Name _____

Evaluate Expressions Involving Exponents

Essential Question How do you use the order of operations to evaluate expressions involving exponents?

Common Core **Expressions and Equations—6.EE.A.1**

MATHEMATICAL PRACTICES **MP4, MP6**

A **numerical expression** is a mathematical phrase that uses only numbers and operation symbols.

$3 + 16 \times 2^2$ $\quad 4 \times (8 + 5^1)$ $\quad 2^3 + 4$

You **evaluate** a numerical expression when you find its value. To evaluate an expression with more than one operation, you must follow a set of rules called the **order of operations**.

Order of Operations

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

Unlock the Problem (Real World)

An archer shoots 6 arrows at a target. Two arrows hit the ring worth 8 points, and 4 arrows hit the ring worth 4 points. Evaluate the expression $2 \times 8 + 4^2$ to find the archer's total number of points.

Follow the order of operations.

Write the expression. There are no parentheses.	$2 \times 8 + 4^2$
Find the value of numbers with exponents.	$2 \times 8 +$ _____
_____ from left to right.	_____ + 16
Then add.	_____

So, the archer scores a total of _____ points.

Math Talk MATHEMATICAL PRACTICES 6

Explain In which order should you perform the operations to evaluate the expression $30 - 10 + 5^2$?

Try This! **Evaluate the expression $24 \div 2^3$.**

There are no parentheses.	$24 \div 2^3$
Find the value of numbers with exponents.	$24 \div$ _____
Then divide.	_____

Example 1 Evaluate the expression $72 \div (13 - 4) + 5 \times 2^3$.

Write the expression.	$72 \div (13 - 4) + 5 \times 2^3$
Perform operations in _____.	$72 \div$ _____ $+ 5 \times 2^3$
Find the values of numbers with _____.	$72 \div 9 + 5 \times$ _____
Multiply and _____ from left to right.	_____ $+ 5 \times 8$
	$8 +$ _____
Then add.	_____

Example 2

Last month, an online bookstore had approximately 10^5 visitors to its website. On average, each visitor bought 2 books. Approximately how many books did the bookstore sell last month?

STEP 1 Write an expression.

Think: The number of books sold is equal to the number of visitors times the number of books each visitor bought.

number of visitors | times | number of books bought

10^5 $\times$ _____

STEP 2 Evaluate the expression.

Write the expression. There are no parentheses.	$10^5 \times 2$
Find the values of numbers with _____.	_____ $\times 2$
Multiply.	_____

So, the bookstore sold approximately _____ books last month.

- MATHEMATICAL PRACTICE 6 **Explain** why the order of operations is necessary.

_____

_____

_____

Name _____

Share and Show

MATH BOARD

1. Evaluate the expression $9 + (5^2 - 10)$.

$9 + (5^2 - 10)$ Write the expression.

$9 + (\_\_\_\_ - 10)$ Follow the order of operations within the parentheses.

$9 + \_\_\_\_$

____ Add.

Evaluate the expression.

2. $6 + 3^3 \div 9$

3. $(15 - 3)^2 \div 9$

4. $(8 + 9^2) - 4 \times 10$

Math Talk

MATHEMATICAL PRACTICES 7

Look for Structure How does the parentheses make the values of these expressions different: $(2^2 + 8) \div 4$ and $2^2 + (8 \div 4)$?

On Your Own

Evaluate the expression.

5. $10 + 6^2 \times 2 \div 9$

6. $6^2 - (2^3 + 5)$

7. $16 + 18 \div 9 + 3^4$

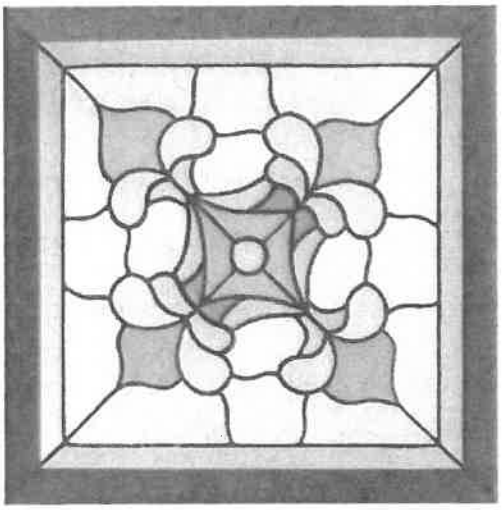
Place parentheses in the expression so that it equals the given value.

