Generating Equivalent Numerical Expressions

MODULE 9

COMMON CORE

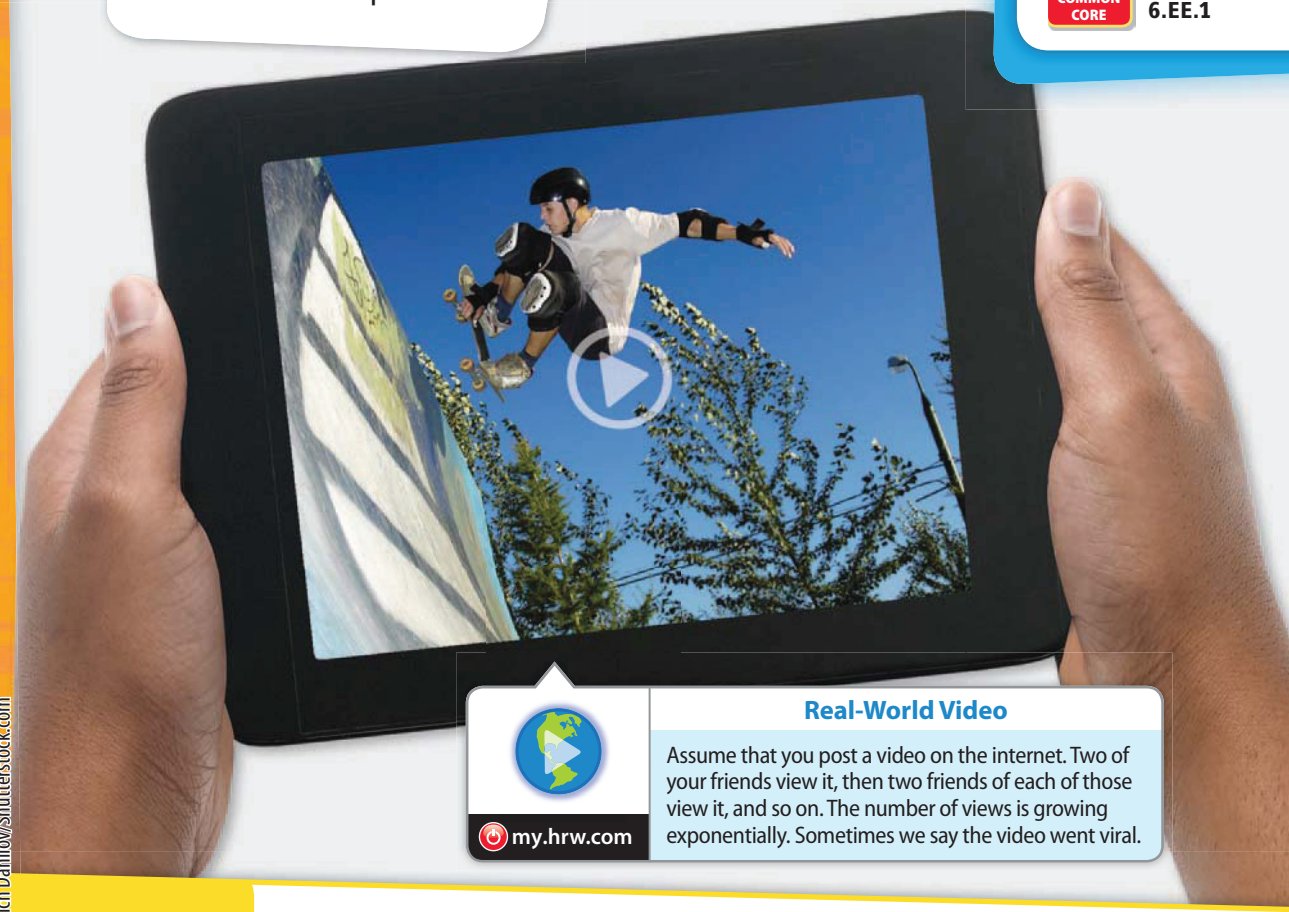
LESSON 9.1
Exponents
COMMON CORE 6.EE.1

LESSON 9.2
Prime Factorization
COMMON CORE 6.EE.1

LESSON 9.3
Order of Operations
COMMON CORE 6.EE.1

ESSENTIAL QUESTION

How can you generate equivalent numerical expressions and use them to solve real-world problems?



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Real-World Video

Assume that you post a video on the internet. Two of your friends view it, then two friends of each of those view it, and so on. The number of views is growing exponentially. Sometimes we say the video went viral.

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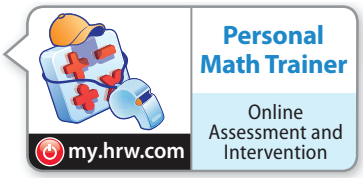
Are YOU Ready?

Complete these exercises to review skills you will need for this module.



Whole Number Operations

EXAMPLE 270×83

$$\begin{array}{r} 270 \\ \times\ 83 \\ \hline 810 \\ +21{,}600 \\ \hline 22{,}410 \end{array}$$

← 3×270
← 80×270
← $(3 \times 270) + (80 \times 270)$

Find the product.

1. 992×16 _____

2. 578×27 _____

3. 839×65 _____

4. 367×23 _____

Use Repeated Multiplication

EXAMPLE $5 \times 5 \times 5 \times 5$

25×5

125×5

625

Multiply the first two factors.

