{7}{9} - \frac{2}{9}$.

$$\begin{aligned} \frac{7}{9} - \frac{2}{9} &= \frac{7-2}{9} && \text{Subtract the numerators.} \\ &= \frac{5}{9} && \text{Simplify.} \end{aligned}$$

To add or subtract two fractions with *unlike denominators*, first write equivalent fractions with a common denominator. There are two methods you can use.

Adding or Subtracting Fractions with Unlike Denominators

Method 1 Multiply the numerator and the denominator of each fraction by the denominator of the other fraction.

Method 2 Use the **least common denominator** (LCD). The LCD of two or more fractions is the least common multiple (LCM) of the denominators.

Example 3 Find $\frac{1}{8} + \frac{5}{6}$.

Method 1: $\frac{1}{8} + \frac{5}{6} = \frac{1 \cdot 6}{8 \cdot 6} + \frac{5 \cdot 8}{6 \cdot 8}$ Rewrite using a common denominator of $8 \cdot 6 = 48$.

$$\begin{aligned} &= \frac{6}{48} + \frac{40}{48} && \text{Multiply.} \\ &= \frac{46}{48}, \text{ or } \frac{23}{24} && \text{Simplify.} \end{aligned}$$

Example 4 Find $5\frac{3}{4} - 1\frac{7}{10}$.

Method 2: Rewrite the difference as $\frac{23}{4} - \frac{17}{10}$.
The LCM of 4 and 10 is 20. So, the LCD is 20.

$$\begin{aligned} \frac{23}{4} - \frac{17}{10} &= \frac{23 \cdot 5}{4 \cdot 5} - \frac{17 \cdot 2}{10 \cdot 2} && \text{Rewrite using the LCD, 20.} \\ &= \frac{115}{20} - \frac{34}{20} && \text{Multiply.} \\ &= \frac{81}{20}, \text{ or } 4\frac{1}{20} && \text{Simplify.} \end{aligned}$$

Practice

Check your answers at BigIdeasMath.com.

Evaluate.

- | | | | |
|---|---|--|------------------------------------|
| 1. $\frac{1}{14} + \frac{5}{14}$ | 2. $\frac{2}{5} + \frac{1}{5}$ | 3. $\frac{9}{10} - \frac{1}{10}$ | 4. $\frac{11}{16} - \frac{3}{16}$ |
| 5. $\frac{5}{8} + \frac{7}{8}$ | 6. $\frac{1}{6} + \frac{1}{6}$ | 7. $\frac{7}{9} + \frac{2}{3}$ | 8. $\frac{3}{5} + \frac{4}{7}$ |
| 9. $\frac{3}{4} - \frac{1}{6}$ | 10. $\frac{7}{12} - \frac{5}{9}$ | 11. $\frac{9}{10} - \frac{5}{6}$ | 12. $\frac{5}{12} + \frac{11}{16}$ |
| 13. $2\frac{3}{5} + 1\frac{2}{5}$ | 14. $4\frac{6}{7} - 2\frac{4}{7}$ | 15. $5\frac{5}{12} + 3\frac{3}{8}$ | |
| 16. $8\frac{1}{3} - 3\frac{2}{11}$ | 17. $\frac{1}{2} + 3\frac{2}{9}$ | 18. $4\frac{3}{14} - \frac{1}{7}$ | |
| 19. $\frac{2}{7} + \frac{3}{4} + \frac{1}{2}$ | 20. $\frac{13}{16} - \frac{1}{4} - \frac{3}{8}$ | 21. $2\frac{1}{6} - \frac{5}{9} + \frac{2}{3}$ | |

Multiplying and Dividing Fractions

To multiply two fractions, multiply the numerators and multiply the denominators.

Multiplying Fractions

$$\frac{a}{b} \cdot \frac{c}{d} = \frac{a \cdot c}{b \cdot d}, \text{ where } b, d \neq 0$$

Example 1 Find $\frac{2}{5} \cdot \frac{3}{8}$.

$$\begin{aligned} \frac{2}{5} \cdot \frac{3}{8} &= \frac{2 \cdot 3}{5 \cdot 8} && \text{Multiply the numerators.} \\ &&& \text{Multiply the denominators.} \\ &= \frac{\cancel{2}^1 \cdot 3}{8 \cdot \cancel{4}_4} && \text{Divide out common factors.} \\ &= \frac{3}{20} && \text{Simplify.} \end{aligned}$$

Example 2 Find $5\frac{1}{2} \cdot \frac{3}{4}$.

$$\begin{aligned} 5\frac{1}{2} \cdot \frac{3}{4} &= \frac{11}{2} \cdot \frac{3}{4} && \text{Rewrite } 5\frac{1}{2} \text{ as } \frac{11}{2}. \\ &= \frac{11 \cdot 3}{2 \cdot 4} && \text{Multiply the numerators.} \\ &&& \text{Multiply the denominators.} \\ &= \frac{33}{8}, \text{ or } 4\frac{1}{8} && \text{Simplify.} \end{aligned}$$

Two numbers whose product is 1 are **reciprocals**. To write the reciprocal of a number, write the number as a fraction. Then invert the fraction. Every number except 0 has a reciprocal.

To divide a number by a fraction, multiply the number by the reciprocal of the fraction.

Dividing Fractions

$$\frac{a}{b} \div \frac{c}{d} = \frac{a}{b} \cdot \frac{d}{c} = \frac{a \cdot d}{b \cdot c}, \text{ where } b, c, d \neq 0$$

Example 3 Find $\frac{3}{7} \div \frac{5}{6}$.

$$\begin{aligned} \frac{3}{7} \div \frac{5}{6} &= \frac{3}{7} \cdot \frac{6}{5} && \text{Multiply by the reciprocal} \\ &&& \text{of } \frac{5}{6}, \text{ which is } \frac{6}{5}. \\ &= \frac{3 \cdot 6}{7 \cdot 5} && \text{Multiply.} \\ &= \frac{18}{35} && \text{Simplify.} \end{aligned}$$

Example 4 Find $8 \div 2\frac{1}{3}$.

$$\begin{aligned} 8 \div 2\frac{1}{3} &= 8 \div \frac{7}{3} && \text{Rewrite } 2\frac{1}{3} \text{ as } \frac{7}{3}. \\ &= 8 \cdot \frac{3}{7} && \text{Multiply by the reciprocal} \\ &&& \text{of } \frac{7}{3}, \text{ which is } \frac{3}{7}. \\ &= \frac{8 \cdot 3}{7} && \text{Multiply.} \\ &= \frac{24}{7}, \text{ or } 3\frac{3}{7} && \text{Simplify.} \end{aligned}$$

Practice

Check your answers at BigIdeasMath.com.

Write the reciprocal of the number.

1. $\frac{3}{8}$

2. 7

3. -12

4. $-\frac{6}{5}$

Evaluate.

5. $\frac{3}{4} \cdot \frac{1}{6}$

6. $\frac{3}{10} \cdot \frac{2}{3}$

7. $\frac{4}{9} \cdot \frac{2}{9}$

8. $\frac{5}{8} \cdot \frac{7}{12}$

9. $4 \cdot \frac{3}{16}$

10. $3\frac{1}{2} \cdot \frac{6}{7}$

11. $1\frac{7}{20} \cdot 2\frac{4}{5}$

12. $\frac{1}{10} \cdot 10$

13. $\frac{1}{6} \div \frac{1}{2}$

14. $\frac{7}{8} \div \frac{7}{8}$

15. $\frac{9}{10} \div \frac{3}{5}$

16. $\frac{3}{4} \div \frac{5}{8}$

17. $18 \div \frac{2}{3}$

18. $7\frac{1}{2} \div 2\frac{1}{10}$

19. $6\frac{3}{7} \div 3$

20. $1\frac{3}{25} \div \frac{1}{5}$

21. **AREA** Find the area of a rectangular court that is $21\frac{3}{5}$ meters long and $13\frac{3}{4}$ meters wide.

22. **CARPENTRY** How many $1\frac{1}{4}$ -foot pieces can you cut from a piece of wood that is 20 feet long?

Writing Fractions, Decimals, and Percents

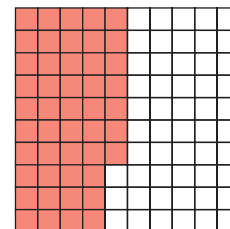
A **percent** is a part-to-whole ratio where the whole is 100. The symbol for percent is %.

In the model, 47 of the 100 squares are shaded. You can write the shaded part of the model as a fraction, a decimal, or a percent.

Fraction: forty-seven out of one hundred, or $\frac{47}{100}$

Decimal: forty-seven hundredths, or 0.47

Percent: forty-seven percent, or 47%



Example 1 Write the percent or decimal as a fraction.

a. $86\% = \frac{86}{100} = \frac{43}{50}$

b. $125\% = \frac{125}{100} = \frac{5}{4}$, or $1\frac{1}{4}$

c. $0.2 = \frac{2}{10} = \frac{1}{5}$

Example 2 Write the percent or fraction as a decimal.

a. $19\% = 19\div 100 = 0.19$

b. $\frac{3}{8} = 3 \div 8 = 0.375$

c. $\frac{3}{20} = \frac{3 \cdot 5}{20 \cdot 5} = \frac{15}{100} = 0.15$

Example 3 Write the decimal or fraction as a percent.

a. $0.34 = 0.34 \cdot 100 = 34\%$

b. $0.915 = 0.915 \cdot 100 = 91.5\%$

c. $\frac{3}{2} = \frac{3 \cdot 50}{2 \cdot 50} = \frac{150}{100} = 150\%$

Practice

Check your answers at BigIdeasMath.com.