8. $10^2 - 50 \div 5$
value: 10

9. $20 + 2 \times 5 + 4^1$
value: 38

10. $28 \div 2^2 + 3$
value: 4

Problem Solving • Applications Real World



Use the table for 11–13.

Art Glass Windows		
Type	**Area (square feet)**	**Price per square foot**
Knot	2^2	$27
Rose	3^2	$30
Tulip	4^2	$33

11. MATHEMATICAL PRACTICE 4 **Write an Expression** To find the cost of a window, multiply its area in square feet by the price per square foot. Write and evaluate an expression to find the cost of a knot window.

_____

12. GO DEEPER A builder installs 2 rose windows and 2 tulip windows. Write and evaluate an expression to find the combined area of the windows.

_____

13. THINK SMARTER DeShawn bought a tulip window. Emma bought a rose window. Write and evaluate an expression to determine how much more DeShawn paid for his window than Emma paid for hers.

Math on the Spot

_____

14. What's the Error? Darius wrote $17 - 2^2 = 225$. Explain his error.

WRITE Math **Show Your Work**

_____

_____

_____

_____

15. THINK SMARTER Ms. Hall wrote the expression $2 \times (3 + 5)^2 \div 4$ on the board. Shyann said the first step is to evaluate 5^2. Explain Shyann's mistake. Then evaluate the expression.

_____

_____

Name _____

Evaluate Algebraic Expressions and Formulas

Essential Question How do you evaluate an algebraic expression or a formula?

Common Core **Expressions and Equations—6.EE.A.2c**

MATHEMATICAL PRACTICES
MP4, MP5, MP6

To evaluate an algebraic expression, substitute numbers for the variables and then follow the order of operations.

Unlock the Problem

Real World

Amir is saving money to buy an MP3 player that costs $120. He starts with $25, and each week he saves $9. The expression $25 + 9w$ gives the amount in dollars that Amir will have saved after w weeks.

- Which operations does the expression $25 + 9w$ include?

_____

- In what order should you perform the operations?

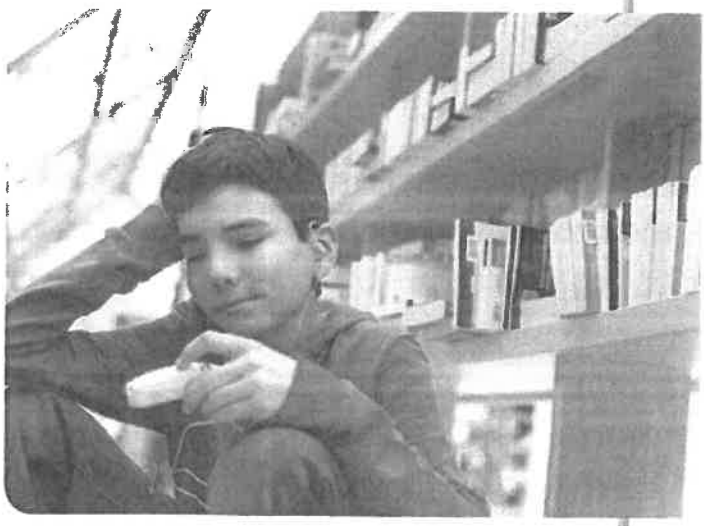
_____

A How much will Amir have saved after 8 weeks?

Evaluate the expression for $w = 8$.

Write the expression.	$25 + 9w$
Substitute 8 for w.	$25 + 9 \times$ ____
Multiply.	$25 +$ ____
Add.	_____

So, Amir will have saved $ _____ after 8 weeks.



B After how many weeks will Amir have saved enough money to buy the MP3 player?

