

1 Numerical Expressions and Factors

- 1.1 Powers and Exponents
- 1.2 Order of Operations
- 1.3 Prime Factorization
- 1.4 Greatest Common Factor
- 1.5 Least Common Multiple

Chapter Learning Target:

Understand factors.

Chapter Success Criteria:

- I can identify factors of a number.
- I can explain order of operations.
- I can solve a problem using factors.
- I can model different types of multiples of numbers.



STEAM Video: "Filling Piñatas"

STEAM Video



Filling Piñatas

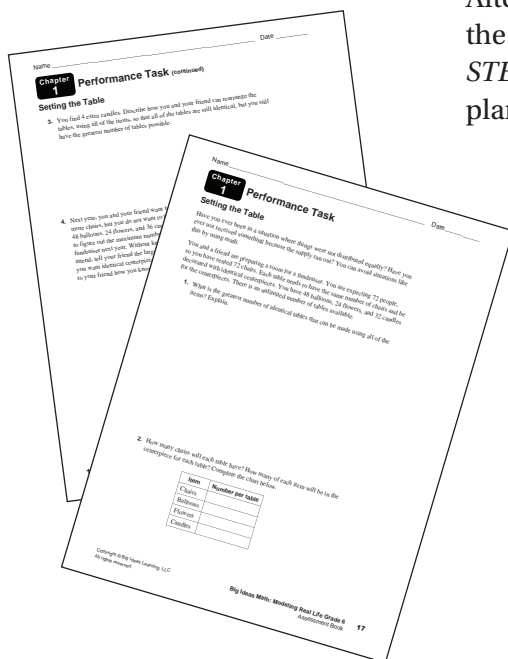
Common factors can be used to make identical groups of objects. Can you think of any situations in which you would want to separate objects into equal groups? Are there any common factors that may be more useful than others? Can you think of any other ways to use common factors?

Watch the STEAM Video “Filling Piñatas.” Then answer the following questions. The table below shows the numbers of party favors that Alex and Enid use to make piñatas.

Party Favor	Taffies	Key Chains	Kazoos	Bubbles	Mints
Number	50	12	16	24	100

1. When finding the number of identical piñatas that can be made, why is it helpful for Alex and Enid to list the factors of each number given in the table?
2. You want to create 6 identical piñatas. How can you change the numbers of party favors in the table to make this happen? Can you do this without changing the total number of party favors?

Performance Task



Setting the Table

After completing this chapter, you will be able to use the concepts you learned to answer the questions in the *STEAM Video Performance Task*. You will be asked to plan a fundraising event with the items below.

72 chairs

48 balloons

24 flowers

32 candles

You will find the greatest number of identical tables that can be prepared, and what will be in each centerpiece. When making arrangements for a party, should a party planner always use the greatest number of identical tables possible? Explain why or why not.

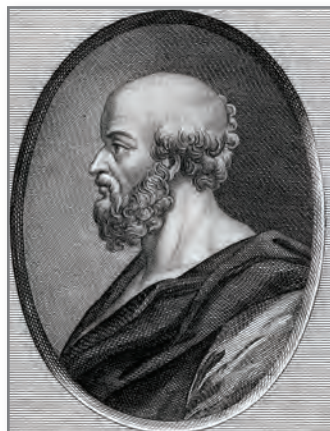
Getting Ready for Chapter 1

1

Chapter Exploration

Work with a partner. In Exercises 1–3, use the table.

	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100



Eratosthenes
(c. 276–c. 194 B.C.)

This table is called the *Sieve of Eratosthenes*. Eratosthenes was a Greek mathematician who was the chief librarian at the Library of Alexandria in Egypt. He was the first person to calculate the circumference of Earth.

1. Cross out the multiples of 2 that are greater than 2. Do the same for 3, 5, and 7.
2. The numbers that are *not* crossed out are called *prime numbers*. The numbers that are crossed out are called *composite numbers*. In your own words, describe the characteristics of prime numbers and composite numbers.
3. **MODELING REAL LIFE** Work with a partner. Cicadas are insects that live underground and emerge from the ground after x or $x + 4$ years. Is it possible that both x and $x + 4$ are prime? Give some examples.

Vocabulary

The following vocabulary terms are defined in this chapter. Think about what each term might mean and record your thoughts.

exponent

numerical expression

order of operations

common factors

greatest common factor

common multiples

least common multiple

1.1 Powers and Exponents

Learning Target: Write and evaluate expressions involving exponents.

- Success Criteria:**
- I can write products of repeated factors as powers.
 - I can evaluate powers.

EXPLORATION 1

Writing Expressions Using Exponents

Work with a partner. Copy and complete the table.

Repeated Factors	Using an Exponent	Value
a. 10×10		
b. 4×4		
c. 6×6		
d. $10 \times 10 \times 10$		
e. $100 \times 100 \times 100$		
f. $3 \times 3 \times 3 \times 3$		
g. $4 \times 4 \times 4 \times 4 \times 4$		
h. $2 \times 2 \times 2 \times 2 \times 2 \times 2$		

Math Practice

Repeat Calculations

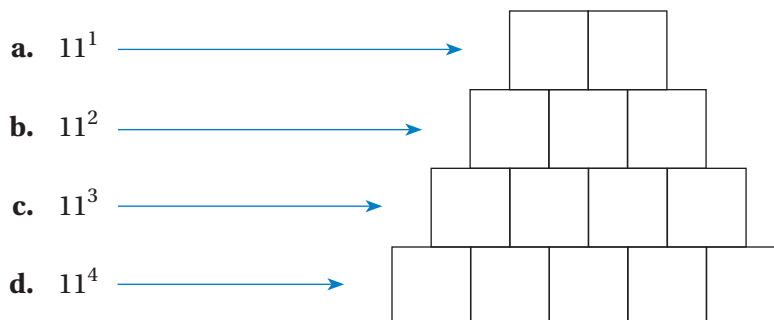
What patterns do you notice in the expressions? How does this help you write exponents?

- i. In your own words, describe what the two numbers in the expression 3^5 mean.

EXPLORATION 2

Using a Calculator to Find a Pattern

Work with a partner. Copy the diagram. Use a calculator to find each value. Write one digit of the value in each box. Describe the pattern in the digits of the values.

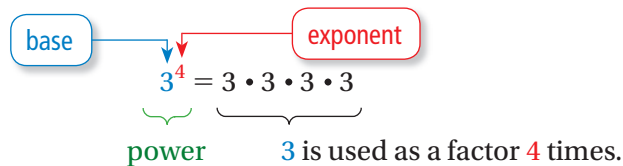


1.1 Lesson

Key Vocabulary

power, p. 4
base, p. 4
exponent, p. 4
perfect square, p. 5

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



Remember

You can use the dot symbol \cdot to indicate multiplication. For example, the product of 3 and 5 can be expressed as 3×5 or $3 \cdot 5$.

Power	Words
3^2	Three <i>squared</i> , or three to the second
3^3	Three <i>cubed</i> , or three to the third
3^4	Three to the fourth
3^5	Three to the fifth

EXAMPLE 1 Writing Expressions as Powers

Write each product as a power.

a. $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$

Because 7 is used as a factor 5 times, its exponent is 5.

▶ So, $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 = 7^5$.

b. $12 \times 12 \times 12$

Because 12 is used as a factor 3 times, its exponent is 3.

▶ So, $12 \times 12 \times 12 = 12^3$.

c. $100 \times 100 \times 100 \times 100 \times 100 \times 100$

Because 100 is used as a factor 6 times, its exponent is 6.

▶ So, $100 \times 100 \times 100 \times 100 \times 100 \times 100 = 100^6$.

Try It Write the product as a power.

1. $2 \times 2 \times 2$

2. $6 \cdot 6 \cdot 6 \cdot 6 \cdot 6 \cdot 6$

3. $15 \times 15 \times 15 \times 15$

4. $20 \cdot 20 \cdot 20 \cdot 20 \cdot 20 \cdot 20 \cdot 20$

EXAMPLE 2

Finding Values of Powers

Find the value of each power.

a. 7^2

$$\begin{aligned} 7^2 &= 7 \cdot 7 && \text{Write as repeated multiplication.} \\ &= 49 && \text{Simplify.} \end{aligned}$$

b. 5^3

$$\begin{aligned} 5^3 &= 5 \cdot 5 \cdot 5 \\ &= 125 \end{aligned}$$

Try It Find the value of the power.

5. 6^3

6. 9^2

7. 3^4

8. 18^2

The square of a whole number is a **perfect square**.

EXAMPLE 3

Identifying Perfect Squares

Determine whether each number is a perfect square.

a. 64

▶ Because $8^2 = 64$, 64 is a perfect square.

b. 20

▶ No whole number squared equals 20. So, 20 is not a perfect square.

Try It Determine whether the number is a perfect square.

9. 25

10. 2

11. 99

12. 36



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

FINDING VALUES OF POWERS Find the value of the power.

13. 8^2

14. 3^5

15. 11^3

16. **VOCABULARY** How are exponents and powers different?

17. **VOCABULARY** Is 10 a perfect square? Is 100 a perfect square? Explain.

18. **WHICH ONE DOESN'T BELONG?** Which one does *not* belong with the other three? Explain your reasoning.

$$2^4 = 2 \times 2 \times 2 \times 2$$

$$3^2 = 3 \times 3$$

$$3 + 3 + 3 + 3 = 3 \times 4$$

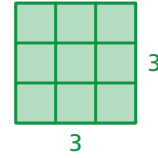
$$5 \cdot 5 \cdot 5 = 5^3$$

Remember



The area of a figure is the amount of surface it covers. Area is measured in square units.

You can use powers to find areas of squares. The area of a square is equal to its side length squared.



$$\text{Area} = 3^2 = 9 \text{ square units}$$

EXAMPLE 4 Modeling Real Life

A life-size MONOPOLY® game board is a square with a side length of 11 yards. What is the area of the game board?

Use a verbal model to solve the problem.

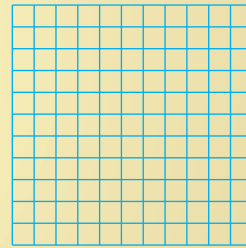
$$\begin{aligned} \text{Area of game board} &= (\text{Side length})^2 \\ &= 11^2 && \text{Substitute 11 for side length.} \\ &= 121 && \text{Multiply.} \end{aligned}$$

▶ The area of the game board is 121 square yards.