Write the percent or decimal as a fraction.

1. 0.7

2. 0.08

3. 0.79

4. 1.75

5. 0.125

6. 0.744

7. 25%

8. 38%

9. 96%

10. 1%

11. 225%

12. 0.5%

Write the percent or fraction as a decimal.

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

14. $\frac{5}{8}$

15. $\frac{11}{50}$

16. $\frac{17}{25}$

17. $\frac{31}{20}$

18. $\frac{101}{200}$

19. 10%

20. 27%

21. 65%

22. 100%

23. 0.8%

24. 350%

Write the decimal or fraction as a percent.

25. 0.35

26. 0.91

27. 0.5

28. 1.4

29. 0.02

30. 0.006

31. $\frac{3}{25}$

32. $\frac{17}{20}$

33. $\frac{7}{8}$

34. $\frac{1}{16}$

35. $\frac{11}{2}$

36. $\frac{23}{40}$

37. Which is greater, $\frac{5}{6}$ or 83%?

38. Which is greater, 11.1% or $0.\bar{1}$?

Calculating with Percents

To represent “ a is p percent of w ,” use the **percent proportion** or the **percent equation**.

Percent Proportion	Percent Equation
$\frac{a}{w} = \frac{p}{100}$	$a = p \cdot w$

Example 1 Answer each question.

- a. What percent of 40 is 18?

percent proportion: $\frac{18}{40} = \frac{p}{100}$

$$1800 = 40p$$

$$45 = p$$

percent equation: $18 = p \cdot 40$

$$0.45 = p$$

► So, 45% of 40 is 18.

- b. What number is 32% of 75?

$$\frac{a}{75} = \frac{32}{100}$$

$$100a = 2400$$

$$a = 24$$

$$a = 0.32 \cdot 75$$

$$a = 24$$

► So, 24 is 32% of 75.

- c. 125% of what number is 80?

$$\frac{80}{w} = \frac{125}{100}$$

$$8000 = 125w$$

$$64 = w$$

$$80 = 1.25 \cdot w$$

$$64 = w$$

► So, 125% of 64 is 80.

A **percent of change** is the percent that a quantity changes from the original amount.

$$\text{percent of change} = \frac{\text{amount of change}}{\text{original amount}}$$

Example 2 Find the percent of change.

- a. Your number of hours worked increases from 24 hours to 42 hours.

$$\frac{42 - 24}{24} = \frac{18}{24} = 0.75$$

► The change is a 75% increase.

- b. A price decreases from \$25.75 to \$15.50.

$$\frac{25.75 - 15.50}{25.75} = \frac{10.25}{25.75} \approx 0.40$$

► The change is about a 40% decrease.

Practice

Check your answers at BigIdeasMath.com.

Use the percent proportion to answer the question.

1. 80% of what number is 64? 2. What number is 15% of 130? 3. What percent of 240 is 6?

Use the percent equation to answer the question.

4. What number is 55% of 94? 5. 3% of what number is 111? 6. What percent of 72 is 64?

Find the percent of change. Round to the nearest percent, if necessary.

7. A club's membership increases from 540 members to 995 members. 8. A graduating class decreases from 482 students to 398 students.

Converting Measures

The **U.S. customary system** is a system of measurement that contains units for length, capacity, and weight. The **metric system** is a decimal system of measurement, based on powers of 10, that contains units for length, capacity, and mass. To convert from one unit of measure to another, multiply by one or more *conversion factors*. A **conversion factor** is a rate that equals 1 and can be written using fraction notation. A list of equivalent measures is located in the back of your textbook. There are two different conversion factors for each statement of equivalent measures.

Statement of Equivalent Measures	Conversion Factors
1 in. = 2.54 cm	$\frac{1 \text{ in.}}{2.54 \text{ cm}}$ and $\frac{2.54 \text{ cm}}{1 \text{ in.}}$

Example 1 Convert 24 quarts to gallons.

$$24 \cancel{\text{qt}} \cdot \frac{1 \text{ gal}}{4 \cancel{\text{qt}}} = \frac{24 \cdot 1 \text{ gal}}{4} = 6 \text{ gal}$$

► So, 24 quarts is 6 gallons.

Example 2 Convert 6.5 meters to feet.

$$6.5 \cancel{\text{m}} \cdot \frac{3.28 \text{ ft}}{1 \cancel{\text{m}}} = 6.5 \cdot 3.28 \text{ ft} \approx 21.32 \text{ ft}$$

► So, 6.5 meters is about 21.32 feet.

Example 3 A sports car reaches a maximum speed of 210 miles per hour. What is the speed in feet per second?

$$\frac{210 \cancel{\text{mi}}}{1 \cancel{\text{h}}} \left(\frac{5280 \text{ ft}}{1 \cancel{\text{mi}}} \right) \left(\frac{1 \cancel{\text{h}}}{3600 \text{ sec}} \right) = \frac{210 \cdot 5280 \text{ ft}}{3600 \text{ sec}} = \frac{1,108,800 \text{ ft}}{3600 \text{ sec}} = \frac{308 \text{ ft}}{1 \text{ sec}}$$

► The speed is 308 feet per second.

Practice

Check your answers at BigIdeasMath.com.

Copy and complete the statement. Round to the nearest hundredth, if necessary.

- 36 oz = lb
- 3400 mL = L
- 18 pt = c
- 7 kg = g
- 246 ft = yd
- 65 cm = mm
- 8.5 mi = ft
- 8 h = sec
- 20 cm $\approx$ in.
- 150 lb $\approx$ kg
- 2.5 km $\approx$ mi
- 4 gal $\approx$ L
- $6\frac{1}{2}$ ft $\approx$ m
- 12 L $\approx$ qt
- 2500 mL $\approx$ c
- 24 oz $\approx$ g

- ENGINE COOLANT** An automobile engine holds 5.8 liters of coolant. You have 2 gallons of coolant. Do you have enough coolant to fill the engine? Explain.
- HUMMINGBIRD** A hummingbird's heart rate is about 1250 beats per minute. What is the heart rate in beats per second?
- EROSION** A shoreline is eroding at a rate of 6.8 meters per year. What is the erosion rate in feet per week?
- SWIMMING POOL** A swimming pool is draining at a rate of 10 fluid ounces per second. What is the drainage rate in gallons per hour?

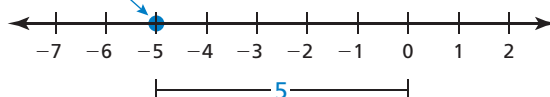
Operations with Integers

Adding and Subtracting Integers

The **absolute value** of an integer is the distance between the number and 0 on a number line. The absolute value of a number x is written as $|x|$.

Example 1 Find the absolute value of -5 .

Graph -5 on a number line.



The distance between -5 and 0 is 5 .

► So, $|-5| = 5$.

Rules for Adding and Subtracting Integers

Adding: To add integers with the *same* sign, add the absolute values of the integers. Then use the common sign.

To add integers with *different* signs, subtract the lesser absolute value from the greater absolute value. Then use the sign of the integer with the greater absolute value.

Subtracting: To subtract an integer, add its opposite.

Example 2 Find (a) $-3 + (-8)$ and (b) $-9 + 6$.

a. $-3 + (-8) = -11$ Add $|-3|$ and $|-8|$.
Use the common sign.

► The sum is -11 .

b. $-9 + 6 = -3$ $|-9| > |6|$. So, subtract $|6|$ from $|-9|$.
Use the sign of -9 .

► The sum is -3 .

Example 3 Find (a) $5 - (-12)$ and (b) $1 - 7$.

a. $5 - (-12) = 5 + 12$ Add the opposite of -12 .
 $= 17$ Add.

► The difference is 17 .

b. $1 - 7 = 1 + (-7)$ Add the opposite of 7 .
 $= -6$ Add.

► The difference is -6 .

Example 4 Simplify $|-14 - (-10)|$.

$-14 - (-10) = |-14 + 10|$ Add the opposite of -10 .
 $= |-4|$ Add.
 $= 4$ Find the absolute value.

► So, $|-14 - (-10)| = 4$.

Operations with Integers

Multiplying and Dividing Integers

Rules for Multiplying and Dividing Integers

Multiplying and Dividing: The product or quotient of two integers with the *same* sign is *positive*.
The product or quotient of two integers with *different* signs is *negative*.

Example 5 Find (a) $-7 \cdot (-1)$ and (b) $-9 \cdot 4$.

a. $-7 \cdot (-1) = 7$ The integers have the same sign,
so the product is positive.

► The product is 7.

b. $-9 \cdot 4 = -36$ The integers have different signs,
so the product is negative.

► The product is -36 .

Example 6 Find (a) $18 \div (-2)$ and (b) $-25 \div (-5)$.

a. $18 \div (-2) = -9$ The integers have different signs,
so the quotient is negative.