Make a table to find the week when the amount saved is at least $120.

Week	Value of $25 + 9w$	Amount Saved
9	$25 + 9 \times 9 = 25 +$ ____ $= 106$	
10	$25 + 9 \times 10 = 25 +$ ____ $=$ _____	
11	$25 + 9 \times 11 = 25 +$ ____ $=$ _____	

So, Amir will have saved enough money for the MP3 player after _____ weeks.

Math Talk **MATHEMATICAL PRACTICES 6**

Explain What does it mean to substitute a value for a variable?

Example 1 Evaluate the expression for the given value of the variable.

A $4 \times (m - 8) \div 3$ for $m = 14$

Write the expression.	$4 \times (m - 8) \div 3$
Substitute 14 for m.	$4 \times (\_\_\_\_ - 8) \div 3$
Perform operations in parentheses.	$4 \times \_\_\_\_ \div 3$
Multiply and divide from left to right.	$\_\_\_\_ \div 3$
	$\_\_\_\_$

B $3 \times (y^2 + 2)$ for $y = 4$

Write the expression.	$3 \times (y^2 + 2)$
Substitute 4 for y.	$3 \times (\_\_\_\_^{\,2} + 2)$
Follow the order of operations within the parentheses.	$3 \times (\_\_\_\_ + 2)$
	$3 \times \_\_\_\_$
Multiply.	$\_\_\_\_$

ERROR Alert

When squaring a number, be sure to multiply the number by itself.

$4^2 = 4 \times 4$

Recall that a *formula* is a set of symbols that expresses a mathematical rule.

Example 2

The formula $P = 2\ell \times 2w$ gives the perimeter P of a rectangle with length ℓ and width w. What is the perimeter of a rectangular garden with a length of 2.4 meters and a width of 1.2 meters?

Write the expression for the perimeter of a rectangle.	$2\ell + 2w$
Substitute 2.4 for ℓ and _____ for w.	$2 \times \_\_\_\_ + 2 \times \_\_\_\_$
Multiply from left to right.	$\_\_\_\_ + 2 \times 1.2$
	$4.8 + \_\_\_\_$
Add.	$\_\_\_\_$

So, the perimeter of the garden is _____ meters.

Math Talk MATHEMATICAL PRACTICES 6

Compare How is evaluating an algebraic expression different from evaluating a numerical expression?

Name _____

Share and Show MATH BOARD

1. Evaluate $5k + 6$ for $k = 4$.

Write the expression. _____

Substitute 4 for k. $5 \times$ _____ $+ 6$

Multiply. _____ $+ 6$

Add. _____

Evaluate the expression for the given value of the variable.

2. $m - 9$ for $m = 13$

3. $16 - 3b$ for $b = 4$

4. $p^2 + 4$ for $p = 6$

5. The formula $A = \ell w$ gives the area A of a rectangle with length ℓ and width w. What is the area in square feet of a United States flag with a length of 12 feet and a width of 8 feet?

Math Talk MATHEMATICAL PRACTICES 8

Use Repeated Reasoning What information do you need to evaluate an algebraic expression?

On Your Own

Practice: Copy and Solve **Evaluate the expression for the given value of the variable.**

6. $7s + 5$ for $s = 3$

7. $21 - 4d$ for $d = 5$

8. $(t - 6)^2$ for $t = 11$

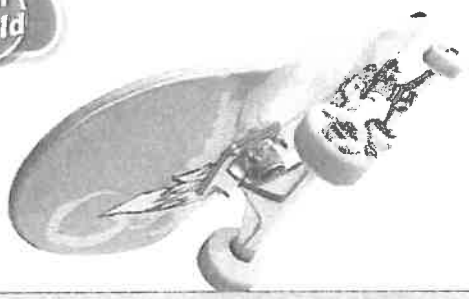
9. $6 \times (2v - 3)$ for $v = 5$

10. $2 \times (k^2 - 2)$ for $k = 6$

11. $5 \times (f - 32) \div 9$ for $f = 95$

12. GO DEEPER The formula $P = 4s$ gives the perimeter P of a square with side length s. How much greater is the perimeter of a square with a side length of $5\frac{1}{2}$ inches than a square with a side length of 5 inches?