Check

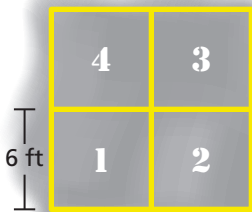
Count the number of squares in an 11×11 grid.

There are 121 squares. ✓



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.



- A square solar panel has an area of 16 square feet. Write the area as a power. Then find the side lengths of the panel.
- The four-square court shown is a square made up of four identical smaller squares. What is the area of the court?
- DIG DEEPER!** Each face of a number cube is a square with a side length of 16 millimeters. What is the total area of all of the faces of the number cube?

1.1 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Multiply.

1. 150×2

2. 175×8

3. 123×3

4. 151×9

Write the sentence as a numerical expression.

5. Add 5 and 8, then multiply by 4.

6. Subtract 7 from 11, then divide by 2.

Round the number to the indicated place value.

7. 4.03785 to the tenths

8. 12.89503 to the hundredths

Complete the sentence.

9. $\frac{1}{10}$ of 30 is .

10. $\frac{4}{5}$ of 25 is .

► Concepts, Skills, & Problem Solving

WRITING EXPRESSIONS USING EXPONENTS Copy and complete the table.

(See Exploration 1, p. 3.)

Repeated Factors	Using an Exponent	Value
11. 8×8		
12. $4 \times 4 \times 4$		
13. $9 \times 9 \times 9 \times 9$		
14. $12 \times 12 \times 12 \times 12$		

WRITING EXPRESSIONS AS POWERS Write the product as a power.

15. 9×9

16. 13×13

17. $15 \times 15 \times 15$

18. $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

19. $14 \times 14 \times 14$

20. $8 \cdot 8 \cdot 8 \cdot 8$

21. $11 \times 11 \times 11 \times 11 \times 11$

22. $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$

23. $16 \cdot 16 \cdot 16 \cdot 16$

24. $43 \times 43 \times 43 \times 43 \times 43$

25. $167 \cdot 167 \cdot 167$

26. $245 \cdot 245 \cdot 245 \cdot 245$

FINDING VALUES OF POWERS Find the value of the power.

27. 5^2

28. 4^3

29. 6^2

30. 1^7

31. 0^3

32. 8^4

33. 2^4

34. 12^2

35. 7^3

36. 5^4

37. 2^5

38. 14^2

USING TOOLS Use a calculator to find the value of the power.

39. 7^6

40. 4^8

41. 12^4

42. 17^5

43. **YOU BE THE TEACHER** Your friend finds the value of 8^3 . Is your friend correct? Explain your reasoning.

$$8^3 = 8 \cdot 3 = 24$$

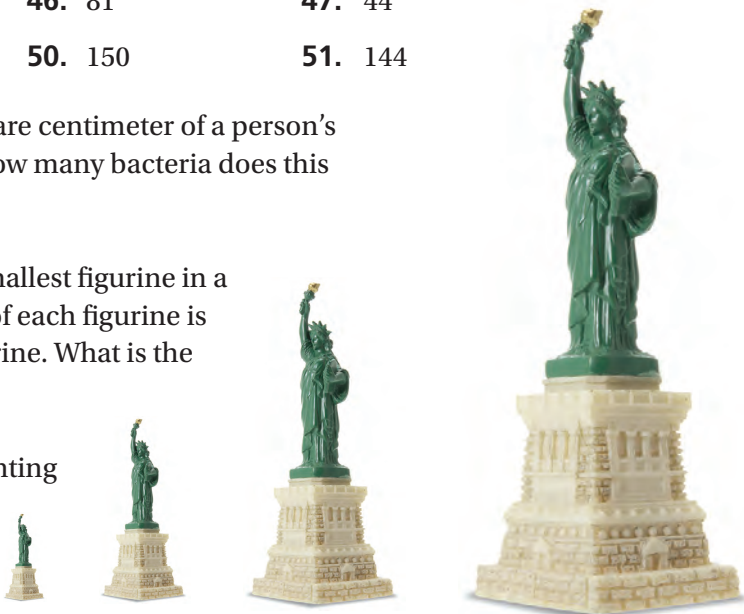
IDENTIFYING PERFECT SQUARES Determine whether the number is a perfect square.

44. 8 45. 4 46. 81 47. 44
 48. 49 49. 125 50. 150 51. 144

52. **MODELING REAL LIFE** On each square centimeter of a person's skin, there are about 39^2 bacteria. How many bacteria does this expression represent?

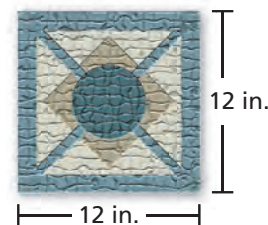
53. **MP REPEATED REASONING** The smallest figurine in a gift shop is 2 inches tall. The height of each figurine is twice the height of the previous figurine. What is the height of the tallest figurine?

54. **MODELING REAL LIFE** A square painting measures 2 meters on each side. What is the area of the painting in square centimeters?



55. **MP NUMBER SENSE** Write three powers that have values greater than 120 and less than 130.

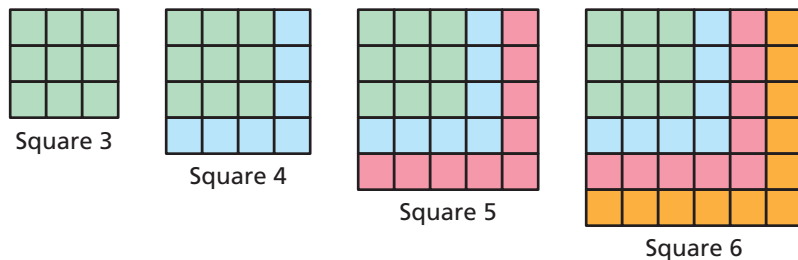
56. **DIG DEEPER!** A landscaper has 125 tiles to build a square patio. The patio must have an area of at least 80 square feet.
- What are the possible arrangements for the patio?
 - How many tiles are not used in each arrangement?



57. **MP PATTERNS** Copy and complete the table. Describe what happens to the value of the power as the exponent decreases. Use this pattern to find the value of 4^0 .

Power	4^6	4^5	4^4	4^3	4^2	4^1
Value	4096	1024				

58. **MP REPEATED REASONING** How many blocks do you need to add to Square 6 to get Square 7? to Square 9 to get Square 10? to Square 19 to get Square 20? Explain.



1.2 Order of Operations

Learning Target: Write and evaluate numerical expressions using the order of operations.

- Success Criteria:**
- I can explain why there is a need for a standard order of operations.
 - I can evaluate numerical expressions involving several operations, exponents, and grouping symbols.
 - I can write numerical expressions involving exponents to represent a real-life problem.

EXPLORATION 1

Comparing Different Orders

Work with a partner. Find the value of each expression by using different orders of operations. Are your answers the same?

- | | |
|-----------------------------|--------------------------|
| a. Add, then multiply. | Multiply, then add. |
| $3 + 2 \times 2$ | $3 + 2 \times 2$ |
| b. Subtract, then multiply. | Multiply, then subtract. |
| $18 - 3 \cdot 3$ | $18 - 3 \cdot 3$ |
| c. Multiply, then subtract. | Subtract, then multiply. |
| $8 \times 8 - 2$ | $8 \times 8 - 2$ |
| d. Multiply, then add. | Add, then multiply. |
| $6 \cdot 6 + 2$ | $6 \cdot 6 + 2$ |

EXPLORATION 2

Determining Order of Operations

Work with a partner.

- Scientific calculators use a standard order of operations when evaluating expressions. Why is a standard order of operations needed?
- Use a scientific calculator to evaluate each expression in Exploration 1. Enter each expression exactly as written. For each expression, which order of operations is correct?
- What order of operations should be used to evaluate $3 + 2^2$, $18 - 3^2$, $8^2 - 2$, and $6^2 + 2$?
- Do $18 \div 3 \cdot 3$ and $18 \div 3^2$ have the same value? Justify your answer.
- How does evaluating powers fit into the order of operations?



Math Practice

Use Technology to Explore

How does a scientific calculator help you explore order of operations?

1.2 Lesson

Key Vocabulary

numerical expression,
p. 10
evaluate, p. 10
order of operations,
p. 10

A **numerical expression** is an expression that contains numbers and operations. To **evaluate**, or find the value of, a numerical expression, use a set of rules called the **order of operations**.

Key Idea

Order of Operations

1. Perform operations in grouping symbols.
2. Evaluate numbers with exponents.
3. Multiply and divide from left to right.
4. Add and subtract from left to right.

EXAMPLE 1 Using Order of Operations

- a. Evaluate $12 - 2 \times 4$.

$$\begin{aligned} 12 - 2 \times 4 &= 12 - 8 \\ &= 4 \end{aligned}$$

Multiply 2 and 4.
Subtract 8 from 12.

- b. Evaluate $60 \div [(4 + 2) \times 5]$.


$$\begin{aligned} 60 \div [(4 + 2) \times 5] &= 60 \div [6 \times 5] \\ &= 60 \div 30 \\ &= 2 \end{aligned}$$

Perform operation in parentheses.
Perform operation in brackets.
Divide 60 by 30.

Try It Evaluate the expression.

1. $7 \cdot 5 + 3$
2. $(28 - 20) \div 4$
3. $[6 + (15 - 10)] \times 5$

EXAMPLE 2 Using Order of Operations with Exponents

 Remember to multiply and divide from left to right. In Example 2, you should divide before multiplying because the division symbol comes first when reading from left to right.

Evaluate $30 \div (7 + 2^3) \times 6$.

$$\begin{aligned} 30 \div (7 + 2^3) \times 6 &= 30 \div (7 + 8) \times 6 \\ &= 30 \div 15 \times 6 \\ &= 2 \times 6 \\ &= 12 \end{aligned}$$

Evaluate power in parentheses.
Perform operation in parentheses.
Divide 30 by 15.
Multiply 2 and 6.

Try It Evaluate the expression.

4. $6 + 2^4 - 1$
5. $4 \cdot 3^2 + 18 - 9$
6. $16 + (5^2 - 7) \div 3$

The symbols \times and \cdot are used to indicate multiplication. You can also use parentheses to indicate multiplication. For example, $3(2 + 7)$ is the same as $3 \times (2 + 7)$.

