

# Properties of Integer Exponents

Name: \_\_\_\_\_

## Prerequisite: Evaluate Numerical Exponential Expressions

**Study the example problem showing how to write and evaluate expressions with exponents. Then solve problems 1–9.**

### Example

Jacob decides to save money for a new tablet. He will save \$3 the first week and then triple the amount he has saved each week for 5 weeks. Write and evaluate an exponential expression to find how much money Jacob will have in his savings in Week 5.

Represent the problem with repeated multiplication and exponential expressions.

Week 1	Week 2	Week 3	Week 4	Week 5
$3 = 3^1$	$3 \cdot 3 = 3^2$	$3 \cdot 3 \cdot 3 = 3^3$	$3 \cdot 3 \cdot 3 \cdot 3 = 3^4$	$3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 3^5$

Week 5 expression:  $3^5$

Evaluate the expression:  $3^5 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 243$

Jacob will have \$243 in his savings in Week 5.

- 1** Look at the table. How many times greater is the amount in Jacob's savings in Week 3 than in Week 2?

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- 2** How much will Jacob have in his account in Week 3?

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- 3** Jacob thinks that  $3^5$  is  $5 \cdot 5 \cdot 5$ , or 125. Explain what Jacob is doing wrong.

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- 4** Margo's dad offers to give her 5¢ on Sunday. Then for each day of the week, he offers to give her 5 times the amount from the previous day. How much will he give her on Saturday? Write an expression to show how much Margo's dad gives her on Saturday.

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### Vocabulary

**base** the number being used as a factor in an exponential expression.

5 is the base.  $\rightarrow 5^3$

**exponent** the number that shows how many times a base is used as a factor.

$5^3 \leftarrow 3$  is the exponent.

**Solve.**

5 Is  $2^4$  equal to  $2 \cdot 4$ ? Explain.

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6 A bacterium cell splits into 2 cells every hour. Write and evaluate an exponential expression to find how many cells there will be in 6 hours. Then use your answer to help you find the number of hours it will take for there to be 1,024 cells.

**Show your work.**

*Solution:* \_\_\_\_\_

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7 The population of California is about 39 million. Is this greater than or less than  $10^7$ ? Explain.

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8 Write each of the numbers 1, 8, 27, 64, and 125 as a base raised to the third power.

$$1 = \square^3 \qquad 8 = \square^3 \qquad 27 = \square^3$$
$$64 = \square^3 \qquad 125 = \square^3$$

9 The exponential expression  $2^8$  has a value of 256. Write two other exponential expressions that have a value of 256. Explain how you got your answers. (Begin by writing out  $2^8$  as the product of 2s.)

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## Products of Powers

Study the example problems showing how to find the power of a power and the products of powers with the same exponent. Then solve problems 1–10.

### Example

#### Same Base and Same Exponent

Simplify:  $(8^2)^3$

One Way:

$$\begin{aligned}(8^2)^3 &= 8^2 \cdot 8^2 \cdot 8^2 \\ &= 8 \cdot 8 \cdot 8 \cdot 8 \cdot 8 \cdot 8 \\ &= 8^6\end{aligned}$$

Another Way:

$$\begin{aligned}(8^2)^3 &= 8^2 \cdot 8^2 \cdot 8^2 \\ &= 8^{2 \cdot 3} \quad \text{Multiply the exponents.} \\ &= 8^6\end{aligned}$$

#### Different Base and Same Exponent

Simplify:  $(2^4)(5^4)$

One Way:

$$\begin{aligned}(2^4)(5^4) &= (2 \cdot 2 \cdot 2 \cdot 2)(5 \cdot 5 \cdot 5 \cdot 5) \\ &= (2 \cdot 5)(2 \cdot 5)(2 \cdot 5)(2 \cdot 5) \\ &= 10 \cdot 10 \cdot 10 \cdot 10 \\ &= 10^4\end{aligned}$$

Another Way:

$$\begin{aligned}(2^4)(5^4) &= (2 \cdot 5)^4 \quad \text{Multiply the bases.} \\ &= 10^4\end{aligned}$$

- 1** The expression  $(8^2)^3$  in the example problem is a product of powers. What are the powers being multiplied? What are the powers being multiplied in the expression  $(2^4)(5^4)$ ?

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- 2** Simplify:  $(7^5)^6$ . Write your answer using an exponent.

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- 3** Simplify:  $(6^3)(9^3)$ . Write your answer using an exponent.

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- 4** Is the statement  $(3^5)^4 = (3^4)^5$  true? Explain your reasoning.

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**Solve.**

5 Simplify:  $(7^5)(4^5)$ . Write your answer using an exponent.

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6 Explain in words how to simplify:  $(153^2)^7$ .

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7 Is the statement  $(10^5)(4^5) = 14^5$  true? Explain your reasoning.

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8 What is the value of  $x$  in the equation  $(5^x)^5 = 5^{35}$ ? Explain.