Problem Solving • Applications (Real World)



The table shows how much a company charges for skateboard wheels. Each pack of 8 wheels costs $50. Shipping costs $7 for any order. Use the table for 13–15.

13. Complete the table.

14. A skateboard club has $200 to spend on new wheels this year. What is the greatest number of packs of wheels the club can order?

_____

15. MATHEMATICAL PRACTICE 1 **Make Sense of Problems** A sporting goods store placed an order for 12 packs of wheels on the first day of each month last year. How much did the sporting goods store spend on these orders last year?

_____

Costs for Skateboard Wheels

Packs	$50 \times n + 7$	Cost
1	$50 \times 1 + 7$	$57
2		
3		
4		
5		

WRITE Math **Show Your Work**

16. THINK SMARTER **What's the Error?** Bob used these steps to evaluate $3m - 3 \div 3$ for $m = 8$. Explain his error.

Math on the Spot

$3 \times 8 - 3 \div 3 = 24 - 3 \div 3$

$= 21 \div 3$

$= 7$

_____

_____

_____

_____

17. THINK SMARTER The surface area of a cube can be found by using the formula $6s^2$, where s represents the length of the side of the cube.

The surface area of a cube that has a side length of 3 meters is [54 / 108 / 2,916] meters squared.

Name _____

Use Algebraic Expressions

Essential Question How can you use variables and algebraic expressions to solve problems?

Common Core **Expressions and Equations—6.EE.B.6**

MATHEMATICAL PRACTICES MP1, MP2, MP4

Sometimes you are missing a number that you need to solve a problem. You can represent a problem like this by writing an algebraic expression in which a variable represents the unknown number.

Unlock the Problem

Real World

Rafe's flight from Los Angeles to New York took 5 hours. He wants to know the average speed of the plane in miles per hour.

A Write an expression to represent the average speed of the plane.

Use a variable to represent the unknown quantity.

Think: The plane's average speed is equal to the distance traveled divided by the time traveled.

Use a variable to represent the unknown quantity.

Let d represent the _____

traveled in units of _____.

Write an algebraic expression for the average speed.

$$\frac{d \text{ mi}}{\text{hr}}$$

B Rafe looks up the distance between Los Angeles and New York on the Internet and finds that the distance is 2,460 miles. Use this distance to find the average speed of Rafe's plane.

Evaluate the expression for $d = 2{,}460$.

Write the expression.

$$\frac{d \text{ mi}}{5 \text{ hr}}$$

Substitute 2,460 for d.

$$\frac{\text{mi}}{5 \text{ hr}}$$

Divide to find the unit rate.

$$\frac{2{,}460 \text{ mi} \div}{5 \text{ hr} \div 5} = \frac{\text{mi}}{1 \text{ hr}}$$

So, the plane's average speed was _____ miles per hour.

Math Talk

MATHEMATICAL PRACTICES 1

Evaluate How could you check whether you found the plane's average speed correctly?

In the problem on the previous page, the variable represented a single value—the distance in miles between Los Angeles and New York. In other situations, a variable may represent any number in a particular set of numbers, such as the set of positive numbers.

Example Joanna makes and sells candles online. She charges $7 per candle, and shipping is $5 per order.

A Write an expression that Joanna can use to find the total cost for any candle order.

Think: The number of candles a customer buys will vary from order to order.

Let n represent the number of _____ a customer buys, where n is a whole number greater than 0.

The cost per order equals | the charge per candle | times | the number of candles | plus | the shipping charge. |

_____ × _____ + _____

So, an expression for the total cost of a candle order is _____.

B In March, one of Joanna's customers placed an order for 4 candles. In May, the same customer placed an order for 6 candles. What was the total charge for both orders?

STEP 1 Find the charge in dollars for each order.