EXAMPLE 3 Using Order of Operations

Remember

You can interpret a fraction as division of the numerator by the denominator.

$$\frac{a}{b} = a \div b$$



a. Evaluate $9 + \frac{8 - 2}{3}$.

$$\begin{aligned} 9 + \frac{8 - 2}{3} &= 9 + (8 - 2) \div 3 \\ &= 9 + 6 \div 3 \\ &= 9 + 2 \\ &= 11 \end{aligned}$$

Rewrite fraction as division.

Perform operation in parentheses.

Divide 6 by 3.

Add 9 and 2.

b. Evaluate $10 - 8(13 + 7) \div 4^2$.

$$\begin{aligned} 10 - 8(13 + 7) \div 4^2 &= 10 - 8(20) \div 4^2 \\ &= 10 - 8(20) \div 16 \\ &= 10 - 160 \div 16 \\ &= 10 - 10 \\ &= 0 \end{aligned}$$

Perform operation in parentheses.

Evaluate 4^2 .

Multiply 8 and 20.

Divide 160 by 16.

Subtract 10 from 10.

Try It Evaluate the expression.

7. $50 + 6(12 \div 4) - 8^2$ 8. $5^2 - \frac{1}{5}(10 - 5)$ 9. $\frac{8(2 + 5)}{7}$



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

USING ORDER OF OPERATIONS Evaluate the expression.

10. $7 + 2 \cdot 4$

11. $8 \div 4 \times 2$

12. $3(5 + 1) \div 3^2$

13. **WRITING** Why does $12 - 8 \div 2 = 8$, but $(12 - 8) \div 2 = 2$?

14. **MP REASONING** Describe the steps in evaluating the expression $8 \div (6 - 4) + 3^2$.

15. **WHICH ONE DOESN'T BELONG?** Which expression does *not* belong with the other three? Explain your reasoning.

$$5^2 - 8 \times 2$$

$$5^2 - (8 \times 2)$$

$$5^2 - 2 \times 8$$

$$(5^2 - 8) \times 2$$

EXAMPLE 4

Modeling Real Life

The diagram shows landing zones for skydivers. Zone 1 is for experts. The remaining space is divided in half and designated as Zones 2 and 3 for tandem divers. What is the area of Zone 2?

Understand the problem.

You are given the dimensions of landing zones and that the areas of Zones 2 and 3 are equal. You are asked to find the area of Zone 2.

Make a plan.

Use a verbal model to write an expression. Subtract the area of Zone 1 from the total area to find the combined area of Zones 2 and 3. Then multiply the combined area by one-half.

Solve and check.

Verbal Model

$$\text{One-half} \left(\text{Total area} - \text{Area of Zone 1} \right)$$

Expression

$$\frac{1}{2} \left(40^2 - 20^2 \right)$$

$$\frac{1}{2} (40^2 - 20^2) = \frac{1}{2} (1600 - 400)$$

Evaluate powers in parentheses.

$$= \frac{1}{2} (1200)$$

Perform operation in parentheses.

$$= 600$$

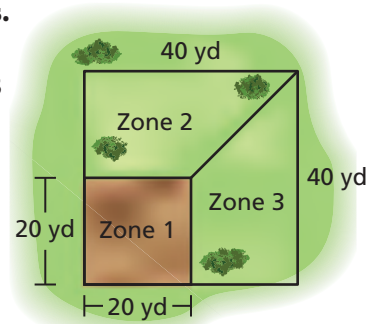
Multiply $\frac{1}{2}$ and 1200.

Check Verify that the areas of the three zones have a sum equal to the total area.

$$400 + 600 + 600 \stackrel{?}{=} 1600$$

$$1600 = 1600 \quad \checkmark$$

The area of Zone 2 is 600 square yards.

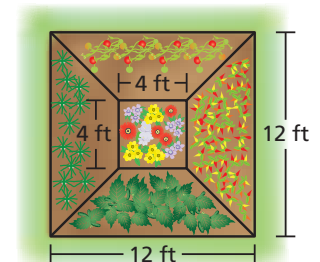


Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

- A square plot of land has side lengths of 40 meters. An archaeologist divides the land into 64 equal parts. What is the area of each part?
- A glass block window is made of two different-sized glass squares. The window has side lengths of 40 inches. The large glass squares have side lengths of 10 inches. Find the total area of the small glass squares.

- DIG DEEPER!** A square vegetable garden has side lengths of 12 feet. You plant flowers in the center portion as shown. You divide the remaining space into 4 equal sections and plant tomatoes, onions, zucchini, and peppers. What is the area of the onion section?



1.2 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

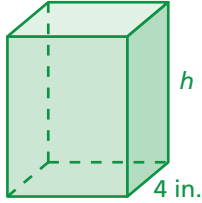
► Review & Refresh

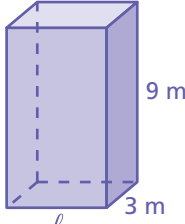
Write the product as a power.

1. $11 \times 11 \times 11 \times 11$

2. $13 \times 13 \times 13 \times 13 \times 13$

Find the missing dimension of the rectangular prism.

3. 
Volume = 192 in.^3

4. 
Volume = 135 m^3

Tell whether the number is prime or composite.

5. 9

6. 11

7. 23

► Concepts, Skills, & Problem Solving

COMPARING DIFFERENT ORDERS Find the value of the expression by using different orders of operations. Are your answers the same? (See Exploration 1, p. 9.)

8. Add, then multiply. Multiply, then add.

$$4 + 6 \times 6$$

$$4 + 6 \times 6$$

9. Subtract, then multiply. Multiply, then subtract.

$$5 \times 5 - 3$$

$$5 \times 5 - 3$$

USING ORDER OF OPERATIONS Evaluate the expression.

10. $5 + 18 \div 6$

11. $(11 - 3) \div 2 + 1$

12. $45 \div 9 \times 12$

13. $6^2 - 3 \cdot 4$

14. $42 \div (15 - 2^3)$

15. $4^2 \cdot 2 + 8 \cdot 7$

16. $(5^2 - 2) \times 1^5 + 4$

17. $4 + 2 \times 3^2 - 9$

18. $8 \div 2 \times 3 + 4^2 \div 4$

19. $3^2 + 12 \div (6 - 3) \times 8$

20. $(10 + 4) \div (26 - 19)$

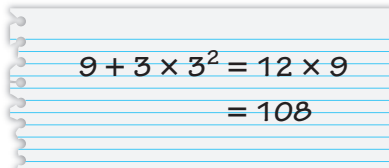
21. $(5^2 - 4) \cdot 2 - 18$

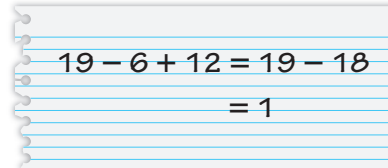
22. $2 \times [(16 - 8) \times 2]$

23. $12 + 8 \times 3^3 - 24$

24. $6^2 \div [(2 + 4) \times 2^3]$

YOU BE THE TEACHER Your friend evaluates the expression. Is your friend correct? Explain your reasoning.

25. 
$$9 + 3 \times 3^2 = 12 \times 9$$
$$= 108$$

26. 
$$19 - 6 + 12 = 19 - 18$$
$$= 1$$

27. **MP PROBLEM SOLVING** You need to read 20 poems in 5 days for an English project. Each poem is 2 pages long. Evaluate the expression $20 \times 2 \div 5$ to find how many pages you need to read each day.

USING ORDER OF OPERATIONS Evaluate the expression.

28. $12 - 2(7 - 4)$

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

30. $6 + \frac{1}{4}(12 - 8)$

31. $9^2 - 8(6 + 2)$

32. $4(3 - 1)^3 + 7(6) - 5^2$

33. $8 \left[\left(1\frac{1}{6} + \frac{5}{6} \right) \div 4 \right]$

34. $7^2 - 2 \left(\frac{11}{8} - \frac{3}{8} \right)$

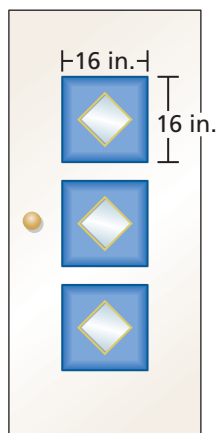
35. $8(7.3 + 3.7 - 8) \div 2$

36. $2^4(5.2 - 3.2) \div 4$

37. $\frac{6^2(3 + 5)}{4}$

38. $\frac{12^2 - 4(6) + 1}{11^2}$

39. $\frac{26 \div 2 + 5}{3^2 - 3}$

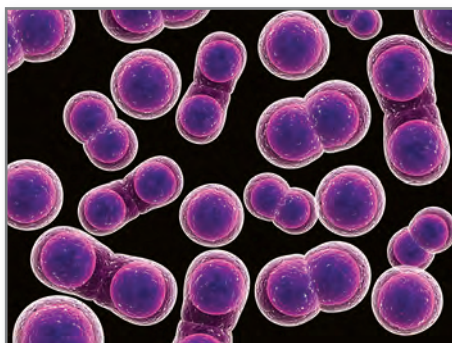


40. **MP PROBLEM SOLVING** Before a show, there are 8 people in a theater. Five groups of 4 people enter, and then three groups of 2 people leave. Evaluate the expression $8 + 5(4) - 3(2)$ to find how many people are in the theater.

41. **MODELING REAL LIFE** The front door of a house is painted white and blue. Each window is a square with a side length of 7 inches. What is the area of the door that is painted blue?

42. **MP PROBLEM SOLVING** You buy 6 notebooks, 10 folders, 1 pack of pencils, and 1 lunch box for school. After using a \$10 gift card, how much do you owe? Explain how you solved the problem.

43. **OPEN-ENDED** Use all four operations and at least one exponent to write an expression that has a value of 100.



44. **MP REPEATED REASONING** A Petri dish contains 35 cells. Every day, each cell in the Petri dish divides into 2 cells in a process called *mitosis*. How many cells are there after 14 days? Justify your answer.

45. **MP REASONING** Two groups collect litter along the side of a road. It takes each group 5 minutes to clean up a 200-yard section. How long does it take both groups working together to clean up 2 miles? Explain how you solved the problem.

46. **MP NUMBER SENSE** Copy each statement. Insert +, −, ×, or ÷ symbols to make each statement true.

a. $27 \square 3 \square 5 \square 2 = 19$

b. $9^2 \square 11 \square 8 \square 4 \square 1 = 60$

c. $5 \square 6 \square 15 \square 9 = 24$

d. $14 \square 2 \square 7 \square 3 \square 9 = 10$

1.3 Prime Factorization

Learning Target: Write a number as a product of prime factors and represent the product using exponents.