► The quotient is -9 .

b. $-25 \div (-5) = 5$ The integers have the same sign,
so the quotient is positive.

► The quotient is 5.

Practice

Check your answers at BigIdeasMath.com.

Find the absolute value.

1. $|13|$

2. $|-8|$

3. $|0|$

4. $|-297|$

Evaluate.

5. $5 + (-11)$

6. $4 - 9$

7. $-15 + (-10)$

8. $9 + (-6)$

9. $0 - (-50)$

10. $-8 + 20$

11. $-11 - 11$

12. $-14 + 0$

13. $20 - (-21)$

14. $-34 - (-25)$

15. $-8 + (-3) + 6$

16. $1 + 7 - 9$

Simplify the expression.

17. $|-15 - 9|$

18. $|18 - (-11)|$

19. $|-14 + 17|$

20. $|-24 - (-19)|$

Evaluate.

21. $-8 \cdot 25$

22. $-33 \div (-3)$

23. $-13(-1)$

24. $-24 \div 4$

25. $0(-4)$

26. $-15(8)$

27. $\frac{0}{-12}$

28. $-1(-1)$

29. $\frac{-16}{-1}$

30. $240 \div (-8)$

31. $5 \cdot (-7) \cdot (-4)$

32. $12 \div (-3) \cdot 2$

33. **ELEVATION** The highest elevation in California is 14,494 feet, on Mount Whitney. The lowest elevation in California is -282 feet in Death Valley. Find the range of elevations in California.

34. **GOLF** The table shows a golfer's score for each round of a tournament. Find the golfer's total score and the golfer's mean score per round.

	Round 1	Round 2	Round 3
Score	-3	-4	$+1$

Operations with Rational Numbers

To add, subtract, multiply, or divide rational numbers, use the same rules for signs as you used for integers.

Example 1 Find (a) $-\frac{5}{6} + \frac{2}{3}$ and (b) $7.3 - (-4.8)$.

a. Write the fractions with the same denominator, then add.

$$-\frac{5}{6} + \frac{2}{3} = -\frac{5}{6} + \frac{4}{6} = \frac{-5 + 4}{6} = \frac{-1}{6} = -\frac{1}{6}$$

b. To subtract a rational number, add its opposite.

$$7.3 - (-4.8) = 7.3 + 4.8 = 12.1 \quad \text{The opposite of } -4.8 \text{ is } 4.8.$$

Example 2 Find (a) $2.25 \cdot 8$, (b) $-2.25 \cdot (-8)$, and (c) $-2.25 \cdot 8$.

a. $2.25 \cdot 8 = 18$

b. $-2.25 \cdot (-8) = 18$

c. $-2.25 \cdot 8 = -18$

Example 3 Find $-\frac{4}{9} \div \frac{3}{4}$.

To divide by a fraction, multiply by its reciprocal.

$$-\frac{4}{9} \div \frac{3}{4} = -\frac{4}{9} \cdot \frac{4}{3} = -\frac{4 \cdot 4}{9 \cdot 3} = -\frac{16}{27} \quad \text{The reciprocal of } \frac{3}{4} \text{ is } \frac{4}{3}.$$

Practice

Check your answers at BigIdeasMath.com.

Add, subtract, multiply, or divide.

1. $-7.5 + 3.8$

2. $-18.3 + (-6.7)$

3. $0.6 - 0.85$

4. $6.13 - (-2.82)$

5. $-6 \cdot 4.75$

6. $-3.2 \cdot (-4.8)$

7. $-1.8 \div (-9)$

8. $3.6 \div (-1.5)$

9. $-\frac{1}{6} + \frac{5}{6}$

10. $-\frac{7}{10} + \left(-\frac{3}{5}\right)$

11. $\frac{4}{9} - \frac{2}{3}$

12. $-\frac{5}{6} - \frac{1}{4}$

13. $-\frac{3}{2} \cdot \left(-\frac{1}{8}\right)$

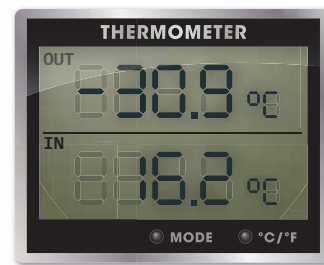
14. $-\frac{3}{4} \cdot \frac{7}{12}$

15. $\frac{5}{8} \div \left(-\frac{1}{4}\right)$

16. $-\frac{4}{7} \div \frac{2}{5}$

17. **TEMPERATURE** The temperature at midnight is shown. The outside temperature decreases 2.3°C over the next two hours. What is the outside temperature at 2 A.M.?

18. **SNOWFALL** In January, a city's snowfall was $\frac{5}{8}$ foot below the historical average. In February, the snowfall was $\frac{3}{4}$ foot above the historical average. Was the city's snowfall in the two-month period above or below the historical average? By how much?



Square Roots

A **square root** of a number is a number that, when multiplied by itself, equals the given number. Every positive number has a positive and a negative square root. A **perfect square** is a number with integers as its square roots.

Example 1 Find the two square roots of 64.

$$8 \cdot 8 = 64 \text{ and } -8 \cdot (-8) = 64$$

► So, the square roots of 64 are 8 and -8 .

The symbol $\sqrt{\quad}$ is called a **radical sign**. It is used to represent a square root. The number under the radical sign is called the **radicand**.

Example 2 Find the square root(s).

a. $\sqrt{49}$

► Because $7^2 = 49$, $\sqrt{49} = \sqrt{7^2} = 7$.

b. $-\sqrt{\frac{1}{4}}$

► Because $\left(\frac{1}{2}\right)^2 = \frac{1}{4}$, $-\sqrt{\frac{1}{4}} = -\sqrt{\left(\frac{1}{2}\right)^2} = -\frac{1}{2}$.

c. $\pm\sqrt{1.21}$

► Because $1.1^2 = 1.21$, $\pm\sqrt{1.21} = \pm\sqrt{1.1^2} = \pm 1.1$.

Example 3 Evaluate $3\sqrt{144} - 10$.

$$\begin{aligned} 3\sqrt{144} - 10 &= 3(12) - 10 && \text{Evaluate the square root.} \\ &= 36 - 10 && \text{Multiply.} \\ &= 26 && \text{Subtract.} \end{aligned}$$

Practice

Check your answers at BigIdeasMath.com.

Find the two square roots of the number.

1. 9

2. 100

3. 169

4. 400

Find the square root(s).

5. $\sqrt{4}$

6. $-\sqrt{81}$

7. $\pm\sqrt{900}$

8. $\pm\sqrt{\frac{1}{36}}$

9. $\sqrt{\frac{4}{9}}$

10. $-\sqrt{\frac{36}{25}}$

11. $\sqrt{2.25}$

12. $\pm\sqrt{0.01}$

Evaluate the expression.

13. $\sqrt{10 + 6}$

14. $4 - 2\sqrt{9}$

15. $12 - \sqrt{\frac{98}{2}}$

16. $4(2\sqrt{25} + 3)$

17. **PERIMETER** What is the perimeter of a square with an area of 900 square feet?

18. **DIAMETER** What is the diameter of a circle with an are of 100π square yards?

Properties of Square Roots

A **radical expression** is an expression that contains a radical. A radical expression involving square roots is in **simplest form** when these three conditions are met.

- No radicands have perfect square factors other than 1.
- No radicands contain fractions.
- No radicals appear in the denominator of a fraction.

You can use the properties below to simplify radical expressions involving square roots.

Product Property of Square Roots	Quotient Property of Square Roots
$\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$, where $a, b \geq 0$	$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$, where $a \geq 0$ and $b > 0$

Example 1 Simplify (a) $\sqrt{75}$ and (b) $\sqrt{\frac{13}{25}}$.

- a. $\sqrt{75} = \sqrt{25 \cdot 3}$ Factor using the greatest perfect square factor.
- $= \sqrt{25} \cdot \sqrt{3}$ Product Property of Square Roots
- $= 5\sqrt{3}$ Simplify.
- b. $\sqrt{\frac{13}{25}} = \frac{\sqrt{13}}{\sqrt{25}}$ Quotient Property of Square Roots
- $= \frac{\sqrt{13}}{5}$ Simplify.

When a radical is in the denominator of a fraction, you can multiply the fraction by an appropriate form of 1 to eliminate the radical from the denominator. This process is called **rationalizing the denominator**.

Example 2 Simplify $\frac{10}{\sqrt{7}}$ by rationalizing the denominator.

$$\begin{aligned} \frac{10}{\sqrt{7}} &= \frac{10}{\sqrt{7}} \cdot \frac{\sqrt{7}}{\sqrt{7}} && \text{Multiply by } \frac{\sqrt{7}}{\sqrt{7}}. \\ &= \frac{10\sqrt{7}}{\sqrt{49}} && \text{Product Property of Square Roots} \\ &= \frac{10\sqrt{7}}{7} && \text{Simplify.} \end{aligned}$$

Practice

Check your answers at BigIdeasMath.com.

Simplify the expression.