Multiply the result by the next factor.

Multiply that result by the next factor.

Continue until there are no more factors to multiply.

Find the product.

5. $7 \times 7 \times 7$ _____

6. $3 \times 3 \times 3 \times 3$ _____

7. $6 \times 6 \times 6 \times 6 \times 6$ _____

8. $2 \times 2 \times 2 \times 2 \times 2 \times 2$ _____

Division Facts

EXAMPLE $54 \div 9 = \square$

Think: 9 times what number equals 54?
$9 \times 6 = 54$

$54 \div 9 = 6$

So, $54 \div 9 = 6$.

Divide.

9. $20 \div 4$ _____

10. $21 \div 7$ _____

11. $42 \div 7$ _____

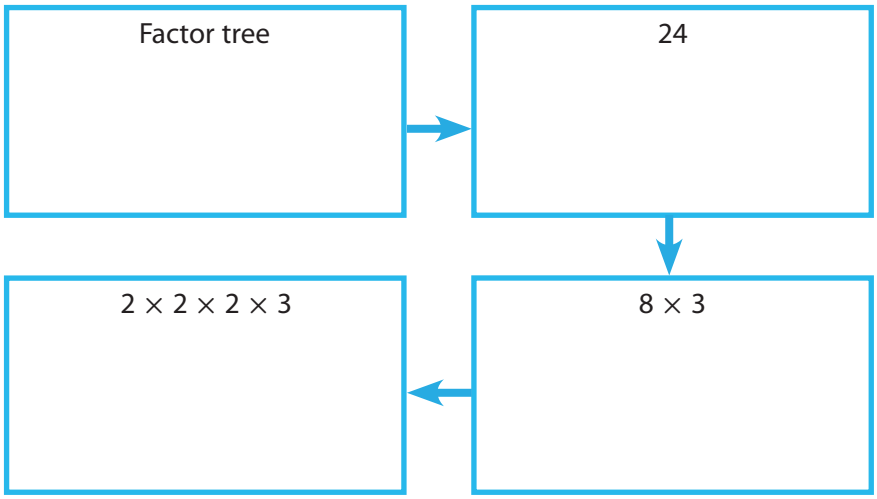
12. $56 \div 8$ _____

Reading Start-Up

Visualize Vocabulary

Use the ✔ words to complete the graphic. You may put more than one word in each box.

Reviewing Factorization



Vocabulary

Review Words

- ✔ factor *(factor)*
- factor tree *(árbol de factores)*
- ✔ integers *(entero)*
- ✔ numerical expression *(expresión numérica)*
- ✔ operations *(operaciones)*
- ✔ prime factorization *(factorización prima)*
- repeated multiplication *(multiplicación repetida)*
- simplified expression *(expresión simplificada)*

Preview Words

- base *(base)*
- exponent *(exponente)*
- order of operations *(orden de las operaciones)*
- power *(potencia)*

Understand Vocabulary

Complete the sentences using the preview words.

1. A number that is formed by repeated multiplication by the same factor is a _____ .
2. A rule for simplifying expressions is _____ .
3. The _____ is a number that is multiplied. The number that indicates how many times this number is used as a factor is the _____ .

Active Reading

Three-Panel Flip Chart Before beginning the module, create a three-panel flip chart to help you organize what you learn. Label each flap with one of the lesson titles from this module. As you study each lesson, write important ideas like vocabulary, properties, and formulas under the appropriate flap.

MODULE 9

Unpacking the Standards

Understanding the standards and the vocabulary terms in the standards will help you know exactly what you are expected to learn in this module.

COMMON CORE **6.EE.1**

Write and evaluate numerical expressions involving whole-number exponents.

Key Vocabulary

exponent *(exponente)* The number that indicates how many times the base is used as a factor.

order of operations *(orden de las operaciones)* A rule for evaluating expressions: first perform the operations in parentheses, then compute powers and roots, then perform all multiplication and division from left to right, and then perform all addition and subtraction from left to right.

What It Means to You

You will simplify numerical expressions using the order of operations.

UNPACKING EXAMPLE 6.EE.1

Ellen is playing a video game in which she captures frogs. There were 3 frogs onscreen, but the number of frogs doubled every minute when she went to get a snack. She returned after 4 minutes and captured 7 frogs. Write an expression for the number of frogs remaining. Simplify the expression.

3×2	number of frogs after 1 minute
$3 \times 2 \times 2$	number of frogs after 2 minutes
$3 \times 2 \times 2 \times 2$	number of frogs after 3 minutes
$3 \times 2 \times 2 \times 2 \times 2$	number of frogs after 4 minutes

Since 3 and 2 are prime numbers, $3 \times 2 \times 2 \times 2 \times 2$ is the prime factorization of the number of frogs remaining.

$3 \times 2 \times 2 \times 2 \times 2$ can be written with exponents as 3×2^4.

The expression $3 \times 2^4 - 7$ is the number of frogs remaining after Ellen captured the 7 frogs.

Use the order of operations to simplify $3 \times 2^4 - 7$.

$$3 \times 2^4 - 7 = 3 \times 16 - 7$$
$$= 48 - 7$$
$$= 41$$

41 frogs remain.