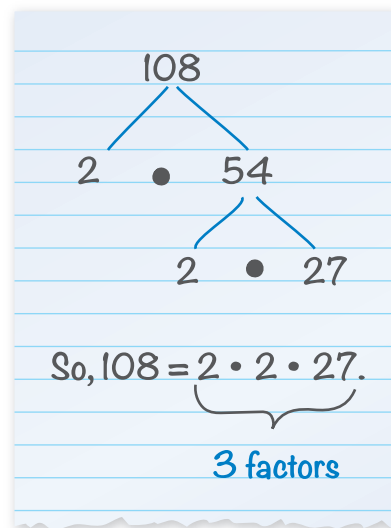
- Success Criteria:**
- I can find factor pairs of a number.
 - I can explain the meanings of prime and composite numbers.
 - I can create a factor tree to find the prime factors of a number.
 - I can write the prime factorization of a number.

EXPLORATION 1

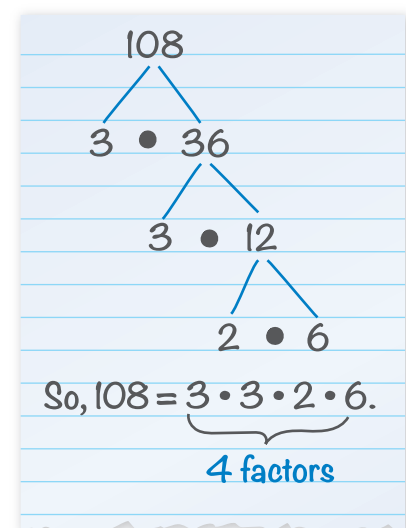
Rewriting Numbers as Products of Factors

Work with a partner. Two students use *factor trees* to write 108 as a product of factors, as shown below.

Student A



Student B



- a. Without using 1 as a factor, can you write 108 as a product with more factors than each student used? Justify your answer.

Math Practice

Interpret Results

How do you know your answer makes sense?

- b. Use factor trees to write 80, 162, and 300 as products of as many factors as possible. Do not use 1 as a factor.



- c. Compare your results in parts (a) and (b) with other groups. For each number, identify the product with the greatest number of factors. What do these factors have in common?



1.3 Lesson

Because 2 is a factor of 10 and $2 \cdot 5 = 10$, 5 is also a factor of 10. The pair 2, 5 is called a **factor pair** of 10.

EXAMPLE 1 Finding Factor Pairs

Key Vocabulary

factor pair, p. 16
prime factorization,
p. 16
factor tree, p. 16

When making an organized list of factor pairs, stop finding pairs when the factors begin to repeat.

The brass section of a marching band has 30 members. The band director arranges the brass section in rows. Each row has the same number of members. How many possible arrangements are there?



Use the factor pairs of 30 to find the number of arrangements.

$30 = 1 \cdot 30$ There could be 1 row of 30 or 30 rows of 1.

$30 = 2 \cdot 15$ There could be 2 rows of 15 or 15 rows of 2.

$30 = 3 \cdot 10$ There could be 3 rows of 10 or 10 rows of 3.

$30 = 5 \cdot 6$ There could be 5 rows of 6 or 6 rows of 5.

$30 = 6 \cdot 5$ The factors 5 and 6 are already listed.

There are 8 possible arrangements: 1 row of 30, 30 rows of 1, 2 rows of 15, 15 rows of 2, 3 rows of 10, 10 rows of 3, 5 rows of 6, or 6 rows of 5.

Try It List the factor pairs of the number.

1. 18 2. 24 3. 51

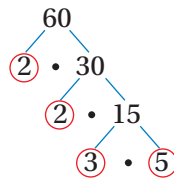
4. **WHAT IF?** The woodwinds section of the marching band has 38 members. Which has more possible arrangements, the brass section or the woodwinds section? Explain.

Key Idea

Prime Factorization

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. A factor tree for 60 is shown.



$$60 = 2 \cdot 2 \cdot 3 \cdot 5, \text{ or } 2^2 \cdot 3 \cdot 5$$

Remember

A **prime number** is a whole number greater than 1 with exactly two factors, 1 and itself. A **composite number** is a whole number greater than 1 with factors in addition to 1 and itself.

EXAMPLE 2

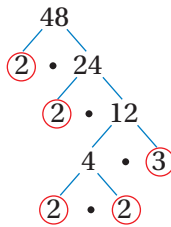
Writing a Prime Factorization

Write the prime factorization of 48.

Choose any factor pair of 48 to begin the factor tree.

Notice that beginning with different factor pairs results in the same prime factorization. Every composite number has only one prime factorization.

Tree 1



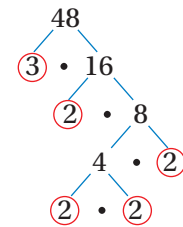
$$48 = 2 \cdot 2 \cdot 3 \cdot 2 \cdot 2$$

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



$$48 = 3 \cdot 2 \cdot 2 \cdot 2 \cdot 2$$

The prime factorization of 48 is $2 \cdot 2 \cdot 2 \cdot 2 \cdot 3$, or $2^4 \cdot 3$.

Try It Write the prime factorization of the number.

5. 20

6. 88

7. 90

8. 462



Self-Assessment for Concepts & Skills

Solve each exercise. Then rate your understanding of the success criteria in your journal.

WRITING A PRIME FACTORIZATION Write the prime factorization of the number.

9. 14

10. 86

11. 40

12. 516

13. **WRITING** Explain the difference between prime numbers and composite numbers.

14. **MP STRUCTURE** Your friend lists the following factor pairs and concludes that there are 6 factor pairs of 12. Explain why your friend is incorrect.

1, 12

2, 6

3, 4

12, 1

6, 2

4, 3

15. **WHICH ONE DOESN'T BELONG?** Which factor pair does *not* belong with the other three? Explain your reasoning.

2, 28

4, 14

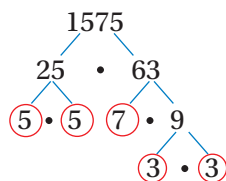
6, 9

7, 8

EXAMPLE 3 Using a Prime Factorization

What is the greatest perfect square that is a factor of 1575?

Because 1575 has many factors, it is not efficient to list all of its factors and check for perfect squares. Use a factor tree to write the prime factorization of 1575. Then analyze the prime factors to find perfect square factors.



$$1575 = 3 \cdot 3 \cdot 5 \cdot 5 \cdot 7$$

The prime factorization shows that 1575 has three factors other than 1 that are perfect squares.

$$3 \cdot 3 = 9$$

$$5 \cdot 5 = 25$$

$$(3 \cdot 5) \cdot (3 \cdot 5) = 15 \cdot 15 = 225$$

► So, the greatest perfect square that is a factor of 1575 is 225.



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

16. A group of 20 friends plays a card game. The game can be played with 2 or more teams of equal size. Each team must have at least 2 members. List the possible numbers and sizes of teams.
17. You arrange 150 chairs in rows for a school play. You want each row to have the same number of chairs. How many possible arrangements are there? Are all of the possible arrangements appropriate for the play? Explain.
18. What is the least perfect square that is a factor of 4536? What is the greatest perfect square that is a factor of 4536?
19. **DIG DEEPER!** The prime factorization of a number is $2^4 \times 3^4 \times 5^4 \times 7^2$. Is the number a perfect square? Explain your reasoning.



1.3 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Evaluate the expression.

1. $2 + 4^2(5 - 3)$

2. $2^3 + 4 \times 3^2$

3. $9 \times 5 - 2^4 \left(\frac{5}{2} - \frac{1}{2} \right)$

Plot the points in a coordinate plane. Draw a line segment connecting the points.

4. (1, 1) and (4, 3)

5. (2, 3) and (5, 9)

6. (2, 5) and (4, 8)

Use the Distributive Property to find the quotient. Justify your answer.

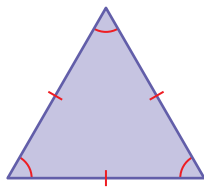
7. $408 \div 4$

8. $628 \div 2$

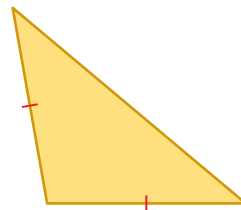
9. $969 \div 3$

Classify the triangle in as many ways as possible.

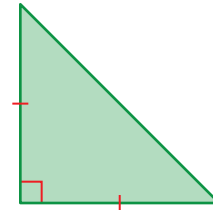
10.



11.



12.



► Concepts, Skills, & Problem Solving

REWRITING A NUMBER Write the number as a product of as many factors as possible. (See Exploration 1, p. 15.)

13. 60

14. 63

15. 120

16. 150

FINDING FACTOR PAIRS List the factor pairs of the number.

17. 15

18. 22

19. 34

20. 39

21. 45

22. 54

23. 59

24. 61

25. 100

26. 58

27. 25

28. 76

29. 52

30. 88

31. 71

32. 91

WRITING A PRIME FACTORIZATION Write the prime factorization of the number.

33. 16

34. 25

35. 30

36. 26

37. 84

38. 54

39. 65

40. 77

41. 46

42. 39

43. 99

44. 24

45. 315

46. 490

47. 140

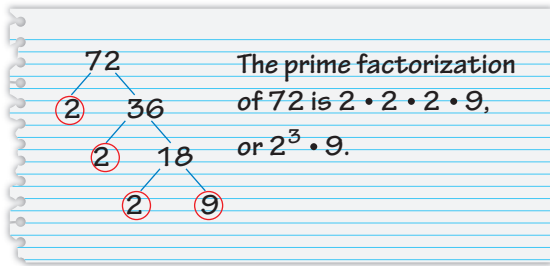
48. 640

USING A PRIME FACTORIZATION Find the number represented by the prime factorization.

49. $2^2 \cdot 3^2 \cdot 5$

50. $3^2 \cdot 5^2 \cdot 7$

51. $2^3 \cdot 11^2 \cdot 13$



52. **YOU BE THE TEACHER** Your friend finds the prime factorization of 72. Is your friend correct? Explain your reasoning.

USING A PRIME FACTORIZATION Find the greatest perfect square that is a factor of the number.