1. $\sqrt{12}$

2. $-\sqrt{45}$

3. $\sqrt{500}$

4. $\sqrt{112}$

5. $\sqrt{\frac{3}{4}}$

6. $\sqrt{\frac{10}{49}}$

7. $-\sqrt{\frac{8}{25}}$

8. $\sqrt{\frac{48}{81}}$

9. $\frac{3}{\sqrt{5}}$

10. $-\frac{14}{\sqrt{10}}$

11. $\sqrt{\frac{3}{8}}$

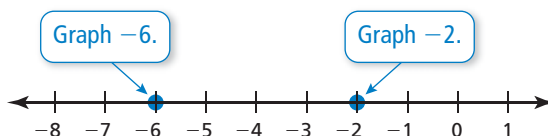
12. $\sqrt{\frac{7}{32}}$

Comparing and Ordering Real Numbers

There are several ways to compare real numbers. One way is to write the numbers as decimals and use a number line.

Example 1 Complete the statement with $<$, $>$, or $=$.

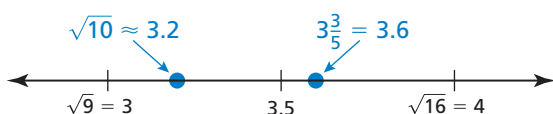
a. -2 -6



► -2 is to the right of -6 . So, $-2 > -6$.

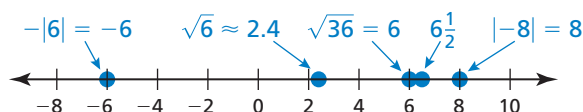
b. $\sqrt{10}$ $3\frac{3}{5}$

Estimate $\sqrt{10}$ to the nearest tenth. Then graph the numbers on a number line.



► $3\frac{3}{5}$ is to the right of $\sqrt{10}$. So, $\sqrt{10} < 3\frac{3}{5}$.

Example 2 Order the values from least to greatest: $\sqrt{36}$, $|-8|$, $\sqrt{6}$, $6\frac{1}{2}$, $-|6|$.



► So, the order from least to greatest is $-|6|$, $\sqrt{6}$, $\sqrt{36}$, $6\frac{1}{2}$, and $|-8|$.

Practice

Check your answers at BigIdeasMath.com.

Complete the statement with $<$, $>$, or $=$.

1. -4 -1

2. 0 -10

3. -12 $|-13|$

4. 7 $|-7|$

5. $\sqrt{14}$ 3.75

6. $2\frac{1}{4}$ $2.\bar{3}$

7. $-\sqrt{15}$ -4

8. π $3\frac{1}{10}$

Order the values from least to greatest.

9. 3 , $-|-2|$, $|-2|$, $|0|$, -1

10. -12 , $-|14|$, 10 , $|-15|$, -9

11. π , 3.14 , $\sqrt{7}$, $2\frac{3}{4}$, $\sqrt{4}$

12. 2π , $5.1\bar{6}$, $5\frac{1}{8}$, $\sqrt{25}$, 5.25

13. $-|-1|$, 0.11 , 0 , $-|11|$, 1.1 , $|-1|$

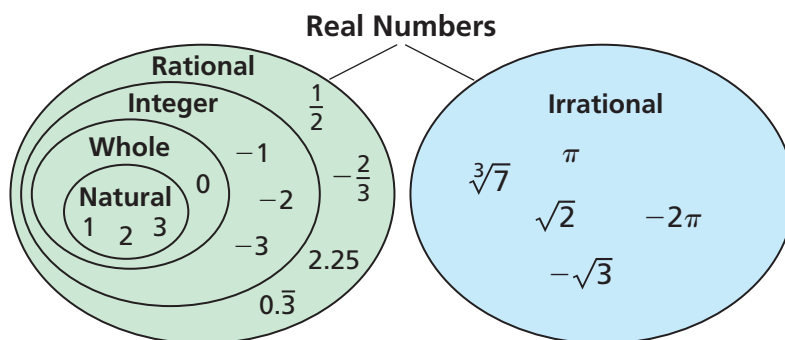
14. $|-4^3|$, $|-9 \cdot 7|$, 60 , $\sqrt{64}$

Classifying Real Numbers

A **rational number** is a number that can be written as the ratio of two integers. An **irrational number** cannot be written as the ratio of two integers.

- The square root of any whole number that is not a perfect square is irrational. The cube root of any integer that is not a perfect cube is irrational.
- The decimal form of an irrational number neither terminates nor repeats.

Rational numbers and irrational numbers together form the set of **real numbers**.



Example 1 Classify each real number in as many ways as possible.

	Number	Subset(s)	Reasoning
a.	$\sqrt{18}$	Irrational	18 is not a perfect square.
b.	$0.\bar{3}\bar{3}$	Rational	$0.\bar{3}\bar{3}$ is a repeating decimal.
c.	$-\sqrt{4}$	Integer, Rational	$-\sqrt{4}$ is equal to -2 .
d.	$\frac{56}{7}$	Natural, Whole, Integer, Rational	$\frac{56}{7}$ is equal to 8.
e.	$\sqrt[3]{5}$	Irrational	5 is not a perfect cube.

Practice

Check your answers at BigIdeasMath.com.

Classify the real number in as many ways as possible.

- $\sqrt{17}$
- $\frac{1}{5}$
- 0.25
- $\frac{48}{6}$
- $-\sqrt{25}$
- $\sqrt[3]{32}$

Determine whether the statement is *always*, *sometimes*, or *never* true. Explain your reasoning.

- A natural number is a whole number.
- An integer is a natural number.
- A natural number is negative.
- A real number is an irrational number.
- A rational number is a real number.
- A whole number is an irrational number.

Evaluating Algebraic Expressions

An **algebraic expression** is an expression that may contain numbers, operations, and one or more symbols. A symbol that represents one or more numbers is called a **variable**. To evaluate an algebraic expression, substitute a number for each variable. Then use the order of operations to find the value of the numerical expression.

Example 1 Evaluate each expression when $x = 3$.

a. $5x + 7$

$$\begin{aligned} 5x + 7 &= 5(3) + 7 && \text{Substitute 3 for } x. \\ &= 15 + 7 && \text{Multiply.} \\ &= 22 && \text{Add.} \end{aligned}$$

b. $14 - x^2$

$$\begin{aligned} 14 - x^2 &= 14 - 3^2 && \text{Substitute 3 for } x. \\ &= 14 - 9 && \text{Evaluate power.} \\ &= 5 && \text{Subtract.} \end{aligned}$$

c. $2x^2 - 8x + 4$

$$\begin{aligned} 2x^2 - 8x + 4 &= 2(3)^2 - 8(3) + 4 && \text{Substitute 3 for } x. \\ &= 2(9) - 8(3) + 4 && \text{Evaluate power.} \\ &= 18 - 24 + 4 && \text{Multiply.} \\ &= -2 && \text{Simplify.} \end{aligned}$$

Example 2 Evaluate each expression when $x = -2$ and $y = 6$.

a. $7x - 5y$

$$\begin{aligned} 7x - 5y &= 7(-2) - 5(6) \\ &= -14 - 30 \\ &= -44 \end{aligned}$$

b. $x^2 - 2xy + y^2$

$$\begin{aligned} x^2 - 2xy + y^2 &= (-2)^2 - 2(-2)(6) + 6^2 \\ &= 4 - 2(-2)(6) + 36 \\ &= 4 - (-24) + 36 \\ &= 64 \end{aligned}$$

Practice

Check your answers at BigIdeasMath.com.

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

1. $3x + 10$

2. $14 - 2y$

3. $5 - y^2$

4. $4x^2 + 9$

5. $y^2 + 8y - 4$

6. $-3x^2 - x + 7$

7. $0.75x - 4x - 1.5$

8. $3(y + 8 - 4y)$

9. $2x + 3y$

10. $6y - 5x$

11. $4x^2 + 3y$

12. $x^2 - y^2$

13. $y - x + y^2$

14. $x^2y^2 + xy$

15. $\frac{x + y}{y - x}$

16. $\frac{2x + y}{xy}$

Copy and complete the table.

17.

x	0	1	2	3	4
$3x - 2$					

18.

x	-2	-1	0	1	2
$-4x + 1$					

19. **MONEY** You earn $8x + 7y$ dollars for working x hours at a restaurant and y hours at a bus station. How much do you earn for working 12 hours at the restaurant and 16 hours at the bus station?

Simplifying Algebraic Expressions

Parts of an algebraic expression are called *terms*. **Like terms** are terms that have the same variables raised to the same exponents. Constant terms are also like terms.

An algebraic expression is in **simplest form** when it has no like terms and no parentheses. To *combine* like terms that have variables, use the Distributive Property to add or subtract the coefficients.

Example 1 Simplify $8y + 7y$.

$$\begin{aligned} 8y + 7y &= (8 + 7)y \\ &= 15y \end{aligned}$$

Distributive Property

Add coefficients.

Example 2 Simplify $2(x + 5) - 3(x - 2)$.

$$\begin{aligned} 2(x + 5) - 3(x - 2) &= 2(x) + 2(5) - 3(x) - 3(-2) \\ &= 2x + 10 - 3x + 6 \\ &= 2x - 3x + 10 + 6 \\ &= -x + 16 \end{aligned}$$

Distributive Property

Multiply.

Group like terms.

Combine like terms.