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LESSON

9.1 Exponents

COMMON CORE 6.EE.1

Write and evaluate ... expressions involving whole-number exponents.

ESSENTIAL QUESTION

How do you use exponents to represent numbers?

EXPLORE ACTIVITY Real World

COMMON CORE 6.EE.1

Identifying Repeated Multiplication

A real-world problem may involve repeatedly multiplying a factor by itself.

A scientist observed the hourly growth of bacteria and recorded his observations in a table.

Time (h)	Total bacteria
0	1
1	2
2	$2 \times 2 =$ ☐
3	$2 \times 2 \times 2 =$ ☐
4	$2 \times 2 \times 2 \times 2 =$ ☐

After 2 hours, there are $2 \cdot 2 =$? bacteria.

A Complete the table. What pattern(s) do you see in the Total bacteria column?

_____

_____

B Complete each statement.

At 2 hours, the total is equal to the product of two 2s.

At 3 hours, the total is equal to the product of _____ 2s.

At 4 hours, the total is equal to the product of _____ 2s.

Reflect

1. **Communicate Mathematical Ideas** How is the time, in hours, related to the number of times 2 is used as a factor?

_____

_____

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Using Exponents

A number that is formed by repeated multiplication of the same factor is called a **power**. You can use an *exponent* and a *base* to write a power. For example, 7^3 means the product of three 7s:

$$7^3 = 7 \times 7 \times 7$$

The **base** is the number that is multiplied.

The **exponent** tells how many times the base appears in the expression.

Power	How to read the power
6^2	6 squared, 6 to the power of 2, 6 raised to the 2nd power
7^3	7 cubed, 7 to the power of 3, 7 raised to the 3rd power
9^4	9 to the power of 4, 9 raised to 4th power

EXAMPLE 1

COMMON CORE 6.EE.1

Use an exponent to write each expression.

A $3 \times 3 \times 3 \times 3 \times 3$

Find the base, or the number being multiplied. The base is 3.

Find the exponent by counting the number of 3s being multiplied. The exponent is 5.

$\underbrace{3 \times 3 \times 3 \times 3 \times 3}_{\text{5 factors of 3}} = 3^5$

Math Talk
Mathematical Practices
What is the value of a number raised to the power of 1?

B $\frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5}$

Find the base, or the number being multiplied. The base is $\frac{4}{5}$.

Find the exponent by counting the number of times $\frac{4}{5}$ appears in the expression. The exponent is 4.

$\underbrace{\frac{4}{5} \times \frac{4}{5} \times \frac{4}{5} \times \frac{4}{5}}_{\text{4 factors of } \frac{4}{5}} = \left(\frac{4}{5}\right)^4$

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YOUR TURN

Use exponents to write each expression.

2. $4 \times 4 \times 4$ _____

3. 6 _____

4. $\frac{1}{8} \times \frac{1}{8}$ _____

5. $5 \times 5 \times 5 \times 5 \times 5 \times 5$ _____

Finding the Value of a Power

To find the value of a power, remember that the exponent indicates how many times to use the base as a factor.

Property of Zero as an Exponent

The value of any nonzero number raised to the power of 0 is 1.

Example: $5^0 = 1$

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EXAMPLE 2

COMMON CORE 6.EE.1

Find the value of each power.

A 10^4

Identify the base and the exponent.
The base is 10, and the exponent is 4.

Evaluate: $10^4 = 10 \times 10 \times 10 \times 10 = 10{,}000$

B 0.4^3

Identify the base and the exponent.
The base is 0.4, and the exponent is 3.

Evaluate: $0.4^3 = 0.4 \times 0.4 \times 0.4 = 0.064$

C $\left(\frac{3}{5}\right)^0$

Identify the base and the exponent.
The base is $\frac{3}{5}$, and the exponent is 0.

Evaluate.

$\left(\frac{3}{5}\right)^0 = 1$ Any number raised to the power of 0 is 1.

D $\left(\frac{2}{3}\right)^2$

Identify the base and the exponent.
The base is $\frac{2}{3}$, and the exponent is 2.

Evaluate.

$\left(\frac{2}{3}\right)^2 = \left(\frac{2}{3}\right) \times \left(\frac{2}{3}\right) = \frac{4}{9}$

Math Talk
Mathematical Practices

Is the value of 2^3 the same as the value of 3^2? Explain.

YOUR TURN

Find the value of each power.

6. 3^4 _____ **7.** $(1)^9$ _____ **8.** $\left(\frac{2}{5}\right)^3$ _____ **9.** 12^2 _____

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Guided Practice

1. Complete the table. (Explore Activity 1)

Exponential form	Product	Simplified product
5^1	5	5
5^2	5×5	
5^3		125
	$5 \times 5 \times 5 \times 5$	
5^5		

Use an exponent to write each expression. (Example 1)

2. $6 \times 6 \times 6$ _____ __ factors of 6

3. $10 \times 10 \times 10 \times 10 \times 10 \times 10 \times 10$ _____

4. $\frac{3}{4} \times \frac{3}{4} \times \frac{3}{4} \times \frac{3}{4} \times \frac{3}{4}$ _____

5. $\frac{7}{9} \times \frac{7}{9} \times \frac{7}{9} \times \frac{7}{9} \times \frac{7}{9} \times \frac{7}{9} \times \frac{7}{9} \times \frac{7}{9}$ _____