53. 250 54. 275 55. 392 56. 338
 57. 244 58. 650 59. 756 60. 1290
 61. 2205 62. 1890 63. 495 64. 4725

65. **VOCABULARY** A botanist separates plants into equal groups of 5 for an experiment. Is the total number of plants in the experiment *prime* or *composite*? Explain.

66. **MP REASONING** A teacher divides 36 students into equal groups for a scavenger hunt. Each group should have at least 4 students but no more than 8 students. What are the possible group sizes?

67. **CRITICAL THINKING** Is 2 the only even prime number? Explain.

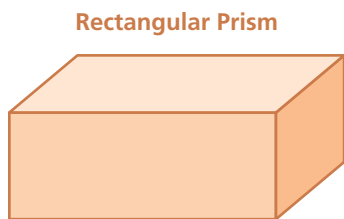
68. **MP LOGIC** One table at a bake sale has 75 cookies. Another table has 60 cupcakes. Which table allows for more rectangular arrangements? Explain.



69. **PERFECT NUMBERS** A *perfect number* is a number that equals the sum of its factors, not including itself. For example, the factors of 28 are 1, 2, 4, 7, 14, and 28. Because $1 + 2 + 4 + 7 + 14 = 28$, 28 is a perfect number. What are the perfect numbers between 1 and 27?

70. **MP REPEATED REASONING** Choose any two perfect squares and find their product. Then multiply your answer by another perfect square. Continue this process. Are any of the products perfect squares? What can you conclude?

71. **MP PROBLEM SOLVING** The stage manager of a school play creates a rectangular stage that has whole number dimensions and an area of 42 square yards. String lights will outline the stage. What is the least number of yards of string lights needed to enclose the stage?



Rectangular Prism

Volume = 40 cubic inches

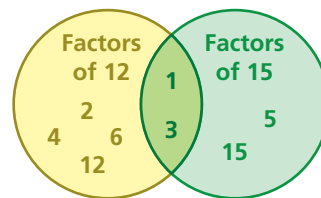
72. **DIG DEEPER!** Consider the rectangular prism shown. Using only whole number dimensions, how many different prisms are possible? Explain.

1.4 Greatest Common Factor

Learning Target: Find the greatest common factor of two numbers.

- Success Criteria:**
- I can explain the meaning of factors of a number.
 - I can use lists of factors to identify the greatest common factor of numbers.
 - I can use prime factors to identify the greatest common factor of numbers.

A **Venn diagram** uses circles to describe relationships between two or more sets. The Venn diagram shows the factors of 12 and 15. Numbers that are factors of both 12 and 15 are represented by the overlap of the two circles.



EXPLORATION 1

Identifying Common Factors

Work with a partner. In parts (a)–(d), create a Venn diagram that represents the factors of each number and identify any *common factors*.

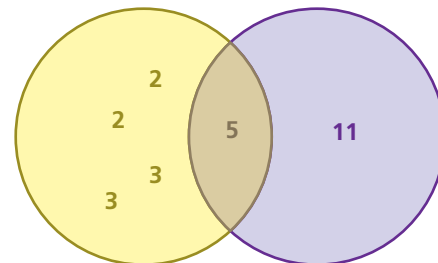
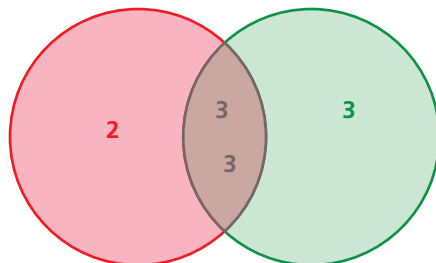
- 36 and 48
 - 16 and 56
 - 30 and 75
 - 54 and 90
- e. Look at the Venn diagrams in parts (a)–(d). Explain how to identify the *greatest common factor* of each pair of numbers. Then circle it in each diagram.

EXPLORATION 2

Using Prime Factors

Work with a partner.

- Each Venn diagram represents the prime factorizations of two numbers. Identify each pair of numbers. Explain your reasoning.



- Create a Venn diagram that represents the prime factorizations of 36 and 48.
- Repeat part (b) for the remaining number pairs in Exploration 1.
- MP STRUCTURE** Make a conjecture about the relationship between the greatest common factors you found in Exploration 1 and the numbers in the overlaps of the Venn diagrams you just created.

Math Practice

Interpret a Solution

What does the diagram representing the prime factorizations mean?

1.4 Lesson

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). One way to find the GCF of two or more numbers is by listing factors.

EXAMPLE 1 Finding the GCF Using Lists of Factors

Find the GCF of 24 and 40.

List the factors of each number.

Factors of 24: ①, ②, 3, ④, 6, ⑧, 12, 24

Circle the common factors.

Factors of 40: ①, ②, ④, 5, ⑧, 10, 20, 40

The common factors of 24 and 40 are 1, 2, 4, and 8. The greatest of these common factors is 8.

▶ So, the GCF of 24 and 40 is 8.

Try It Find the GCF of the numbers using lists of factors.

1. 8, 36

2. 18, 72

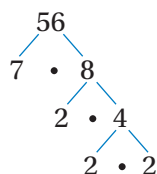
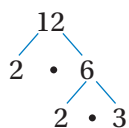
3. 14, 28, 49

Another way to find the GCF of two or more numbers is by using prime factors. The GCF is the product of the common prime factors of the numbers.

EXAMPLE 2 Finding the GCF Using Prime Factorizations

Find the GCF of 12 and 56.

Make a factor tree for each number.



Write the prime factorization of each number.

$$12 = 2 \cdot 2 \cdot 3$$

Circle the common prime factors.

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

$$\begin{array}{c} \uparrow \quad \uparrow \\ 2 \cdot 2 = 4 \end{array}$$

Find the product of the common prime factors.

▶ So, the GCF of 12 and 56 is 4.

Try It Find the GCF of the numbers using prime factorizations.

4. 20, 45

5. 32, 90

6. 45, 75, 120

Key Vocabulary

Venn diagram, p. 21
common factors, p. 22
greatest common factor, p. 22

Examples 1 and 2 show two different methods for finding the GCF. After solving with one method, you can use the other method to check your answer.

EXAMPLE 3**Finding Two Numbers with a Given GCF**

Which pair of numbers has a GCF of 15?

- A. 10, 15 B. 30, 60 C. 21, 45 D. 45, 75

The number 15 cannot be a factor of the lesser number 10. So, you can eliminate Choice A.

The number 15 cannot be a factor of a number that does not have a 0 or 5 in the ones place. So, you can eliminate Choice C.

List the factors for Choices B and D. Then identify the GCF for each.

Choice B: Factors of 30: ①, ②, ③, ⑤, ⑥, ⑩, ⑮, ③①

Factors of 60: ①, ②, ③, 4, ⑤, ⑥, ⑩, 12, ⑮, 20, ③①, 60

The GCF of 30 and 60 is 30.

Choice D: Factors of 45: ①, ③, ⑤, 9, ⑮, 45

Factors of 75: ①, ③, ⑤, ⑮, 25, 75

The GCF of 45 and 75 is 15.

▶ The correct answer is **D**.

Try It

7. Write a pair of numbers whose greatest common factor is 10.

**Self-Assessment for Concepts & Skills**

Solve each exercise. Then rate your understanding of the success criteria in your journal.

FINDING THE GCF Find the GCF of the numbers.

8. 16, 40 9. 35, 63 10. 18, 72, 144

11. **MULTIPLE CHOICE** Which number is *not* a factor of 10? Explain.

- A. 1 B. 2 C. 4 D. 5

12. **DIFFERENT WORDS, SAME QUESTION** Which is different? Find “both” answers.

What is the greatest common factor of 24 and 32?

What is the greatest common divisor of 24 and 32?

What is the greatest common prime factor of 24 and 32?

What is the product of the common prime factors of 24 and 32?

EXAMPLE 4

Modeling Real Life

You are filling piñatas for your friend's birthday party. The list shows the gifts you are putting into the piñatas. You want identical groups of gifts in each piñata with no gifts left over. What is the greatest number of piñatas you can make?

* 18 kazoos

* 24 mints

* 42 lollipops

The GCF of the numbers of gifts represents the greatest number of identical groups of gifts you can make with no gifts left over. So, to find the number of piñatas, find the GCF.

Write the prime factorization of each number.

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

$$24 = 2 \cdot 3 \cdot 2 \cdot 2$$

$$42 = 2 \cdot 3 \cdot 7$$

Circle the common prime factors.

$$2 \cdot 3 = 6$$

Find the product of the common prime factors.

The GCF of 18, 24, and 42 is 6.

► So, you can make at most 6 piñatas.

Check Verify that 6 identical piñatas will use all of the gifts.

$$18 \text{ kazoos} \div 6 \text{ piñatas} = 3 \text{ kazoos per piñata}$$

$$24 \text{ mints} \div 6 \text{ piñatas} = 4 \text{ mints per piñata}$$

$$42 \text{ lollipops} \div 6 \text{ piñatas} = 7 \text{ lollipops per piñata} \quad \checkmark$$



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.

13. You use 30 sandwiches and 42 granola bars to make identical picnic baskets. You make the greatest number of picnic baskets with no food left over. How many sandwiches and how many granola bars are in each basket?
14. You fill bags with cookies to give to your friends. You bake 45 chocolate chip cookies, 30 peanut butter cookies, and 15 oatmeal cookies. You want identical groups of cookies in each bag with no cookies left over. What is the greatest number of bags you can make?



1.4 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

List the factor pairs of the number.

1. 20 2. 16 3. 56 4. 87

Tell whether the statement is *always*, *sometimes*, or *never* true.

5. A rectangle is a rhombus. 6. A rhombus is a square.
7. A square is a rectangle. 8. A trapezoid is a parallelogram.

► Concepts, Skills, & Problem Solving

USING A VENN DIAGRAM Use a Venn diagram to find the greatest common factor of the numbers. (See Exploration 1, p. 21.)

9. 12, 30 10. 32, 54 11. 24, 108

FINDING THE GCF Find the GCF of the numbers using lists of factors.

12. 6, 15 13. 14, 84 14. 45, 76
15. 39, 65 16. 51, 85 17. 40, 63
18. 12, 48 19. 24, 52 20. 30, 58

FINDING THE GCF Find the GCF of the numbers using prime factorizations.