	March	May
Write the expression.	$7n + 5$	$7n + 5$
Substitute the number of candles ordered for n.	$7 \times$ _____ $+ 5$	$7 \times$ _____ $+ 5$
Follow the order of operations.	_____ $+ 5$	_____ $+ 5$
	_____	_____

STEP 2 Find the charge in dollars for both orders.

Add the charge in dollars for March to the charge in dollars for May. _____ + _____ = _____

So, the total charge for both orders was _____.

Math Talk MATHEMATICAL PRACTICES 2

Reasoning Why is the value of the variable n in the Example restricted to the set of whole numbers greater than 0?

Name _____

Share and Show MATH BOARD

Louisa read that the highest elevation of Mount Everest is 8,848 meters. She wants to know how much higher Mount Everest is than Mount Rainier. Use this information for 1–2.

✓ **1.** Write an expression to represent the difference in heights of the two mountains. Tell what the variable in your expression represents.

✓ **2.** Louisa researches the highest elevation of Mount Rainier and finds that it is 4,392 meters. Use your expression to find the difference in the mountains' heights.

Math Talk MATHEMATICAL PRACTICES 2

Reason Quantitatively Explain whether the variable in Exercise 1 represents a single unknown number or any number in a particular set.

On Your Own

A muffin recipe calls for 3 times as much flour as sugar. Use this information for 3–5.

3. Write an expression that can be used to find the amount of flour needed for a given amount of sugar. Tell what the variable in your expression represents.

4. Use your expression to find the amount of flour needed when $\frac{3}{4}$ cup of sugar is used.

5. MATHEMATICAL PRACTICE 2 **Reason Quantitatively** Is the value of the variable in your expression restricted to a particular set of numbers? Explain.

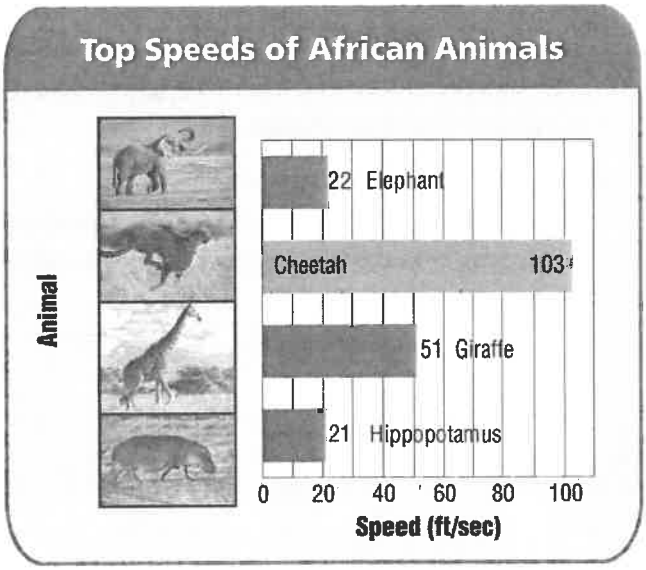
Practice: Copy and Solve **Write an algebraic expression for each word expression. Then evaluate the expression for these values of the variable: $\frac{1}{2}$, 4, and 6.5.**

6. the quotient of p and 4

7. 4 less than the sum of x and 5

Problem Solving • Applications Real World

Use the graph for 8–10.



8. Write expressions for the distance in feet that each animal could run at top speed in a given amount of time. Tell what the variable in your expressions represents.

_____

_____

_____

_____

9. GO DEEPER How much farther could a cheetah run in 20 seconds at top speed than a hippopotamus could?

_____

10. THINK SMARTER A giraffe runs at top speed toward a tree that is 400 feet away. Write an expression that represents the giraffe's distance in feet from the tree after s seconds.

_____

Math on the Spot

WRITE Math Show Your Work

Personal Math Trainer

11. THINK SMARTER A carnival charges \$7 for admission and \$2 for each ride. An expression for the total cost of going to the carnival and riding n rides is $7 + 2n$.

Complete the table by finding the total cost of going to the carnival and riding n rides.

Number of rides, n	$7 + 2n$	Total Cost
1		
2		
3		
4		