Find the value of each power. (Example 2)

6. 8^3 _____ **7.** 7^4 _____ **8.** 10^3 _____

9. $\left(\frac{1}{4}\right)^2$ _____ **10.** $\left(\frac{1}{3}\right)^3$ _____ **11.** $\left(\frac{6}{7}\right)^2$ _____

12. 0.8^2 _____ **13.** 0.5^3 _____ **14.** 1.1^2 _____

15. 8^0 _____ **16.** 12^1 _____ **17.** $\left(\frac{1}{2}\right)^0$ _____

18. $(13)^2$ _____ **19.** $\left(\frac{2}{5}\right)^2$ _____ **20.** 0.9^2 _____

ESSENTIAL QUESTION CHECK-IN

21. How do you use an exponent to represent a number such as 16?

_____

_____

_____

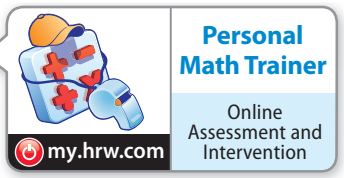
_____

_____

Name _____ Class _____ Date _____

9.1 Independent Practice

COMMON CORE 6.EE.1



Write the missing exponent.

22. $100 = 10^{\square}$

23. $8 = 2^{\square}$

24. $25 = 5^{\square}$

25. $27 = 3^{\square}$

26. $\frac{1}{169} = \left(\frac{1}{13}\right)^{\square}$

27. $14 = 14^{\square}$

28. $32 = 2^{\square}$

29. $\frac{64}{81} = \left(\frac{8}{9}\right)^{\square}$

Write the missing base.

30. $1{,}000 = \square^{3}$

31. $256 = \square^{4}$

32. $16 = \square^{4}$

33. $9 = \square^{2}$

34. $\frac{1}{9} = \left(\square\right)^{2}$

35. $64 = \square^{2}$

36. $\frac{9}{16} = \left(\square\right)^{2}$

37. $729 = \square^{3}$

For Exercises 38–42, write the answer with and without using an exponent.

38. Hadley's softball team has a phone tree in case a game is canceled. The coach calls 3 players. Then each of those players calls 3 players, and so on. How many players will be notified during the third round of calls?

_____

39. Tim is reading a book. On Monday he reads 3 pages. On each day after that, he reads 3 times the number of pages that he read on the previous day. How many pages does he read on Thursday?

_____

40. The square tile shown has a side length of 10.5 inches. What power can you write to represent the area of the tile? Write the power as an expression with a base and an exponent, and then find the area of the square.

_____

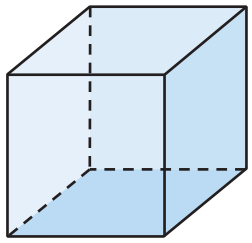
41. Antonia is saving for a video game. On the first day, she saves two dollars in her piggy bank. Each day after that, she doubles the number of dollars she saved on the previous day. How many dollars does she save on the sixth day?

_____

42. A certain colony of bacteria triples in length every 10 minutes. Its length is now 1 millimeter. How long will it be in 40 minutes?

_____

43. Which power can you write to represent the volume of the cube shown? Write the power as an expression with a base and an exponent, and then find the volume of the cube.



44. Write a power represented with a positive base and a positive exponent whose value is less than the base.

H.O.T. FOCUS ON HIGHER ORDER THINKING

Work Area

45. **Communicate Mathematical Ideas** What is the value of 1 raised to the power of any exponent? What is the value of 0 raised to the power of any nonnegative nonzero exponent? Explain.

46. **Look for a Pattern** Find the values of the powers in the following pattern: 10^1, 10^2, 10^3, 10^4.... Describe the pattern, and use it to evaluate 10^6 without using multiplication.

47. **Critical Thinking** Some numbers can be written as powers of different bases. For example, $81 = 9^2$ and $81 = 3^4$. Write the number 64 using three different bases.

48. **Justify Reasoning** Oman said that it is impossible to raise a number to the power of 2 and get a value less than the original number. Do you agree with Oman? Justify your reasoning.

LESSON
9.2 Prime Factorization

COMMON CORE 6.EE.1
Write and evaluate numerical expressions involving whole-number exponents

ESSENTIAL QUESTION

How do you write the prime factorization of a number?

Finding Factors of a Number

Whole numbers that are multiplied to find a product are called factors of that product. A number is divisible by its factors. For example, 4 and 2 are factors of 8 because $4 \cdot 2 = 8$, and 8 is divisible by 4 and by 2.

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EXAMPLE 1 Real World

COMMON CORE Prep for 6.EE.1

Ana wants to build a rectangular garden with an area of 24 square feet. What are the possible whole number lengths and widths of the garden?

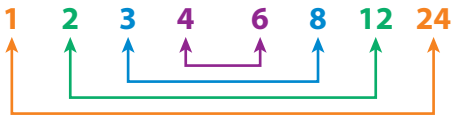
STEP 1 Recall that area = length · width. For Ana's garden, 24 ft^2 = length · width.

STEP 2 List the factors of 24 in pairs. List each pair only once.

$24 = 1 \cdot 24$
$24 = 2 \cdot 12$
$24 = 3 \cdot 8$
$24 = 4 \cdot 6$

$4 \cdot 6 = 6 \cdot 4$, so you only list $4 \cdot 6$.

