

LESSON

1

# Rules for Exponents

## Review It!

When you work with exponents, remember these words:

**equation** a math sentence with an equal (=) sign

**base** the number that is multiplied by itself

**exponent** the number of times the base is used as a factor

To multiply numbers with the same base, add the exponents.

To divide numbers with the same base, subtract the exponents.

$$\begin{array}{c}
 \text{exponent} \\
 \downarrow \\
 8^3 = 8 \times 8 \times 8 \\
 \text{base} \uparrow
 \end{array}$$

$$x^3 \times x^4 = x^{3+4} = x^7$$

$$\frac{x^9}{x^3} = x^{9-3} = x^6$$

What is the value of  $n$  in the equation below? What is the value of  $3^n$ ?

$$3^4 \times 3^2 = 3^n$$

Step 1 Simplify the left side.

$$3^4 = 3 \times 3 \times 3 \times 3 \text{ and } 3^2 = 3 \times 3$$

$$3^4 \times 3^2 = (3 \times 3 \times 3 \times 3) \times (3 \times 3) = 3^{4+2} = 3^6$$

**REMEMBER** To multiply numbers with the same base, add the exponents.

Step 2 Find  $n$ .

$$3^6 = 3^n, \text{ so } n = 6$$

Step 3 Find the value.

$$3^6 = 3 \times 3 \times 3 \times 3 \times 3 \times 3 = 729$$

**REMEMBER** The exponent tells how many times the base is a factor.

So,  $n = 6$  and  $3^n = 3^6 = 729$

## Try It!

Use an exponent to write each expression.

1.  $4 \times 4 \times 4 = 4^3$       2.  $5 \times 5 \times 5 \times 5 = 5^4$

3.  $10 \times 10 \times 10 \times 10 \times 10 \times 10 = 10^6$

What is the value of  $n$  in each equation?

4.  $(9^5)^3 = 9^n$  15      5.  $\frac{7^4}{7^2} = 7^n$  2

6.  $4^8 \times 4^8 = 4^n$  16      7.  $\frac{8^9}{8^6} = 8^n$  3

8.  $(6^{16})^{10} = 6^n$  160      9.  $2^{24} \times 2^{12} = 2^n$  36

What is the value of each expression?

10.  $\frac{9^6}{9^4} = 81$       11.  $(3^2)^4 = 9$

12.  $5^2 \times 5^4 = 5^6$       13.  $\frac{6^5}{6^2} = 36$

Solve.

14. The formula  $N = 10(3^t)$  gives  $N$ , the number of bacteria present in a culture after  $t$  hours. How many bacteria are present in the culture after 2 hours?

90

15. The formula  $B = 10(2^t)$  gives  $B$ , the number of bacteria present in a culture after  $t$  hours. How many bacteria are present in the culture after 6 hours?

640

## Ask Yourself

1. How many factors of 4? 4, or 3?

4.  $(9^5)^3 = ?$   
 $9^5 \times 3$ , or  $9^5 + 3$ ?

10.  $\frac{9^6}{9^4} = ?$   
 $9^6 - 4$ , or  $9^2$ ?

14.  $t = ?$   
1, 2, or 3?

**On Your Own!**

Circle the best answer for each question.

1. Which is the same as  $8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8 \times 8$ ?

- A.  $8 \times 10$
- B.  $10^8$
- C.  $8^{10}$**
- D.  $80^{10}$

2. What is the value of  $n$  in the equation?

$$7^4 \times 7^6 = 7^n$$

- A. 24
- B. 13
- C. 10**
- D. 2

3. What is the value of  $n$  in the equation?

$$(8^2)^7 = 8^n$$

- A. 49
- B. 14**
- C. 9
- D. 5

4. What is the value of  $n$  in the equation?

$$\frac{3^{14}}{3^2} = 3^n$$

- A. 196
- B. 28
- C. 21
- D. 12**

5. What is the value of  $4^3 \times 4^5$ ?

- A. 65,536**
- B. 16,384
- ~~C. 240~~
- ~~D. 60~~

6. What is the value of  $(2^3)^3$ ?

- A. 1,024
- B. 512**
- C. 128
- D. 64

7. The formula  $N = 10(2^t)$  gives  $N$ , the number of bacteria present in a culture after  $t$  hours. How many bacteria are present in the culture after 3 hours?

- A. 80**
- B. 160
- C. 320
- D. 640

8. The formula  $X = 10(3^t)$  gives  $X$ , the number of bacteria present in a culture after  $t$  hours. How many bacteria are present in the culture after 5 hours?

- A. 7,290**
- B. 2,430
- C. 729
- D. 243

$4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4$   
 $4^8$

$256$   
 $256$

$2^9 \cdot 2^6 = 64 \cdot 8$   
 $512$

9. Scientists calculate that the distance between the asteroid Vesta and Earth is more than  $5^7 \times 5^9 = 5^n$  miles. What is the value of  $n$  in the equation?

16

10. The mass of the asteroid Ida is  $10^5 \times 10^8 \times 10^4 = 10^n$  kilograms. What is the value of  $n$  in the equation?

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**Math Words**

Fill in the blanks.

11. To multiply numbers with the same base, such as  $a^n \times a^m$ , add the exponents.

12. To raise a number with an exponent to a power, such as  $(a^n)^m$ , multiply the exponents.

13. To simplify the expression  $\frac{a^n}{a^m}$ , subtract the exponents.