Example 3 Simplify $xy + 3y - 2x + 5y - 3xy$.

$$\begin{aligned} xy + 3y - 2x + 5y - 3xy &= xy - 3xy + 3y + 5y - 2x \\ &= -2xy + 8y - 2x \end{aligned}$$

Group like terms.

Combine like terms.

Practice

Check your answers at BigIdeasMath.com.

Simplify the expression.

1. $7x + 15x$

2. $8y - 14y$

3. $7d + 9 - 5d$

4. $3w + 2(2 - 3w) + 2$

5. $(x + 3) + (3x - 7)$

6. $(5k + 6) + (4k - 8)$

7. $(-7n + 6) + (5n + 15)$

8. $(9z + 12) - (6z + 8)$

9. $(8b + 1) - (-10b - 5)$

10. $s(8 - 2t) + 3t(4 - 2s) + 5t$

11. $qr + 2q^2 - 3qr - r^2 - 6q^2$

12. $g^3(h - 4g) - h(3 - 2g^3)$

13. **EARNINGS** The original price of a model car is d dollars. You use a coupon and buy the kit for $(d - 10)$ dollars. You assemble the model car and sell it for $(2d - 20)$ dollars. Write an expression that represents your earnings. Interpret the expression.

Powers and Exponents

A **power** is a product of repeated factors. The **base** of a power is the common factor. The **exponent** of a power indicates the number of times the base is used as a factor.

$$\left(\frac{2}{5}\right)^3 = \frac{2}{5} \cdot \frac{2}{5} \cdot \frac{2}{5}$$

$\frac{2}{5}$ is used as factor 3 times

Example 1 Write each product using exponents.

a. $(-9) \cdot (-9) \cdot (-9) \cdot (-9) \cdot (-9)$

Because -9 is used as a factor 5 times, its exponent is 5.

► So, $(-9) \cdot (-9) \cdot (-9) \cdot (-9) \cdot (-9) = (-9)^5$.

b. $\pi \cdot \pi \cdot h \cdot h \cdot h$

Because π is used as a factor 2 times, its exponent is 2. Because h is used as a factor 3 times, its exponent is 3.

► So, $\pi \cdot \pi \cdot h \cdot h \cdot h = \pi^2 h^3$.

Example 2 Evaluate each expression.

a. $(-5)^4$

$$\begin{aligned} (-5)^4 &= (-5) \cdot (-5) \cdot (-5) \cdot (-5) \\ &= 625 \end{aligned}$$

Write as repeated multiplication.

Simplify.

b. -5^4

$$\begin{aligned} -5^4 &= -(5 \cdot 5 \cdot 5 \cdot 5) \\ &= -625 \end{aligned}$$

Write as repeated multiplication.

Simplify.

Practice

Check your answers at BigIdeasMath.com.

Write the product using exponents.

1. $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$

2. $\left(-\frac{1}{3}\right) \cdot \left(-\frac{1}{3}\right) \cdot \left(-\frac{1}{3}\right)$

3. $x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y$

4. $2.5 \cdot 2.5 \cdot b \cdot b \cdot b \cdot b$

5. $(-n) \cdot (-n) \cdot (-n) \cdot (-n)$

6. $(-12) \cdot (-12) \cdot v \cdot v \cdot v$

Evaluate the expression.

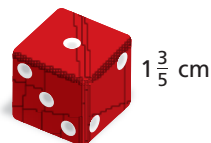
7. 10^4

8. -15^2

9. $\left(\frac{3}{4}\right)^3$

10. $\left(-\frac{1}{2}\right)^5$

11. **VOLUME** Write an expression involving a power that represents the volume (in cubic centimeters) of the die shown. Then find the volume.



The Distributive Property

To multiply a sum or difference by a number, multiply each number in the sum or difference by the number outside the parentheses, then evaluate.

Distributive Property	
With addition: $5(7 + 3) = 5(7) + 5(3)$	$a(b + c) = a(b) + a(c)$
With subtraction: $5(7 - 3) = 5(7) - 5(3)$	$a(b - c) = a(b) - a(c)$

Example 2 Simplify each expression.

a. $6(x + 9)$

$$\begin{aligned} 6(x + 9) &= 6(x) + 6(9) \\ &= 6x + 54 \end{aligned}$$

b. $10(12 + z + 7)$

$$\begin{aligned} 10(12 + z + 7) &= 10(12) + 10(z) + 10(7) \\ &= 120 + 10z + 70 \\ &= 10z + 190 \end{aligned}$$

c. $16(8w - 3)$

$$\begin{aligned} 16(8w - 3) &= 16(8w) - 16(3) \\ &= 128w - 48 \end{aligned}$$

d. $5(4m - 3n - 1)$

$$\begin{aligned} 5(4m - 3n - 1) &= 5(4m) - 5(3n) - 5(1) \\ &= 20m - 15n - 5 \end{aligned}$$

Practice

Check your answers at BigIdeasMath.com.

Evaluate.

1. $25(7 + 11)$

2. $4(13 - 5)$

3. $9(16 + 7 - 8)$

4. $-4(10 - 9 - 6)$

Simplify the expression.

5. $4(y + 7)$

6. $-2(z + 5)$

7. $5(b - 11)$

8. $-8(d - 1)$

9. $12(4a + 13)$

10. $9(20 + 17m)$

11. $11(2k - 11)$

12. $-7(-2n - 9)$

13. $3(x + 4 + 9)$

14. $6(25 + 6z + 10)$

15. $8(p - 6 - 5)$

16. $-10(4 + v - 1)$

17. $7(2x + 7 + 9y)$

18. $-4(4r - s + 17)$

19. $-3(-12 - 3d - 8)$

20. $2 - 6(2n - 9)$

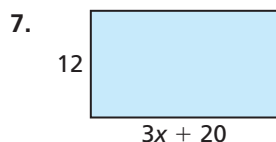
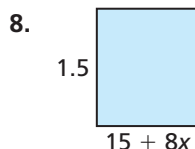
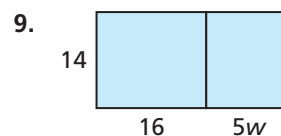
21. $1.5(6c + 10d + 3)$

22. $\frac{3}{4}\left(q + \frac{1}{6} + \frac{7}{8}\right)$

23. $-2.4(5h - 10 + 4)$

24. $0.5(2.6x + 5.8)$

Write and simplify an expression for the area of the rectangle.



Order of Operations

To evaluate numerical expressions, use a set of rules called the **order of operations**.

Order of Operations

1. Perform operations in **P**arentheses.
2. Evaluate numbers with **E**xponents.
3. **M**ultiply or **D**ivide from left to right.
4. **A**dd or **S**ubtract from left to right.

Example 1 Evaluate each expression.

a. $20 - 5 \cdot 6$

$$\begin{aligned} 20 - 5 \cdot 6 &= 20 - 30 \\ &= -10 \end{aligned}$$

Multiply 5 and 6.

Subtract 30 from 20.

b. $12 \cdot 3 + 4^2 \div 8$

$$\begin{aligned} 12 \cdot 3 + 4^2 \div 8 &= 12 \cdot 3 + 16 \div 8 \\ &= 36 + 16 \div 8 \\ &= 36 + 2 \\ &= 38 \end{aligned}$$

Evaluate 4^2 .

Multiply 12 and 3.

Divide 16 by 8.

Add 36 and 2.

c. $7(5 - 3) + 6^2 \div (-3)$

$$\begin{aligned} 7(5 - 3) + 6^2 \div (-3) &= 7(2) + 6^2 \div (-3) \\ &= 7(2) + 36 \div (-3) \\ &= 14 + 36 \div (-3) \\ &= 14 + (-12) \\ &= 2 \end{aligned}$$

Perform operation in parentheses.

Evaluate 6^2 .

Multiply 7 and 2.

Divide 36 by -3 .

Add 14 and -12 .

Practice

Check your answers at BigIdeasMath.com.

Evaluate the expression.

1. $8 + 2 \cdot 5$

2. $40 \div 8 - 7$

3. $5 \cdot 4^2 \div 8$

4. $1 - 7 + 5^2$

5. $\frac{3 - (-9)}{-10 + 6}$

6. $\frac{2 + 4}{1 - 5} - 1$

7. $(12 - 8)^2 \div 2^5$

8. $18 + 9^2 - 7 \cdot (-3)$

9. $32 \div 8 + 2 \cdot 8^2$

10. $6 \div (7 \div 28)$

11. $36 \div (1 - |2 - 7|)$

12. $(-2)^2 \cdot 5 - 7(9 - 5)$

13. $4(3 + 8) - 8^2 \div 32$

14. $10(3 - 6)^3 + 41$

15. $(2 - 5)^2 - (4 \cdot 5^2)$

16. **RESTAURANT** There are 82 people in a restaurant. Four groups of 3 leave and then five groups of 2 enter. Evaluate the expression $82 - 4(3) + 5(2)$ to find how many people are in the restaurant.