You can also use a diagram to show the factor pairs.



The factors of 24 are 1, 2, 3, 4, 6, 8, 12, 24.

STEP 3 The possible lengths and widths are:

Length (ft)	24	12	8	6
Width (ft)	1	2	3	4

Math Talk
Mathematical Practices

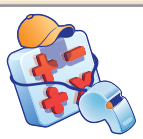
Give an example of a whole number that has exactly two factors. What type of number has exactly two factors?

YOUR TURN

List all the factors of each number.

1. 21 _____ **2.** 37 _____

3. 42 _____ **4.** 30 _____



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EXPLORE ACTIVITY 1 COMMON CORE 6.EE.1

Finding the Prime Factorization of a Number

The prime factorization of a number is the number written as the product of its prime factors. For example, the prime factors of 12 are 3, 2, and 2.

The prime factorization of 12 is $2 \cdot 3 \cdot 2$ or $2^2 \cdot 3$.

Use exponents to show repeated factors.

Use a factor tree to find the prime factorization of 240.

A List the factor pairs of 240.

240
· 48

_____

_____

B Choose any factor pair to begin the tree. If a number in this pair is prime, circle it. If a number in the pair can be written as a product of two factors, draw additional branches and write the factors.

C Continue adding branches until the factors at the ends of the branches are prime numbers.

D Write the prime factorization of 240.

_____

Then write the prime factorization using exponents.

_____

240

Reflect

5. **What If?** What will the factor tree for 240 look like if you start the tree with a different factor pair? Check your prediction by creating another factor tree for 240 that starts with a different factor pair.

_____

_____

_____

_____

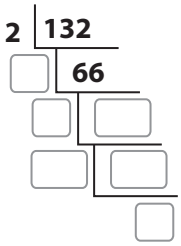
EXPLORE ACTIVITY 2

COMMON CORE 6.EE.1

Using a Ladder Diagram

A ladder diagram is another way to find the prime factorization of a number.

Use a ladder diagram to find the prime factorization of 132.



A Write 132 in the top "step" of the ladder. Choose a prime factor of 132 to write next to the step with 132. Choose 2. Divide 132 by 2 and write the quotient 66 in the next step of the ladder.

B Now choose a prime factor of 66. Write the prime factor next to the step with 66. Divide 66 by that prime factor and write the quotient in the next step of the ladder.

C Keep choosing prime factors, dividing, and adding to the ladder until you get a quotient of 1.

D What are the prime factors of 132? How can you tell from the ladder diagram?

_____

_____

E Write the prime factorization of 132 using exponents.

_____

Reflect

6. Complete a factor tree and a ladder diagram to find the prime factorization of 54.

7. **Communicate Mathematical Ideas** If one person uses a ladder diagram and another uses a factor tree to write a prime factorization, will they get the same result? Explain.

_____

_____

Guided Practice

Use a diagram to list the factor pairs of each number. (Example 1)

1. 18

2. 52

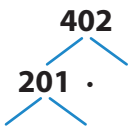
3. Karl needs to build a stage that has an area of 72 square feet. The length of the stage should be longer than the width. What are the possible whole number measurements for the length and width of the stage? (Example 1)

Complete the table with possible measurements of the stage.

Length	72					
Width		2				

Use a factor tree to find the prime factorization of each number. (Explore Activity 1)

4. 402



5. 36

Use a ladder diagram to find the prime factorization of each number. (Explore Activity 2)

6. 64

7. 27

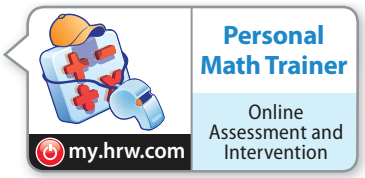
ESSENTIAL QUESTION CHECK-IN

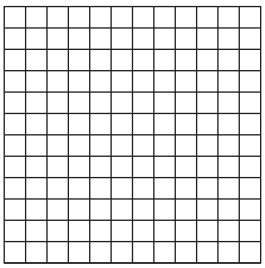
8. Tell how you know when you have found the prime factorization of a number.

Name _____ Class _____ Date _____

9.2 Independent Practice

COMMON CORE 6.EE.1





9. **Multiple Representations** Use the grid to draw three different rectangles so that each has an area of 12 square units and they all have different widths. What are the dimensions of the rectangles?

_____

_____

10. Brandon has 32 stamps. He wants to display the stamps in rows, with the same number of stamps in each row. How many different ways can he display the stamps? Explain.

_____

_____

_____

11. **Communicate Mathematical Ideas** How is finding the factors of a number different from finding the prime factorization of a number?

_____

_____

_____

_____

Find the prime factorization of each number.

12. 891 _____

13. 504 _____

14. 23 _____

15. 230 _____

16. The number 2 is chosen to begin a ladder diagram to find the prime factorization of 66. What other numbers could have been used to start the ladder diagram for 66? How does starting with a different number change the diagram?

_____

_____

_____

17. **Critical Thinking** List five numbers that have 3, 5, and 7 as prime factors.

_____

18. In a game, you draw a card with three consecutive numbers on it. You can choose one of the numbers and find the sum of its prime factors. Then you can move that many spaces. You draw a card with the numbers 25, 26, 27. Which number should you choose if you want to move as many spaces as possible? Explain.