21. 45, 60 22. 27, 63 23. 36, 81
24. 72, 84 25. 61, 73 26. 38, 95
27. 60, 75 28. 42, 60 29. 42, 63
30. 24, 96 31. 189, 200 32. 90, 108

OPEN-ENDED Write a pair of numbers with the indicated GCF.

33. 5 34. 12 35. 37

36. **MODELING REAL LIFE** A teacher is making identical activity packets using 92 crayons and 23 sheets of paper. What is the greatest number of packets the teacher can make with no items left over?

37. **MODELING REAL LIFE** You are making balloon arrangements for a birthday party. There are 16 white balloons and 24 red balloons. Each arrangement must be identical. What is the greatest number of arrangements you can make using every balloon?



YOU BE THE TEACHER Your friend finds the GCF of the two numbers. Is your friend correct? Explain your reasoning.

38.

$42 = 2 \cdot 3 \cdot 7$
 $154 = 2 \cdot 7 \cdot 11$
 The GCF is 7.

39.

$36 = 2^2 \cdot 3^2$
 $60 = 2^2 \cdot 3 \cdot 5$
 The GCF is $2^2 \cdot 3 = 12$.

FINDING THE GCF Find the GCF of the numbers.

40. 35, 56, 63

41. 30, 60, 78

42. 42, 70, 84

43. 40, 55, 72

44. 18, 54, 90

45. 16, 48, 88

46. 52, 78, 104

47. 96, 120, 156

48. 280, 300, 380

49. **OPEN-ENDED** Write three numbers that have a GCF of 16. What method did you use to find your answer?

CRITICAL THINKING Tell whether the statement is *always*, *sometimes*, or *never* true. Explain your reasoning.

50. The GCF of two even numbers is 2. 51. The GCF of two prime numbers is 1.

52. When one number is a multiple of another, the GCF of the numbers is the greater of the numbers.

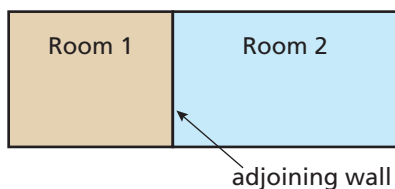
53. **MP PROBLEM SOLVING** A science museum makes gift bags for students using 168 magnets, 48 robot figurines, and 24 packs of freeze-dried ice cream. What is the greatest number of gift bags that can be made using all of the items? How many of each item are in each gift bag?

54. **VENN DIAGRAM** Consider the numbers 252, 270, and 300.

- Create a Venn diagram using the prime factors of the numbers.
- Use the Venn diagram to find the GCF of 252, 270, and 300.
- What is the GCF of 252 and 270? 252 and 300? 270 and 300? Explain how you found your answers.

55. **MP REASONING** You are making fruit baskets using 54 apples, 36 oranges, and 73 bananas.

- Explain why you cannot make identical fruit baskets without leftover fruit.
- What is the greatest number of identical fruit baskets you can make with the least amount of fruit left over? Explain how you found your answer.



56. **DIG DEEPER!** Two rectangular, adjacent rooms share a wall. One-foot-by-one-foot tiles cover the floor of each room. Describe how the greatest possible length of the adjoining wall is related to the total number of tiles in each room. Draw a diagram that represents one possibility.

1.5 Least Common Multiple

Learning Target: Find the least common multiple of two numbers.

- Success Criteria:**
- I can explain the meaning of multiples of a number.
 - I can use lists of multiples to identify the least common multiple of numbers.
 - I can use prime factors to identify the least common multiple of numbers.

EXPLORATION 1

Identifying Common Multiples

Work with a partner. In parts (a)–(d), create a Venn diagram that represents the first several multiples of each number and identify any *common multiples*.

- 8 and 12
 - 4 and 14
 - 10 and 15
 - 20 and 35
- e. Look at the Venn diagrams in parts (a)–(d). Explain how to identify the *least common multiple* of each pair of numbers. Then circle it in each diagram.

EXPLORATION 2

Using Prime Factors

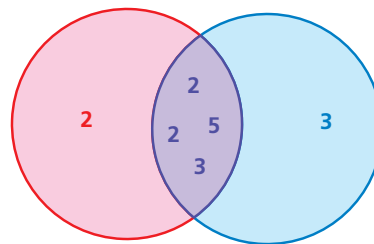
Work with a partner.

- Create a Venn diagram that represents the prime factorizations of 8 and 12.
- Repeat part (a) for the remaining number pairs in Exploration 1.
- MP STRUCTURE** Make a conjecture about the relationship between the least common multiples you found in Exploration 1 and the numbers in the Venn diagrams you just created.
- The Venn diagram shows the prime factors of two numbers.

Math Practice

Analyze Conjectures

How can you test your conjecture in part (c)?



Use the diagram to complete the following tasks.

- Identify the two numbers.
- Find the greatest common factor.
- Find the least common multiple.

1.5 Lesson

Key Vocabulary

common multiples,
p. 28

least common multiple,
p. 28

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)**. You can find the LCM of two or more numbers by listing multiples or using prime factors.

EXAMPLE 1 Finding the LCM Using Lists of Multiples

Find the LCM of 4 and 6.

List the multiples of each number.

Multiples of 4: 4, 8, **12**, 16, 20, **24**, 28, 32, **36**, ... Circle the common multiples.

Multiples of 6: 6, **12**, 18, **24**, 30, **36**, ...

Some common multiples of 4 and 6 are 12, 24, and 36. The least of these common multiples is 12.

▶ So, the LCM of 4 and 6 is 12.

Try It Find the LCM of the numbers using lists of multiples.

1. 3, 8

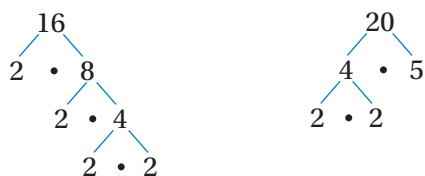
2. 9, 12

3. 6, 10

EXAMPLE 2 Finding the LCM Using Prime Factorizations

Find the LCM of 16 and 20.

Make a factor tree for each number.



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

$$16 = \textcircled{2} \cdot \textcircled{2} \cdot \textcircled{2} \cdot \textcircled{2}$$

2 appears more often here, so circle all 2s.

$$20 = 2 \cdot 2 \cdot \textcircled{5}$$

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

$$2 \cdot 2 \cdot 2 \cdot 2 \cdot 5 = 80$$

Find the product of the circled factors.

▶ So, the LCM of 16 and 20 is 80.

Try It Find the LCM of the numbers using prime factorizations.

4. 14, 18

5. 28, 36

6. 24, 90

EXAMPLE 3**Finding the LCM of Three Numbers**

Find the LCM of 4, 15, and 18.

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

$$4 = 2 \cdot 2$$

2 appears most often here, so circle both 2s.

$$15 = 3 \cdot 5$$

5 appears here only, so circle 5.

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

3 appears most often here, so circle both 3s.

$$2 \cdot 2 \cdot 5 \cdot 3 \cdot 3 = 180$$

Find the product of the circled factors.

▶ So, the LCM of 4, 15, and 18 is 180.

Try It

Find the LCM of the numbers.

7. 2, 5, 8

8. 6, 10, 12

9. Write three numbers that have a least common multiple of 100.

**Self-Assessment for Concepts & Skills**

Solve each exercise. Then rate your understanding of the success criteria in your journal.

FINDING THE LCM Find the LCM of the numbers.

10. 6, 9

11. 30, 40

12. 5, 11

13. **MP REASONING** Write two numbers such that 18 and 30 are multiples of the numbers. Justify your answer.

14. **MP REASONING** You need to find the LCM of 13 and 14. Would you rather list their multiples or use their prime factorizations? Explain.



15. **MP CHOOSE TOOLS** A student writes the prime factorizations of 8 and 12 in a table as shown. She claims she can use the table to find the greatest common factor and the least common multiple of 8 and 12. How is this possible?

8 =	2	2	2		
12 =	2	2		3	

16. **CRITICAL THINKING** How can you use least common multiples to add or subtract fractions with different denominators?

EXAMPLE 4

Modeling Real Life

One firefly flashes every 8 seconds. Another firefly flashes every 10 seconds. Both fireflies just flashed. After how many seconds will both fireflies flash at the same time again?

Understand the problem.

You are given the numbers of seconds between flashes for two different fireflies. You are asked when the fireflies will flash at the same time again.

Make a plan.

The LCM of the numbers of seconds between flashes represents the number of seconds it will take for both fireflies to flash at the same time again. So, find the LCM of 8 and 10 by listing the multiples of each number.

Solve and check.

Multiples of 8: 8, 16, 24, 32, **40**, . . .

Multiples of 10: 10, 20, 30, **40**, 50, . . .

The LCM of 8 and 10 is 40.

So, both fireflies will flash at the same time again after 40 seconds.

Another Method Find the LCM using prime factorizations.

$$8 = 2 \cdot 2 \cdot 2 \quad 10 = 2 \cdot 5$$

So, the LCM is $2 \cdot 2 \cdot 2 \cdot 5 = 40$. ✓



Self-Assessment for Problem Solving

Solve each exercise. Then rate your understanding of the success criteria in your journal.



- A geyser erupts every fourth day. Another geyser erupts every sixth day. Today both geysers erupted. In how many days will both geysers erupt on the same day again?
- A water park has two large buckets that slowly fill with water. One bucket dumps water every 12 minutes. The other bucket dumps water every 10 minutes. Five minutes ago, both buckets dumped water. When will both buckets dump water at the same time again?
- DIG DEEPER!** You purchase disposable plates, cups, and forks for a cookout. Plates are sold in packages of 24, cups in packages of 32, and forks in packages of 48. What are the least numbers of packages you should buy in order to have the same number of plates, cups, and forks?

1.5 Practice



Go to BigIdeasMath.com to get HELP with solving the exercises.

► Review & Refresh

Find the GCF of the numbers.

1. 18, 42

2. 72, 96

3. 38, 76, 114

Divide.

4. $900 \div 6$

5. $1944 \div 9$

6. $672 \div 12$

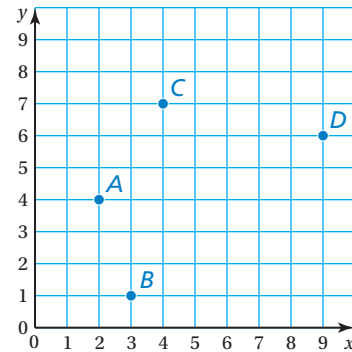
Write an ordered pair that corresponds to the point.