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9 Without evaluating the expressions, tell which is greater,  $(4^4)(5^4)$  or  $(2^5)(10^5)$ . Explain your reasoning.

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10 Nicholas says that  $(2^6)(2^6)$  equals  $2^{12}$  and also equals  $4^6$ . Do you agree? Explain your reasoning.

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## Zero and Negative Exponents

Study the example problems showing how to simplify expressions with zero and negative exponents. Then solve problems 1–12.

### Example

#### Zero Exponent

Simplify:  $217^0$

In general,  $n^0 = 1$ , where  $n \neq 0$ .

So,  $217^0 = 1$ .

#### Negative Exponent

Simplify:  $15^{-2}$

In general,  $n^{-a} = \frac{1}{n^a}$ , where  $n \neq 0$ .

So,  $15^{-2} = \frac{1}{15^2}$ .

- 1 Simplify:  $100^0$  \_\_\_\_\_
- 2 Write  $(-32)^{-2}$  as an expression without a negative exponent. \_\_\_\_\_
- 3 Write  $\frac{1}{7^6}$  as an expression with a negative exponent. \_\_\_\_\_
- 4 Compare  $8^0$  and  $8^{-2}$ . Which is greater? Explain your reasoning.  
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- 5 Simplify  $(12^0)(12^6)$ . Write your answer using an exponent. Explain how you found your answer.  
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- 6 What is the value of  $x$  in the equation  $(-35)^x = 1$ ? Explain.  
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- 7 Write an expression using exponents that is equivalent to each of the following expressions.
  - a.  $5^{-3} =$  \_\_\_\_\_
  - b.  $(-16)^{-2} =$  \_\_\_\_\_
  - c.  $\frac{1}{8^4} =$  \_\_\_\_\_



**Solve.**

8 Simplify the expression  $52^{-5}$ . Then write it as repeated multiplication.

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9 Write an exponential expression that is equivalent to  $(4^{14})^{-2}$ .

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10 Is  $6^{-2}$  positive or negative? Explain.

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11 Write  $9^0$ ,  $9^3$ , and  $9^{-2}$  in order from least to greatest.

**Show your work.**

*Solution:* \_\_\_\_\_

12 Lizbeth says that  $(-12)^{-3}$  equals a positive number because the product of two negative integers is a positive integer. Do you agree? Use what you know about exponential expressions to explain.

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## Simplify Expressions with Exponents

Solve the problems.

- 1 Look at the equations below. Tell whether each equation is *True* or *False*.

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|--|-------------------------------|--------------------------------|
| a. $3^5 \cdot 3^7 = 3^{35}$                        | <input type="checkbox"/> True | <input type="checkbox"/> False |
| b. $(6^3 \cdot 3^3)^2 = 18^6$                      | <input type="checkbox"/> True | <input type="checkbox"/> False |
| c. $7^{-6} \cdot \frac{1}{7^4} = \frac{1}{7^{10}}$ | <input type="checkbox"/> True | <input type="checkbox"/> False |
| d. $4^4 \cdot 4^2 = 4^6$                           | <input type="checkbox"/> True | <input type="checkbox"/> False |
| e. $\frac{13^{-4}}{13^4} = 13^0$                   | <input type="checkbox"/> True | <input type="checkbox"/> False |
| f. $(2^3 \cdot 8^3)^0 = 16^9$                      | <input type="checkbox"/> True | <input type="checkbox"/> False |

You may have to apply more than one rule when working with exponents.



- 2 Tyler simplified the expression  $5^4 \cdot 5^{-9}$ . All of his work except his answer is shown below.

$$\begin{aligned} 5^4 \cdot 5^{-9} &= 5^{4+(-9)} \\ &= 5^{-5} \\ &= ? \end{aligned}$$

Which expression is the correct answer for Tyler's work?

- A  $5^5$   
 B  $\frac{1}{5^5}$   
 C  $\frac{1}{5^{-5}}$   
 D 5

Remember what you know about negative exponents.



- 3 Complete the table.

Expression	$10^4 \cdot 10^{-2}$	$5^4 \cdot 7^4$	$(2^7 \cdot 4^7)^3$
Simplified Expression			

Are the bases equal?  
 Are the exponents equal?



**Solve.**

- 4 Simplify:  $\frac{32^{-1}}{32^6}$ . Write your answer with a positive exponent.

**Show your work.**

The expression is a quotient of powers.



Solution: \_\_\_\_\_

- 5 Write  $9^6$  as a power with a base of 3.

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What are the factors of 9?



- 6 Which expression is equivalent to  $(3^4 \cdot 5^4)^{-3}$ ?

- A  $\frac{1}{15^5}$
- B  $15^{-48}$
- C  $\frac{1}{15^{12}}$
- D  $15^5$

Remember the order of operations. Simplify the expression within the parentheses first.



Tania chose **B** as the correct answer. How did she get that answer?

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