19. **Explain the Error** When asked to write the prime factorization of the number 27, a student wrote $9 \cdot 3$. Explain the error and write the correct answer.

H.O.T. FOCUS ON HIGHER ORDER THINKING

20. **Communicate Mathematical Ideas** Explain why it is possible to draw more than two different rectangles with an area of 36 square units, but it is not possible to draw more than two different rectangles with an area of 15 square units. The sides of the rectangles are whole numbers.

21. **Critique Reasoning** Alice wants to find all the prime factors of the number you get when you multiply $17 \cdot 11 \cdot 13 \cdot 7$. She thinks she has to use a calculator to perform all the multiplications and then find the prime factorization of the resulting number. Do you agree? Why or why not?

22. **Look for a Pattern** Ryan wrote the prime factorizations shown below. If he continues this pattern, what prime factorization will he show for the number one million? What prime factorization will he show for one billion?

$10 = 5 \cdot 2$

$100 = 5^2 \cdot 2^2$

$1{,}000 = 5^3 \cdot 2^3 = 1{,}000$

Work Area

LESSON
9.3 Order of Operations

COMMON CORE 6.EE.1
Write and evaluate ... expressions involving whole-number exponents.

ESSENTIAL QUESTION

How do you use the order of operations to simplify expressions with exponents?

EXPLORE ACTIVITY Real World

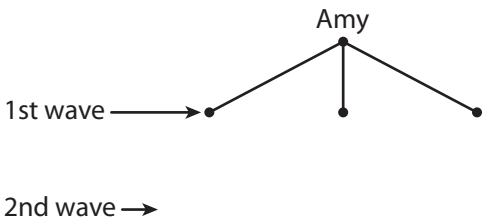
COMMON CORE 6.EE.1

Exploring the Order of Operations

Order of Operations

1. Perform operations in parentheses.
2. Find the value of numbers with exponents.
3. Multiply or divide from left to right.
4. Add or subtract from left to right.

Amy and three friends launch a new website. Each friend e-mails the web address to three new friends. These new friends forward the web address to three more friends. If no one receives the e-mail more than once, how many people will receive the web address in the second wave of e-mails?



A Use a diagram to model the situation for Amy. Each dot represents one e-mail. Complete the diagram to show the second wave.

B Complete the table to show how many e-mails are sent in each wave of Amy's diagram.

Wave	Number of e-mails	Power of 3
1st		
2nd		

C Amy is just one of four friends initiating the first wave of e-mails. Write an expression for the total number of e-mails sent in the 2nd wave.

number of people × number of e-mails in 2nd wave written as a power

☐ × ☐

D Identify the computation that should be done first to simplify the expression in **C**. Then simplify the expression.

Multiply 4 and 3 / Find the value of 3^2

The value of the expression is 4 × _____ = _____.

EXPLORE ACTIVITY *(cont'd)*

Reflect

1. In **B**, why does it makes sense to write the numbers of e-mails as powers? What is the pattern for the number of e-mails in each wave for Amy?

_____

_____

_____

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Simplifying Numerical Expressions

A numerical expression is an expression involving numbers and operations. You can use the order of operations to simplify numerical expressions.

EXAMPLE 1

COMMON CORE 6.EE.1

Simplify each expression.

A $5 + 18 \div 3^2$

$5 + 18 \div 3^2 = 5 + 18 \div 9$ Evaluate 3^2.

$= 5 + 2$ Divide.

$= 7$ Add.

B $21 + \frac{3^2}{3}$

$21 + \frac{3^2}{3} = 21 + \frac{9}{3}$ Evaluate 3^2.

$= 21 + 3$ Divide.

$= 24$ Add.

C $6 \times 2^3 \div 3 + 1$

$6 \times 2^3 \div 3 + 1 = 6 \times 8 \div 3 + 1$ Evaluate 2^3.

$= 48 \div 3 + 1$ Multiply.

$= 16 + 1$ Divide.

$= 17$ Add.

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YOUR TURN

Simplify each expression using the order of operations.

2. $7 + 15 \times 9^2 =$ _____ **3.** $220 - 450 \div 3^2 =$ _____

Using Exponents with Grouping Symbols

Remember to perform operations inside parentheses first when you simplify expressions.

EXAMPLE 2

COMMON CORE 6.EE.1

Simplify each expression using the order of operations.

A $4 \times (9 \div 3)^2$

$4 \times (9 \div 3)^2 = 4 \times 3^2$ Perform operations inside parentheses.

$= 4 \times 9$ Evaluate 3^2.

$= 36$ Multiply.

B $5^3 + (12 - 2)^2$

$5^3 + (12 - 2)^2 = 5^3 + 10^2$ Perform operations inside parentheses.

$= 125 + 100$ Evaluate powers.

$= 225$ Add.

C $8 + \frac{(12 - 8)^2}{2}$

$8 + \frac{(12 - 8)^2}{2} = 8 + \frac{4^2}{2}$ Perform operations inside parentheses.

$= 8 + \frac{16}{2}$ Evaluate 4^2.

$= 8 + 8$ Divide.

$= 16$ Add.