7. Point A

8. Point B

9. Point C

10. Point D



► Concepts, Skills, & Problem Solving

USING A VENN DIAGRAM Use a Venn diagram to find the least common multiple of the numbers. (See Exploration 1, p. 27.)

11. 3, 7

12. 6, 8

13. 4, 5

FINDING THE LCM Find the LCM of the numbers using lists of multiples.

14. 1, 5

15. 2, 6

16. 2, 3

17. 2, 9

18. 3, 4

19. 8, 9

20. 5, 8

21. 11, 12

22. 12, 18

FINDING THE LCM Find the LCM of the numbers using prime factorizations.

23. 7, 12

24. 5, 9

25. 4, 11

26. 9, 10

27. 12, 27

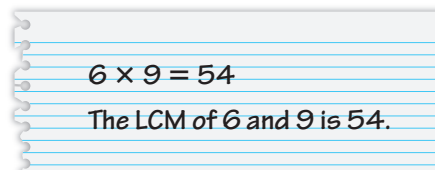
28. 18, 45

29. 22, 33

30. 36, 60

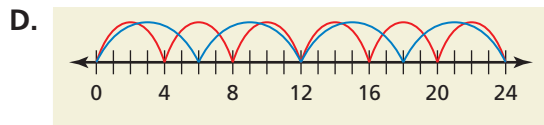
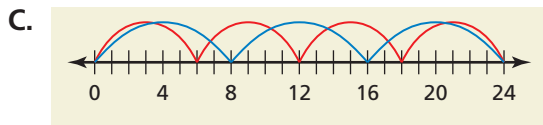
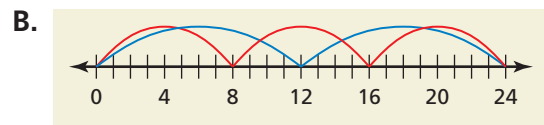
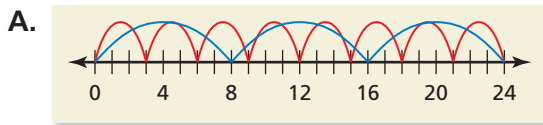
31. 35, 50

32. **YOU BE THE TEACHER** Your friend finds the LCM of 6 and 9. Is your friend correct? Explain your reasoning.



33. **MODELING REAL LIFE** You have diving lessons every fifth day and swimming lessons every third day. Today you have both lessons. In how many days will you have both lessons on the same day again?

34. **MP REASONING** Which model represents an LCM that is different from the other three? Explain your reasoning.



FINDING THE LCM Find the LCM of the numbers.

35. 2, 3, 7

36. 3, 5, 11

37. 4, 9, 12

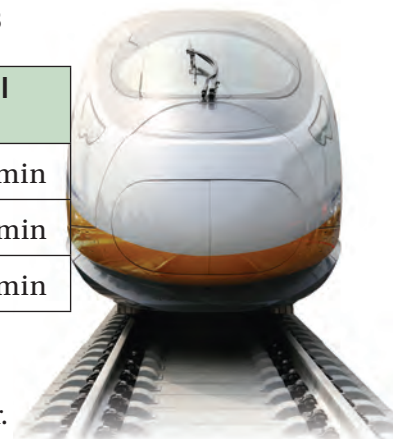
38. 6, 8, 15

39. 7, 18, 21

40. 9, 10, 28

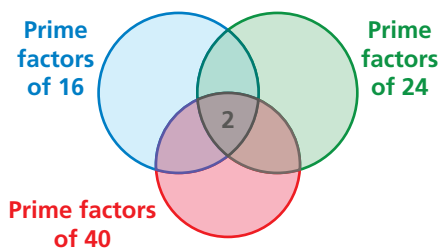
41. **MP PROBLEM SOLVING** At Union Station, you notice that three subway lines just arrived at the same time. How long must you wait until all three lines arrive at Union Station at the same time again?

Subway Line	Arrival Time
A	Every 10 min
B	Every 12 min
C	Every 15 min



42. **DIG DEEPER!** A radio station gives away \$15 to every 15th caller, \$25 to every 25th caller, and a free concert ticket to every 100th caller. When will the station first give away *all* three prizes to one caller? When this happens, how much money and how many tickets are given away?

43. **MP LOGIC** You and a friend are running on treadmills. You run 0.5 mile every 3 minutes, and your friend runs 2 miles every 14 minutes. You both start and stop running at the same time and run a whole number of miles. What are the least possible numbers of miles you and your friend can run?



44. **VENN DIAGRAM** Refer to the Venn diagram.

- Copy and complete the Venn diagram.
- What is the LCM of 16, 24, and 40?
- What is the LCM of 16 and 40? 24 and 40? 16 and 24? Explain how you found your answers.

CRITICAL THINKING Tell whether the statement is *always*, *sometimes*, or *never true*. Explain your reasoning.

- The LCM of two different prime numbers is their product.
- The LCM of a set of numbers is equal to one of the numbers in the set.
- The GCF of two different numbers is the LCM of the numbers.

1

Connecting Concepts

Problem-Solving Strategies

Using an appropriate strategy will help you make sense of problems as you study the mathematics in this course. You can use the following strategies to solve problems that you encounter.

- Use a verbal model.
- Draw a diagram.
- Write an equation.
- Solve a simpler problem.
- Sketch a graph or number line.
- Make a table.
- Make a list.
- Break the problem into parts.

► Using the Problem-Solving Plan

1. A sports team gives away shirts at the stadium. There are 60 large shirts, 1.6 times as many small shirts as large shirts, and 1.5 times as many medium shirts as small shirts. The team wants to divide the shirts into identical groups to be distributed throughout the stadium. What is the greatest number of groups that can be formed using every shirt?

Understand the problem.

You know the number of large shirts and two relationships among the numbers of small, medium, and large shirts. You are asked to find the greatest number of identical groups that can be formed using every shirt.

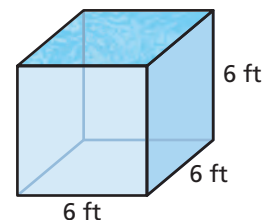
Make a plan.

Break the problem into parts. First use multiplication to find the number of each size shirt. Then find the GCF of these numbers.

Solve and check.

Use the plan to solve the problem. Then check your solution.

2. An escape artist fills the tank shown with water. Find the number of cubic feet of water needed to fill the tank. Then find the number of cubic yards of water that are needed to fill the tank. Justify your answer.



Performance Task

Setting the Table

At the beginning of this chapter, you watched a STEAM video called “Filling Piñatas.” You are now ready to complete the performance task for this video, available at BigIdeasMath.com. Be sure to use the problem-solving plan as you work through the performance task.





► Review Vocabulary

Write the definition and give an example of each vocabulary term.

power, p. 4

base, p. 4

exponent, p. 4

perfect square, p. 5

numerical expression, p. 10

evaluate, p. 10

order of operations, p. 10

factor pair, p. 16

prime factorization, p. 16

factor tree, p. 16

Venn diagram, p. 21

common factors, p. 22

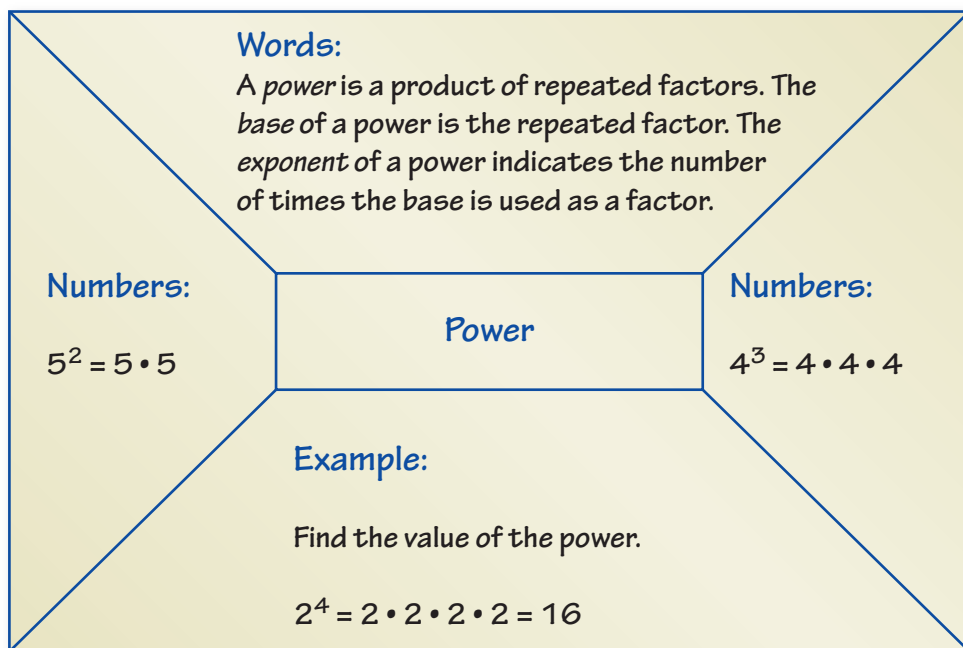
greatest common factor, p. 22

common multiples, p. 28

least common multiple, p. 28

► Graphic Organizers

You can use an **Information Frame** to organize and remember concepts. Here is an example of an Information Frame for the vocabulary term *power*.



Choose and complete a graphic organizer to help you study the concept.

- perfect square
- numerical expression
- order of operations
- prime factorization
- greatest common factor (GCF)
- least common multiple (LCM)



"Dear Mom, I am sending you an **Information Frame** card for Mother's Day!"

▶ Chapter Self-Assessment

As you complete the exercises, use the scale below to rate your understanding of the success criteria in your journal.