Properties of Exponents

Product of Powers	Power of a Product	Power of a Power	
$a^m \cdot a^n = a^{m+n}$ Add exponents.	$(ab)^m = a^m b^m$ Find the power of each factor.	$(a^m)^n = a^{mn}$ Multiply exponents.	
Quotient of Powers	Power of a Quotient	Negative Exponent	Zero Exponent
$\frac{a^m}{a^n} = a^{m-n}, a \neq 0$ Subtract exponents.	$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}, b \neq 0$ Find the power of the numerator and the power of the denominator.	$a^{-n} = \frac{1}{a^n}, a \neq 0$	$a^0 = 1, a \neq 0$

Example 1 Evaluate (a) $4 \cdot 9^0$ and (b) $(-3)^{-4}$.

a. $4 \cdot 9^0 = 1$ Definition of zero exponent

b. $(-3)^{-4} = \frac{1}{(-3)^4}$ Definition of negative exponent
 $= \frac{1}{81}$ Evaluate power.

Example 2 Simplify each expression. Write your answer using only positive exponents.

a. $2^3 \cdot 2^4 = 2^7 = 128$

b. $\frac{5^9}{5^6} = 5^{9-6} = 5^3 = 125$

c. $\frac{12y^0}{x^{-7}} = 12y^0 x^7 = 12x^7$

d. $\frac{x^6 \cdot x^2}{x^5} = \frac{x^{6+2}}{x^5} = x^{8-5} = x^3$

e. $(z^4)^2 = z^{4 \cdot 2} = z^8$

f. $(6mn)^3 = 6^3 \cdot m^3 \cdot n^3 = 216m^3 n^3$

g. $\left(\frac{y}{3}\right)^4 = \frac{y^4}{3^4} = \frac{y^4}{81}$

h. $\frac{10x^6 y^{-2}}{5x^3 y} = \frac{10}{5} x^{(6-3)} y^{(-2-1)} = 2x^3 y^{-3} = \frac{2x^3}{y^3}$

Practice

Check your answers at BigIdeasMath.com.

Evaluate the expression.

1. $(-9)^0$

2. -8^{-1}

3. 4^{-3}

4. $\frac{-5^0}{3^{-2}}$

Simplify the expression. Write your answer using only positive exponents.

5. $2^9 \cdot 2^{-6}$

6. $-\frac{10^8}{10^{12}}$

7. $y \cdot y^{-5}$

8. $\frac{x^7}{x^{-7}}$

9. $-5x^7 \cdot x^{-11} \cdot 2x^4$

10. $\frac{x^{-2}}{5z^0}$

11. $(w^2)^{-3}$

12. $(8xy)^2$

13. $3x^5 \cdot (-2x)^4$

14. $(-5m^2 n^{-1})^3$

15. $\frac{z^8}{z^{-2} \cdot z^9}$

16. $\frac{(x^5)^3}{x^6}$

17. $\left(\frac{3x}{2}\right)^3$

18. $\left(\frac{6x^4}{5y}\right)^{-2}$

19. $\frac{xy^{-2}}{x^4 y^{-3}}$

20. $\frac{8xy}{6x^5 y z^{-2}}$

21. **METRIC SYSTEM** There are 10^6 micrometers in a meter and 10^3 meters in a kilometer. How many micrometers are there in 10^6 kilometers?

Scientific Notation

A number is written in **scientific notation** when it is represented as the product of a factor and a power of 10. The factor must be greater than or equal to 1 and less than 10.

$$c \times 10^n \quad 1 \leq c < 10 \text{ and } n \text{ is an integer}$$

When a number is written in scientific notation, you can write the number in standard form using the absolute value of the exponent n . When n is negative, move the decimal point $|n|$ places to the left. When n is positive, move the decimal point $|n|$ places to the right.

Example 1 Write (a) 7.4×10^5 and (b) 3.96×10^{-4} in standard form.

a. $7.4 \times 10^5 = 740,000$ Move decimal point $|5| = 5$ places to the right.



b. $3.96 \times 10^{-4} = 0.000396$ Move decimal point $|-4| = 4$ places to the left.



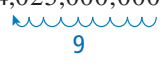
When a number is written in standard form, you can write the number in scientific notation using the following steps.

Step 1 Move the decimal point so it is located to the right of the leading nonzero digit.

Step 2 Count the number n of places you moved the decimal point. The exponent of the power of 10 is n when you move the decimal point to the left and $-n$ when you move the decimal point to the right.

Example 2 Write each number in scientific notation.

a. 4,025,000,000

$$4,025,000,000 = 4.025 \times 10^9$$

Move decimal point 9 places to the left. The exponent is 9.

b. 0.00000591

$$0.00000591 = 5.91 \times 10^{-6}$$

Move decimal point 6 places to the right. The exponent is -6 .

Practice

Check your answers at BigIdeasMath.com.

Write the number in standard form.

- | | | | |
|-------------------------|--------------------------|------------------------|--------------------------|
| 1. 2×10^4 | 2. 8.4×10^1 | 3. 7×10^{-3} | 4. 5.05×10^{-1} |
| 5. 1.8×10^{-7} | 6. 6.29×10^{-5} | 7. 5.591×10^0 | 8. 3.0504×10^9 |

Write the number in scientific notation.

- | | | | |
|-----------------|-------------|-----------------|-------------|
| 9. 400 | 10. 72,000 | 11. 0.8 | 12. 0.00019 |
| 13. 100,500,000 | 14. 324,900 | 15. 0.000002621 | 16. 0.05008 |

17. **NEURONS** A study found that the average human brain has 8.6×10^{10} neurons. Write this number in standard form. The cell bodies of neurons have widths between 0.000004 meter and 0.0001 meter. Write this range in scientific notation.

Properties of Equality

Addition Property of Equality

Words When you add the same number to each side of an equation, the two sides remain equal.

Numbers $6 + 4 = 6 + 4$

$$10 = 10$$

Algebra $x - 5 + 5 = 3 + 5$

$$x = 8$$

Subtraction Property of Equality

Words When you subtract the same number from each side of an equation, the two sides remain equal.

Numbers $7 - 2 = 7 - 2$

$$5 = 5$$

Algebra $y + 3 - 3 = 1 - 3$

$$y = -2$$

Multiplication Property of Equality

Words When you multiply each side of an equation by the same nonzero number, the two sides remain equal.

Numbers $\frac{6}{3} \cdot 3 = 2 \cdot 3$

$$6 = 6$$

Algebra $\frac{z}{3} \cdot 3 = 2 \cdot 3$

$$z = 6$$

Division Property of Equality

Words When you divide each side of an equation by the same nonzero number, the two sides remain equal.

Numbers $6 \cdot 2 \div 2 = 12 \div 2$

$$6 = 6$$

Algebra $\frac{2w}{2} = \frac{12}{2}$

$$w = 6$$

Example 1 Solve each equation. Tell which algebraic property of equality you used.

a. $c - 3 = -2$

$$c - 3 + 3 = -2 + 3 \quad \text{Addition Property of Equality}$$

$$c = 1 \quad \text{Simplify.}$$

► The solution is $c = 1$. The property is the Addition Property of Equality.

b. $\frac{d}{5} = 7$

$$\frac{d}{5} \cdot 5 = 7 \cdot 5 \quad \text{Multiplication Property of Equality}$$

$$d = 35 \quad \text{Simplify.}$$

► The solution is $d = 35$. The property is the Multiplication Property of Equality.

Practice

Check your answers at BigIdeasMath.com.

Solve the equation. Tell which algebraic property of equality you used.

1. $h - 6 = 2$

2. $\frac{j}{3} = 9$

3. $k + 8 = -9$

4. $4m = 12$

5. $n + 2 = 6$

6. $\frac{p}{6} = -2$

7. $q - 3 = -8$

8. $8r = 48$

9. $s + 9 = 5$

10. $6t = 48$

11. $w + 3 = 29$

12. $\frac{z}{7} = 7$

Solving Linear Equations

To determine whether a value is a solution of an equation, substitute the value into the equation and simplify.

Example 1 Determine whether (a) $x = 1$ or (b) $x = -2$ is a solution of $5x - 1 = 4$.

a. $5x - 1 = -2x + 6$

$$5(1) - 1 \stackrel{?}{=} -2(1) + 6 \quad \text{Substitute.}$$

$$4 = 4 \quad \checkmark \quad \text{Simplify.}$$

► So, $x = 1$ is a solution.

b. $5x - 1 = -2x + 6$

$$5(-2) - 1 \stackrel{?}{=} -2(-2) + 6 \quad \text{Substitute.}$$

$$-11 \neq 10 \quad \times \quad \text{Simplify.}$$

► So, $x = -2$ is *not* a solution.

To solve a linear equation, isolate the variable.

Example 2 Solve each equation. Check your solution.

a. $4x - 3 = 13$

$$4x - 3 + 3 = 13 + 3 \quad \text{Add 3.}$$

$$4x = 16 \quad \text{Simplify.}$$

$$\frac{4x}{4} = \frac{16}{4} \quad \text{Divide by 4.}$$

$$x = 4 \quad \text{Simplify.}$$

Check

$$4x - 3 = 13$$

$$4(4) - 3 \stackrel{?}{=} 13$$

$$13 = 13 \quad \checkmark$$

b. $2(y - 8) = y + 6$

$$2y - 16 = y + 6 \quad \text{Distributive Property}$$

$$2y - y - 16 = y - y + 6 \quad \text{Subtract } y.$$

$$y - 16 = 6 \quad \text{Simplify.}$$

$$y - 16 + 16 = 6 + 16 \quad \text{Add 16.}$$

$$y = 22 \quad \text{Simplify.}$$

Check

$$2(y - 8) = y + 6$$

$$2(22 - 8) \stackrel{?}{=} 22 + 6$$

$$28 = 28 \quad \checkmark$$

Practice

Check your answers at BigIdeasMath.com.