My Notes

Reflect

4. **Critique Reasoning** John wants to simplify the expression $(5 + 3)^2$. As a first step, he writes $5^2 + 3^2$. Will he get the correct value for the expression? If not, what should he do to simplify the expression?

_____

_____

_____

YOUR TURN

Simplify each expression using the order of operations.

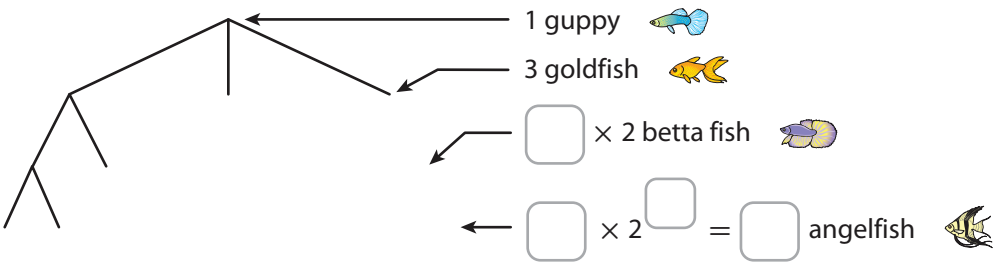
5. $5 \times (20 \div 4)^2 =$ _____

6. $8^2 - (5 + 2)^2 =$ _____

7. $7 - \frac{(63 \div 9)^2}{7} =$ _____

Guided Practice

1. In a video game, a guppy that escapes a net turns into three goldfish. Each goldfish can turn into two betta fish. Each betta fish can turn into two angelfish. Complete the diagram and write the number of fish at each stage. Write and evaluate an expression for the number of angelfish that can be formed from one guppy. (Explore Activity)



_____

Complete to simplify each expression. (Examples 1 and 2)

2. $89 - 4^2 \times 4 + 12 = 89 - \_\_\_\_\_ \times 4 + 12$

$= 89 - \_\_\_\_\_ + 12$

$= \_\_\_\_\_ + 12$

$= \_\_\_\_\_$

3. $6 \times (36 \div 12)^2 + 8 = 6 \times (\_\_\_\_\_)^2 + 8$

$= 6 \times \_\_\_\_\_ + 8$

$= \_\_\_\_\_ + 8$

$= \_\_\_\_\_$

4. $12 \times \left(\frac{(4+2)^2}{4}\right) - 7 = 12 \times \left(\frac{\left(\square\right)^2}{4}\right) - 7$

$= 12 \times \left(\frac{\square}{4}\right) - 7$

$= 12 \times \_\_\_\_\_ - 7$

$= \_\_\_\_\_ - 7$

$= \_\_\_\_\_$

5. $320 \div \left(\frac{(11-9)^3}{2}\right) \times 8 = 320 \div \left(\frac{\left(\square\right)^3}{2}\right) \times 8$

$= 320 \div \left(\frac{\square}{2}\right) \times 8$

$= 320 \div \_\_\_\_\_ \times 8$

$= \_\_\_\_\_ \times 8$

$= \_\_\_\_\_$

ESSENTIAL QUESTION CHECK-IN

6. How do you use the order of operations to simplify expressions with exponents?

_____

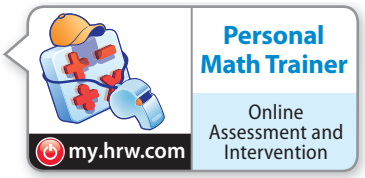
_____

_____

Name _____ Class _____ Date _____

9.3 Independent Practice

COMMON CORE 6.EE.1



Simplify each expression using the order of operations.

7. $5 \times 2 + 3^2$ _____

8. $15 - 7 \times 2 + 2^3$ _____

9. $(11 - 8)^3 - 2 \times 6$ _____

10. $6 + 3(13 - 2) - 5^2$ _____

11. $12 + \frac{9^2}{3}$ _____

12. $\frac{8 + 6^2}{11} + 7 \times 2$ _____

13. **Explain the Error** Jay simplified the expression $3 \times (3 + 12 \div 3) - 4$. For his first step, he added $3 + 12$ to get 15. What was Jay's error? Find the correct answer.

_____

_____

14. **Multistep** A clothing store has the sign shown in the shop window. Pani sees the sign and wants to buy 3 shirts and 2 pairs of jeans. The cost of each shirt before the discount is $12, and the cost of each pair of jeans is $19 before the discount.

a. Write and simplify an expression to find the amount Pani pays if a $3 discount is applied to her total.

_____

b. Pani says she should get a $3 discount on the price of each shirt and a $3 discount on the price of each pair of jeans. Write and simplify an expression to find the amount she would pay if this is true.

_____

c. **Analyze Relationships** Why are the amounts Pani pays in **a** and **b** different?

_____

_____

d. If you were the shop owner, how would you change the sign? Explain.

_____

_____

_____

_____

15. Ellen is playing a video game in which she captures butterflies. There are 3 butterflies onscreen, but the number of butterflies doubles every minute. After 4 minutes, she was able to capture 7 of the butterflies.

a. **Look for a Pattern** Write an expression for the number of butterflies after 4 minutes. Use a power of 2 in your answer.

_____

b. Write an expression for the number of butterflies remaining after Ellen captured the 7 butterflies. Simplify the expression.