1.1 Powers and Exponents (pp. 3–8)

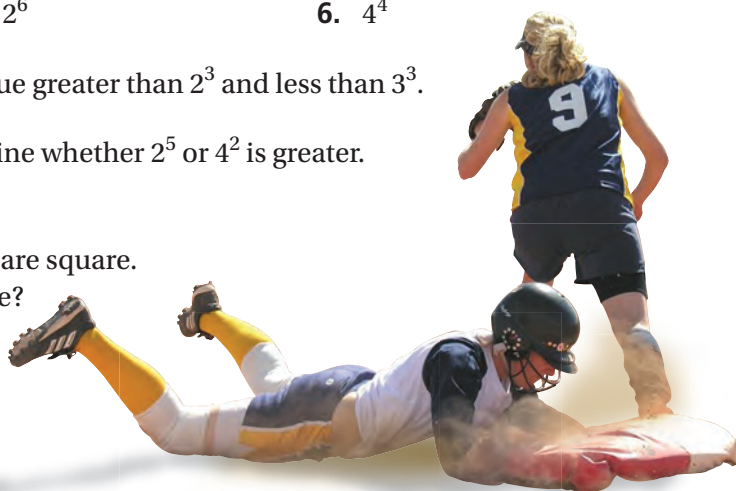
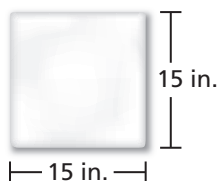
Learning Target: Write and evaluate expressions involving exponents.

Write the product as a power.

1. $3 \times 3 \times 3 \times 3 \times 3 \times 3$ 2. $5 \times 5 \times 5$ 3. $17 \cdot 17 \cdot 17 \cdot 17 \cdot 17$

Find the value of the power.

4. 3^3 5. 2^6 6. 4^4
7. Write a power that has a value greater than 2^3 and less than 3^3 .
8. Without evaluating, determine whether 2^5 or 4^2 is greater. Explain.
9. The bases on a softball field are square. What is the area of each base?



1.2 Order of Operations (pp. 9–14)

Learning Target: Write and evaluate numerical expressions using the order of operations.

Evaluate the expression.

10. $3 \times 6 - 12 \div 6$ 11. $30 \div (14 - 2^2) \times 5$
12. $\frac{5(2.3 + 3.7)}{2}$ 13. $4^3 - \frac{1}{2}(7^2 + 5)$
14. $20 \times (3^2 - 4) \div 50$ 15. $5 + 3(4^2 - 2) \div 6$
16. Use grouping symbols and at least one exponent to write a numerical expression that has a value of 80.



1.3 Prime Factorization (pp. 15–20)

Learning Target: Write a number as a product of prime factors and represent the product using exponents.

List the factor pairs of the number.

17. 28

18. 44

19. 96



20. There are 36 graduated cylinders to put away on a shelf after science class. The shelf can fit a maximum of 20 cylinders across and 4 cylinders deep. The teacher wants each row to have the same number of cylinders. List the possible arrangements of the graduated cylinders on the shelf.

Write the prime factorization of the number.

21. 42

22. 50

23. 66



1.4 Greatest Common Factor (pp. 21–26)

Learning Target: Find the greatest common factor of two numbers.

Find the GCF of the numbers using lists of factors.

24. 27, 45

25. 30, 48

26. 28, 48

Find the GCF of the numbers using prime factorizations.

27. 24, 80

28. 52, 68

29. 32, 56

30. Write a pair of numbers that have a GCF of 20.



31. What is the greatest number of friends you can invite to an arcade using the coupon such that the tokens and slices of pizza are equally split between you and your friends with none left over? How many slices of pizza and tokens will each person receive?



1.5 Least Common Multiple (pp. 27–32)

Learning Target: Find the least common multiple of two numbers.

Find the LCM of the numbers using lists of multiples.

32. 4, 14

33. 6, 20

34. 12, 28

Find the LCM of the numbers using prime factorizations.

35. 6, 45

36. 10, 12

37. 18, 27

38. Find the LCM of 8, 12, and 18.

39. Write a pair of numbers that have an LCM of 84.

40. Write three numbers that have an LCM of 45.

41. You water your roses every sixth day and your hydrangeas every fifth day. Today you water both plants. In how many days will you water both plants on the same day again?



42. Hamburgers are sold in packages of 20, while buns are sold in packages of 12. What are the least numbers of packages you should buy in order to have the same number of hamburgers and buns?

43. A science museum is giving away a magnetic liquid kit to every 50th guest and a plasma ball to every 35th guest until someone receives both prizes.

- Which numbered guest will receive both a magnetic liquid kit and a plasma ball?
- How many people will receive a plasma ball?

1

Practice Test

- Find the value of 2^3 .
- Evaluate $\frac{5 + 4(12 - 2)}{3^2}$.
- Write $264 \cdot 264 \cdot 264$ as a power.
- List the factor pairs of 66.
- Write the prime factorization of 56.

Find the GCF of the numbers.

6. 24, 54 7. 16, 32, 72 8. 52, 65

Find the LCM of the numbers.

9. 9, 24 10. 26, 39 11. 6, 12, 14

- You have 16 yellow beads, 20 red beads, and 24 orange beads to make identical bracelets. What is the greatest number of bracelets that you can make using all of the beads?
- A bag contains equal numbers of green marbles and blue marbles. You can divide all of the green marbles into groups of 12 and all the blue marbles into groups of 16. What is the least number of each color of marble that can be in the bag?
- The ages of the members of a family are 65, 58, 27, 25, 5, and 2 years old. What is the total admission price for the family to visit the zoo?

ZOO	
ADMISSION PRICE (PER PERSON)	
AGES	PRICE
12 AND UNDER	\$8
13-59	\$12
60 AND OLDER	\$10

- A competition awards prizes for fourth, third, second, and first place. The fourth place winner receives \$5. Each place above that receives a prize that is five times the amount of the previous prize. How much prize money is awarded?
- You buy tealight candles and mints as party favors for a baby shower. The tealight candles come in packs of 12 for \$3.50. The mints come in packs of 50 for \$6.25. What is the least amount of money you can spend to buy the same number of candles and mints?



1

Cumulative Practice

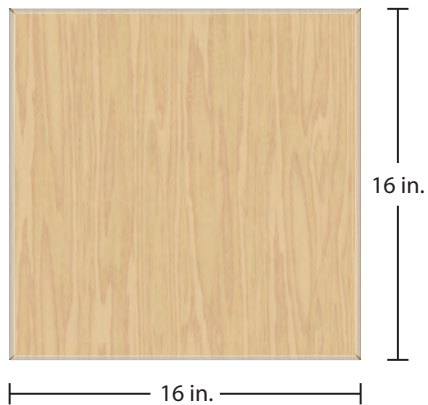
1. What is the value of 8×135 ?



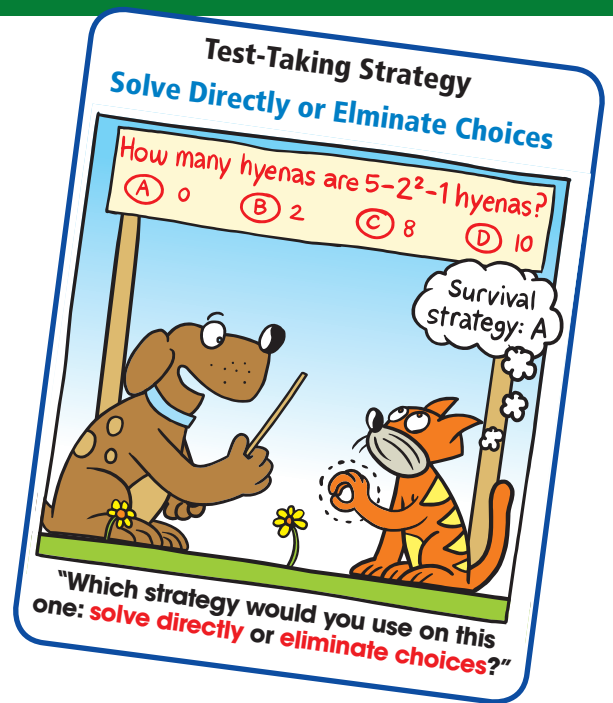
2. Which number is equivalent to the expression below?

$$3 \cdot 2^3 - 8 \div 4$$

- A. 0
B. 4
C. 22
D. 214
3. The top of an end table is a square with a side length of 16 inches. What is the area of the tabletop?



- F. 16 in.^2
G. 32 in.^2
H. 64 in.^2
I. 256 in.^2
4. You are filling baskets using 18 green eggs, 36 red eggs, and 54 blue eggs. What is the greatest number of baskets that you can fill so that the baskets are identical and there are no eggs left over?
- A. 3
B. 6
C. 9
D. 18



5. What is the value of $2^3 \cdot 3^2 \cdot 5$?



6. You hang the two strands of decorative lights shown below.



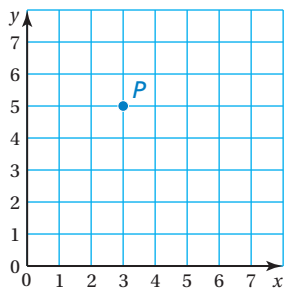
Strand 1: changes between red and blue every 15 seconds



Strand 2: changes between green and gold every 18 seconds

Both strands just changed color. After how many seconds will the strands change color at the same time again?

- F. 3 seconds
G. 30 seconds
H. 90 seconds
I. 270 seconds
7. Point P is plotted in the coordinate plane below.



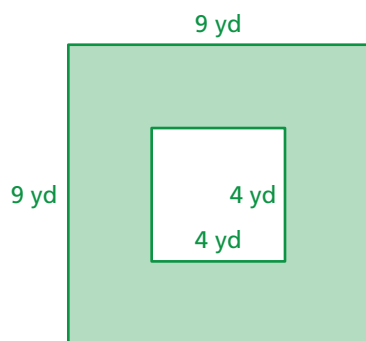
What are the coordinates of Point P ?

- A. (5, 3)
B. (4, 3)
C. (3, 5)
D. (3, 4)
8. What is the prime factorization of 1100?
- F. $2 \times 5 \times 11$
G. $2^2 \times 5^2 \times 11$
H. $4 \times 5^2 \times 11$
I. $2^2 \times 5 \times 55$

9. What is the least common multiple of 3, 8, and 10?

- A. 24
B. 30
C. 80
D. 120

10. What is the area of the shaded region of the figure below?



- F. 16 yd^2
G. 65 yd^2
H. 81 yd^2
I. 97 yd^2

11. Which expression represents a prime factorization?

- A. $4 \times 4 \times 7$
B. $2^2 \times 21 \times 23$
C. $3^4 \times 5 \times 7$
D. $5 \times 5 \times 9 \times 11$

12. Find the greatest common factor for each pair of numbers.

Think
Solve
Explain

10 and 15 10 and 21 15 and 21

What can you conclude about the greatest common factor of 10, 15, and 21?
Explain your reasoning.