Determine whether (a) $x = -1$ or (b) $x = 3$ is a solution of the equation.

1. $5x + 7 = 2$

2. $-4x + 8 = -4$

3. $2x - 1 = 3x - 4$

Solve the equation. Check your solution.

4. $x - 9 = 24$

5. $n + 14 = 0$

6. $-16 = 4y$

7. $-\frac{5}{6}t = -15$

8. $81 = 46 - x$

9. $4x + 5 = 1$

10. $x + 5 = 11x$

11. $9(y - 3) = 45$

12. $6 = 7k + 8 - k$

13. $6n + 3 = -4n + 7$

14. $2c + 5 = 3(c - 8)$

15. $18m + 3(2m + 8) = 0$

16. $\frac{w - 6}{5} = 8$

17. $\frac{15 + h}{3} = 10$

18. $\frac{8 - 3x}{5} = x$

19. $(8r + 6) + (4r - 1) = 14$

20. $\frac{2}{3}y - 3 = 9$

21. $\frac{1}{2}x - \frac{3}{10} = \frac{5}{2}x + \frac{7}{10}$

22. **MONEY** You have a total of \$3.25 in change made up of 25 pennies, 6 nickels, 2 dimes, and x quarters. How many quarters do you have?

Solving Absolute Value Equations

An **absolute value equation** is an equation that contains an absolute value expression. You can solve these types of equations by solving two related linear equations.

To solve $|ax + b| = c$ when $c \geq 0$, solve the related linear equations

$$ax + b = c \quad \text{or} \quad ax + b = -c.$$

When $c < 0$, the absolute value equation $|ax + b| = c$ has no solution because absolute value always indicates a number that is not negative.

To solve $|ax + b| = |cx + d|$, solve the related linear equations

$$ax + b = cx + d \quad \text{or} \quad ax + b = -(cx + d).$$

When you solve an absolute value equation, it is possible for a solution to be *extraneous*. An **extraneous solution** is an apparent solution that must be rejected because it does not satisfy the original equation.

Example 1 Solve $|x - 7| = 8$.

Write the two related linear equations for $|x - 7| = 8$. Then solve.

$$\begin{array}{rcl} x - 7 = 8 & \text{or} & x - 7 = -8 \\ \underline{+7} \quad \underline{+7} & & \underline{+7} \quad \underline{+7} \\ x = 15 & & x = -1 \end{array}$$

► The solutions are $x = 15$ and $x = -1$.

Example 2 Solve $|x + 3| = |x + 9|$.

By equating the expression $x + 3$ and the opposite of $x + 9$, you obtain

$$\begin{array}{ll} x + 3 = -(x + 9) & \text{Write related linear equation.} \\ x + 3 = -x - 9 & \text{Distributive Property} \\ 2x + 3 = -9 & \text{Add } x \text{ to each side.} \\ 2x = -12 & \text{Subtract 3 from each side.} \\ x = -6. & \text{Divide each side by 2.} \end{array}$$

However, by equating the expressions $x + 3$ and $x + 9$, you obtain

$$\begin{array}{ll} x + 3 = x + 9 & \text{Write related linear equation.} \\ x = x + 6 & \text{Subtract 3 from each side.} \\ 0 = 6 \quad \times & \text{Subtract } x \text{ from each side.} \end{array}$$

which is a false statement. So, the original equation has only one solution.

► The solution is $x = -6$.

Check

$$\begin{array}{l} |x - 7| = 8 \\ |15 - 7| \stackrel{?}{=} 8 \\ |8| \stackrel{?}{=} |8| \\ 8 = 8 \quad \checkmark \end{array}$$

$$\begin{array}{l} |x - 7| = 8 \\ |-1 - 7| \stackrel{?}{=} 8 \\ |-8| \stackrel{?}{=} |-8| \\ 8 = 8 \quad \checkmark \end{array}$$

Practice

Check your answers at BigIdeasMath.com.

Solve the equation. Check your solutions.

1. $|x - 3| = 6$

2. $|2x - 1| = 9$

3. $|x - 5| = |x + 7|$

4. $|x + 2| = |x + 8|$

5. $|x - 3| = |x - 5|$

6. $|x + 2| = |2x + 1|$

Rewriting Literal Equations

An equation that has two or more variables is called a **literal equation**. To rewrite a literal equation, solve for one variable in terms of the other variable(s).

Example 1 Solve each literal equation for y .

a. $3x + 5y = 45$

$$3x - 3x + 5y = 45 - 3x \quad \text{Subtract } 3x \text{ from each side.}$$

$$5y = 45 - 3x \quad \text{Simplify.}$$

$$\frac{5y}{5} = \frac{45 - 3x}{5} \quad \text{Divide each side by 5.}$$

$$y = 9 - \frac{3}{5}x \quad \text{Simplify.}$$

► The rewritten literal equation is $y = 9 - \frac{3}{5}x$.

b. $2xy + 5y = 7$

$$y(2x + 5) = 7 \quad \text{Distributive Property}$$

$$\frac{y(2x + 5)}{2x + 5} = \frac{7}{2x + 5} \quad \text{Divide each side by } 2x + 5.$$

$$y = \frac{7}{2x + 5} \quad \text{Simplify.}$$

► The rewritten literal equation is $y = \frac{7}{2x + 5}$.

c. $2x = \frac{3 + y}{y}$

$$2x \cdot y = \frac{3 + y}{y} \cdot y \quad \text{Multiply each side by } y.$$

$$2xy = 3 + y \quad \text{Simplify.}$$

$$2xy - y = 3 + y - y \quad \text{Subtract } y \text{ from each side.}$$

$$2xy - y = 3 \quad \text{Simplify.}$$

$$y(2x - 1) = 3 \quad \text{Distributive Property}$$

$$\frac{y(2x - 1)}{2x - 1} = \frac{3}{2x - 1} \quad \text{Divide each side by } 2x - 1.$$

$$y = \frac{3}{2x - 1} \quad \text{Simplify.}$$

► The rewritten literal equation is $y = \frac{3}{2x - 1}$.

Practice

Check your answers at BigIdeasMath.com.

Solve the literal equation for y .

1. $x + 3y = 9$

2. $4x - 2y = 16$

3. $2x + 7y = 5$

4. $2x + 3y = 6$

5. $5x - 4y = 10$

6. $x - 2y = 8$

7. $2xy - 6 = 8x$

8. $4x = 9y + xy$

9. $4yz = 3y - 8x$

10. $2xy = 3z + 4y$

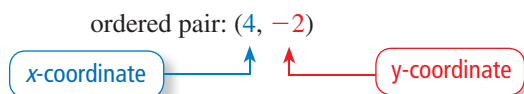
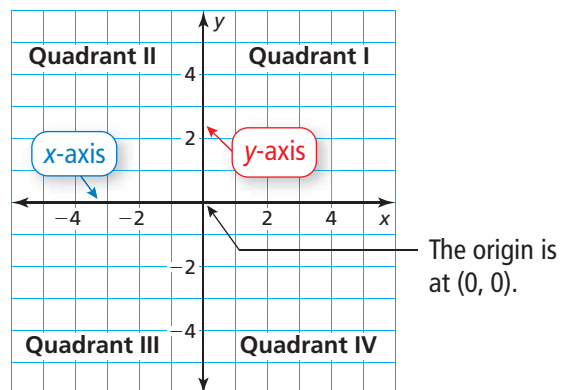
11. $\frac{2 + 7y}{y} = x$

12. $3x = \frac{5 + y}{y}$

The Coordinate Plane

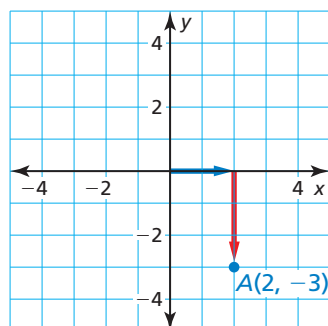
A **coordinate plane** is formed by the intersection of a horizontal number line and a vertical number line. The number lines intersect at the **origin** and separate the coordinate plane into four regions called **quadrants**.

An **ordered pair** is used to locate a point in a coordinate plane.

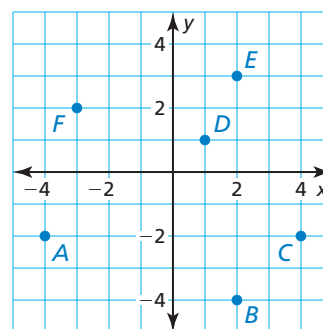


Example 1 Plot the point $A(2, -3)$ in a coordinate plane. Describe the location of the point.

Start at the origin. Move 2 units **right** and 3 units **down**. Then plot the point. The point is in Quadrant IV.



Example 2 What ordered pair corresponds to point A?



Point A is 4 units to the left of the origin and 2 units down. So, the x -coordinate is -4 and the y -coordinate is -2 .

► The ordered pair $(-4, -2)$ corresponds to point A.

