LESSON
9.3 Order of Operations

FL 6.EE.1.1
Write and evaluate ... expressions involving whole-number exponents.

ESSENTIAL QUESTION

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

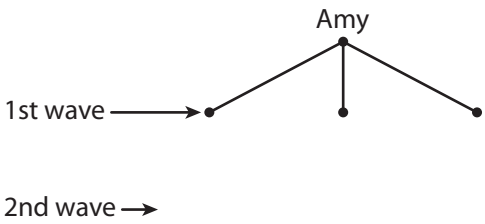
EXPLORE ACTIVITY Real World FL 6.EE.1.1

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

FL 6.EE.1.1

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.

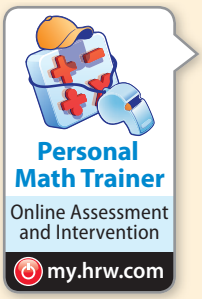
C $6 \times 2^3 \div 3 + 1$

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

$= 48 \div 3 + 1$ Multiply.

$= 16 + 1$ Divide.

$= 17$ Add.



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

FL 6.EE.1.1

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.

$= 325$ 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.

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?

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My Notes

YOUR TURN

Simplify each expression using the order of operations.

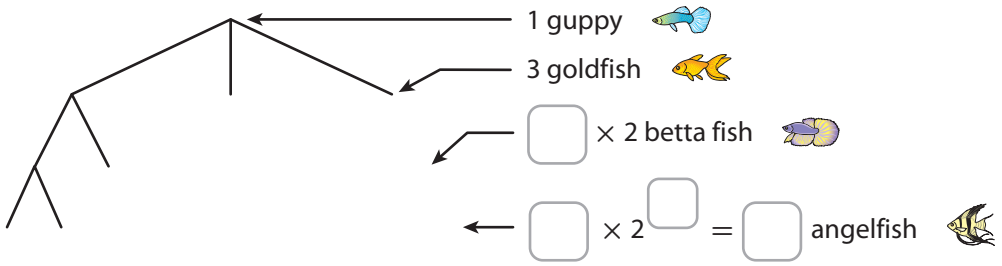
5. $5 \times (20 \div 4)^2 =$ _____

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)



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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?

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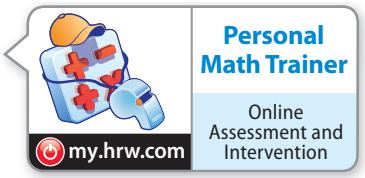
Name _____ Class _____ Date _____

9.3 Independent Practice

FL 6.EE.1.1



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.

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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.

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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.

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

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

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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.

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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?

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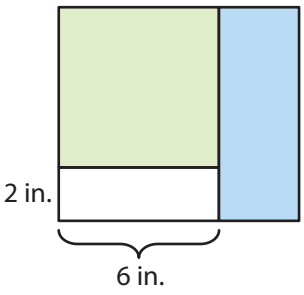
H.O.T. FOCUS ON HIGHER ORDER THINKING

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.

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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?

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

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Work Area