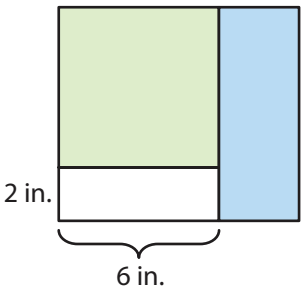
_____

16. Show how to write, evaluate and simplify an expression to represent and solve this problem: Jeff and his friend each text four classmates about a concert. Each classmate then texts four students from another school about the concert. If no one receives the message more than once, how many students from the other school receive a text about the concert?

_____

H.O.T. FOCUS ON HIGHER ORDER THINKING

17. **Geometry** The figure shown is a rectangle. The green shape in the figure is a square. The blue and white shapes are rectangles, and the area of the blue rectangle is 24 square inches.



a. Write an expression for the area of the entire figure that includes an exponent. Then find the area.

_____

b. Find the dimensions of the entire figure.

_____

18. **Explain the Error** Rob and Lila try to simplify $18 \times 4^2 + (9 - 3)^2$. Rob simplifies the expression and gets 360. Lila simplifies it and gets 324. Which student is correct? What error did the other student make?

_____

_____

_____

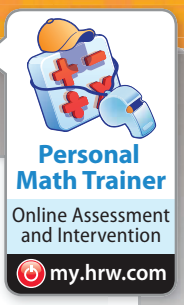
19. **Persevere in Problem Solving** Use parentheses to make this statement true: $8 \times 4 - 2 \times 3 + 8 \div 2 = 25$

_____

Work Area

MODULE QUIZ

Ready to Go On?



9.1 Exponents

Find the value of each power.

1. 7^3 _____ **2.** 9^2 _____ **3.** $\left(\frac{7}{9}\right)^2$ _____ **4.** $\left(\frac{1}{2}\right)^6$ _____

5. $\left(\frac{2}{3}\right)^3$ _____ **6.** $\left(\frac{1}{3}\right)^4$ _____ **7.** 12^0 _____ **8.** 1.4^2 _____

9.2 Prime Factorization

Find the factors of each number.

9. 96 _____

10. 120 _____

Find the prime factorization of each number.

11. 58 _____ **12.** 212 _____

13. 2,800 _____ **14.** 900 _____

9.3 Order of Operations

Simplify each expression using the order of operations.

15. $(21 - 3) \div 3^2$ _____ **16.** $7^2 \times (6 \div 3)$ _____

17. $17 + 15 \div 3 - 2^4$ _____ **18.** $(8 + 56) \div 4 - 3^2$ _____

19. The nature park has a pride of 7 adult lions and 4 cubs. The adults eat 6 pounds of meat each day and the cubs eat 3 pounds. Simplify $7 \times 6 + 4 \times 3$ to find the amount of meat consumed each day by the lions. _____

ESSENTIAL QUESTION

20. How do you use numerical expressions to solve real-world problems?

_____

_____

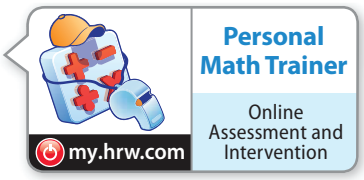
_____

_____

COMMON CORE

MODULE 9 MIXED REVIEW

Assessment Readiness



Selected Response

1. Which expression has a value that is less than the base of that expression?

Ⓐ 2^3

Ⓑ $\left(\frac{5}{6}\right)^2$

Ⓒ 3^2

Ⓓ 4^4

2. After the game the coach bought 9 chicken meals for $5 each and 15 burger meals for $6 each. What percent of the total amount the coach spent was used for the chicken meals?

Ⓐ $33\frac{1}{3}\%$

Ⓑ 45%

Ⓒ $66\frac{2}{3}\%$

Ⓓ 90%

3. Which operation should you perform first when you simplify $175 - (8 + 45 \div 3) \times 7$?

Ⓐ addition

Ⓑ division

Ⓒ multiplication

Ⓓ subtraction

4. For a game, three people are chosen in the first round. Each of those people chooses 3 people in the second round, and so on. How many people are chosen in the sixth round?

Ⓐ 18

Ⓑ 216

Ⓒ 243

Ⓓ 729

5. Which expression shows the prime factorization of 100?

Ⓐ $2^2 \times 5^2$

Ⓑ 10×10

Ⓒ 10^{10}

Ⓓ $2 \times 5 \times 10$

6. Which number has only two factors?

Ⓐ 21

Ⓑ 23

Ⓒ 25

Ⓓ 27

7. Which expression is equivalent to $3.6 \times 3.6 \times 3.6 \times 3.6$?

Ⓐ 3.6×4

Ⓑ 36^3

Ⓒ $3^4 \times 6^4$

Ⓓ 3.6^4

8. Which expression gives the prime factorization of 80?

Ⓐ $2^4 \times 10$

Ⓑ $2 \times 5 \times 8$

Ⓒ $2^3 \times 5$

Ⓓ $2^4 \times 5$

Mini-Task

9. George wants to put carpeting in a rectangular living room and a square bedroom. The length and width of the living room is 12 feet by 18 feet. One side of the square bedroom is 13 feet. It will cost $3.50 per square foot to carpet the rooms.

a. Write an expression that can be used to find the total amount George will pay for carpeting.

_____

b. Evaluate the expression. How much will George pay for the carpeting?

_____