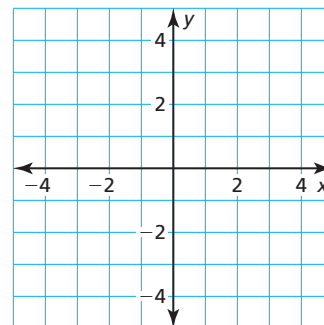
Practice

Plot the ordered pair in a coordinate plane. Describe the location of the point.

- $A(1, 3)$
- $B(-2, 2)$
- $C(2, -4)$
- $D(1, -1)$
- $E(-4, -2.5)$
- $F(-3, 0)$
- $G(0, 1)$
- $H(4, \frac{1}{2})$

Use the graph in Example 2 to answer the questions.

- What ordered pair corresponds to point C?
- What ordered pair corresponds to point F?

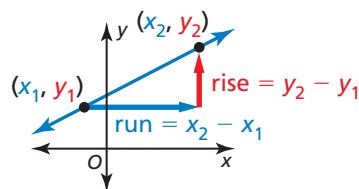


Check your answers at BigIdeasMath.com.

Slope of a Line

The **slope** of a nonvertical line is the ratio of vertical change (*rise*) to horizontal change (*run*) between any two points on the line. If a line in the coordinate plane passes through points (x_1, y_1) and (x_2, y_2) , then the slope m is

$$m = \frac{\text{rise}}{\text{run}} = \frac{\text{change in } y}{\text{change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$



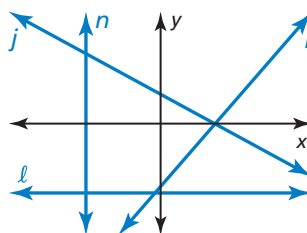
Slopes of Lines in the Coordinate Plane

Negative slope: falls from left to right, as in line j

Positive slope: rises from left to right, as in line k

Zero slope (slope of 0): horizontal, as in line ℓ

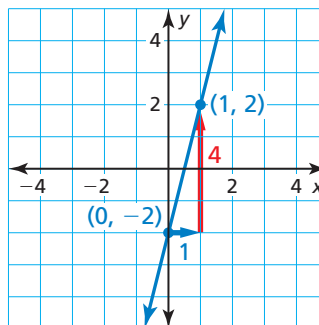
Undefined slope: vertical, as in line n



Example 1 Find the slope of the line shown.

Let $(x_1, y_1) = (0, -2)$ and $(x_2, y_2) = (1, 2)$.

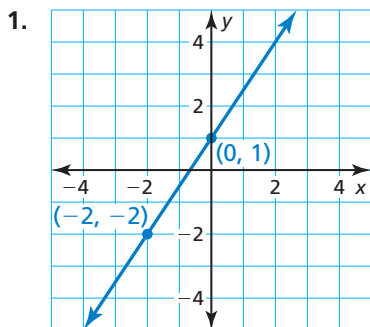
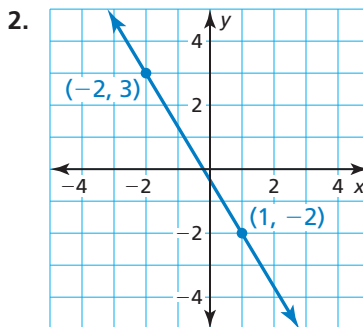
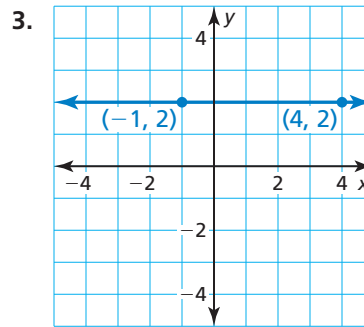
$$\begin{aligned} \text{slope} &= \frac{y_2 - y_1}{x_2 - x_1} && \text{Write formula for slope.} \\ &= \frac{2 - (-2)}{1 - 0} && \text{Substitute.} \\ &= 4 && \text{Simplify.} \end{aligned}$$



Practice

Check your answers at BigIdeasMath.com.

Find the slope of the line.

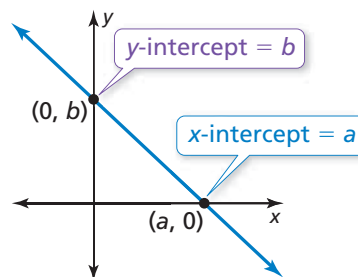


Slope-Intercept Form

The **x-intercept** of a line is the x -coordinate of the point where the line crosses the x -axis. It occurs when $y = 0$.

The **y-intercept** of a line is the y -coordinate of the point where the line crosses the y -axis. It occurs when $x = 0$.

A linear equation written in the form $y = mx + b$ is in **slope-intercept form**. The slope of the line is m , and the y -intercept of the line is b .



$$y = mx + b$$

The diagram shows the equation $y = mx + b$. A green arrow points from the word "slope" to the coefficient m . A purple arrow points from the word "y-intercept" to the constant b .

Example 1 Identify the slope and the y -intercept of the graph of each linear equation.

a. $y = -3x - 8$

$y = -3x + (-8)$ Write in slope-intercept form.

► The slope is -3 , and the y -intercept is -8 .

b. $y - 4 = \frac{1}{3}x$

$y = \frac{1}{3}x + 4$ Add 4 to each side.

► The slope is $\frac{1}{3}$, and the y -intercept is 4 .

Example 2 Find the x -intercept and the y -intercept of the graph of $2x + y = 4$.

To find the x -intercept, substitute 0 for y and solve for x .

$$\begin{aligned} 2x + y &= 4 \\ 2x + (0) &= 4 \\ x &= 2 \end{aligned}$$

To find the y -intercept, substitute 0 for x and solve for y .

$$\begin{aligned} 2x + y &= 4 \\ 2(0) + y &= 4 \\ y &= 4 \end{aligned}$$

► The x -intercept is 2 , and the y -intercept is 4 .

Practice

Check your answers at BigIdeasMath.com.

Identify the slope and the y -intercept of the graph of the linear equation.

1. $y = 4x + 7$

2. $y = -\frac{1}{3}x + 8$

3. $y = \frac{1}{9}x - 6$

4. $y + 9 = -5x$

5. $y - 2x = -6$

6. $7 + y = -\frac{2}{3}x$

Find the x -intercept and the y -intercept of the graph of the equation.

7. $y = 2x$

8. $y = x + 8$

9. $y = 3x + 6$

10. $3x + y = 9$

11. $2x + 3y = 12$

12. $2x - 5y = 10$

13. **SHOPPING** The amount of money you spend on x books and y movies is given by the equation $8x + 12y = 96$. Find the intercepts of the graph of the equation. What do these values represent?

Graphing Linear Equations

Example 1 Graph $x + 3y = -3$ using intercepts.

Step 1 To find the x -intercept, substitute 0 for y .

$$\begin{aligned} x + 3y &= -3 \\ x + 3(0) &= -3 \\ x &= -3 \end{aligned}$$

To find the y -intercept, substitute 0 for x .

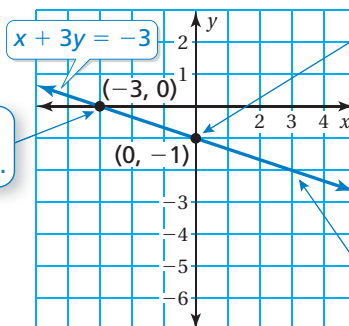
$$\begin{aligned} x + 3y &= -3 \\ 0 + 3y &= -3 \\ y &= -1 \end{aligned}$$

Step 2 Graph the equation.

The x -intercept is -3 . So, plot $(-3, 0)$.

The y -intercept is -1 . So, plot $(0, -1)$.

Draw a line through the points.



Example 2 Graph $y = \frac{2}{3}x - 2$ using the slope and y -intercept.

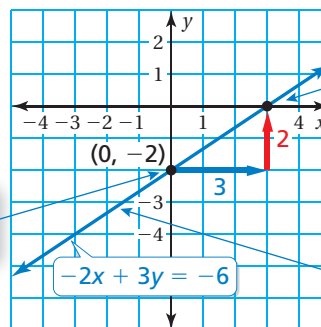
$$y = \frac{2}{3}x + (-2)$$

slope $\uparrow$ y -intercept

The y -intercept is -2 . So, plot $(0, -2)$.

Use the slope to plot another point, $(3, 0)$.

Draw a line through the points.



Practice

Check your answers at BigIdeasMath.com.

Graph the linear equation using intercepts.

1. $x - 4y = -8$

2. $-18x + 9y = 72$

3. $2x - 3y = 12$

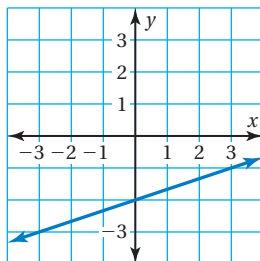
Match the equation with its graph. Identify the slope and y -intercept.

4. $y = 2x + 1$

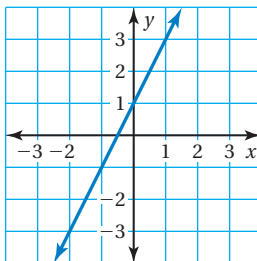
5. $y = \frac{1}{3}x - 2$

6. $y = -\frac{2}{3}x + 1$

A.



B.



C.

