# **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
<b>3</b> = <b>3</b> <sup>1</sup>	$3 \cdot 3 = 3^2$	$\mathbf{3\cdot 3\cdot 3}=\mathbf{3^3}$	$\mathbf{3\cdot 3\cdot 3\cdot 3}=\mathbf{3^4}$	$3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 3^{5}$

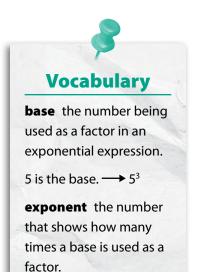
Week 5 expression:  $3^5$ Evaluate the expression:  $3^5 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 243$ 

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?

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

- 3 Jacob thinks that 3<sup>5</sup> is 5 ⋅ 5 ⋅ 5, or 125. Explain what Jacob is doing wrong.
- 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.



 $5^3 - 3$  is the exponent.

5	Is 2 <sup>4</sup> equal to 2 · 4? Explain.
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:
7	The population of California is about 39 million. Is this greater than or less than 10 <sup>7</sup> ? Explain.
8	Write each of the numbers 1, 8, 27, 64, and 125 as a base raised to the third power.
	$1 = \boxed{3} \qquad 8 = \boxed{3} \qquad 27 = \boxed{3}$
	$64 = \boxed{3} \qquad 125 = \boxed{3}$
9	The exponential expression 2 <sup>8</sup> 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 <sup>8</sup> 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	Different Base and Same Exponent
Simplify: (8 <sup>2</sup> ) <sup>3</sup>	Simplify: (2 <sup>4</sup> )(5 <sup>4</sup> )
One Way: $(8^2)^3 = 8^2 \cdot 8^2 \cdot 8^2$ $= 8 \cdot 8 \cdot 8 \cdot 8 \cdot 8 \cdot 8$ $= 8^6$	One Way: $(2^4)(5^4) = (2 \cdot 2 \cdot 2 \cdot 2)(5 \cdot 5 \cdot 5 \cdot 5)$ $= (2 \cdot 5)(2 \cdot 5)(2 \cdot 5)(2 \cdot 5)$ $= 10 \cdot 10 \cdot 10 \cdot 10$ $= 10^4$
Another Way: $(8^2)^3 = 8^2 \cdot 8^2 \cdot 8^2$ $= 8^{2 \cdot 3}$ Multiply the exponents. $= 8^6$	Another Way: $(2^4)(5^4) = (2 \cdot 5)^4$ Multiply the bases. $= 10^4$

 The expression (8<sup>2</sup>)<sup>3</sup> 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<sup>4</sup>)(5<sup>4</sup>)?

2 Simplify: (7<sup>5</sup>)<sup>6</sup>. Write your answer using an exponent.

**3** Simplify: (6<sup>3</sup>)(9<sup>3</sup>). Write your answer using an exponent.

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

5 Simplify: (7<sup>5</sup>)(4<sup>5</sup>). Write your answer using an exponent.

6 Explain in words how to simplify: (153<sup>2</sup>)<sup>7</sup>.

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

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

9 Without evaluating the expressions, tell which is greater, (4<sup>4</sup>)(5<sup>4</sup>) or (2<sup>5</sup>)(10<sup>5</sup>). Explain your reasoning.

Nicholas says that (2<sup>6</sup>)(2<sup>6</sup>) equals 2<sup>12</sup> and also equals 4<sup>6</sup>.
Do you agree? Explain your reasoning.

# 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	Negative Exponent		
Simplify: 217 <sup>0</sup>	Simplify: 15 <sup>-2</sup>		
In general, $n^0 = 1$ , where $n \neq 0$ .	In general, $n^{-a} = \frac{1}{n^{a}}$ , where $n \neq 0$ .		
So, 217 <sup>0</sup> = 1.	So, $15^{-2} = \frac{1}{15^2}$ .		
Simplify: 100º			
Write $(-32)^{-2}$ as an expression with	out a negative		
exponent			
Write $\frac{1}{7^6}$ as an expression with a negative exponent.			
Compare 8 <sup>°</sup> and 8 <sup>-2</sup> . Which is greater? Explain your reasoning.			
Simplify (12º)(12 <sup>6</sup> ). Write your answe Explain how you found your answe	5		
What is the value of x in the equation $(-35)^x = 1$ ? Explain.			
Write an expression using exponen to each of the following expression	•		
<b>a</b> . 5 <sup>-3</sup> =			
<b>b</b> . (-16) <sup>-2</sup> =			
<b>c</b> . $\frac{1}{8^4} =$			

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8 Simplify the expression 52<sup>-5</sup>. Then write it as repeated multiplication.

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

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

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

### Show your work.

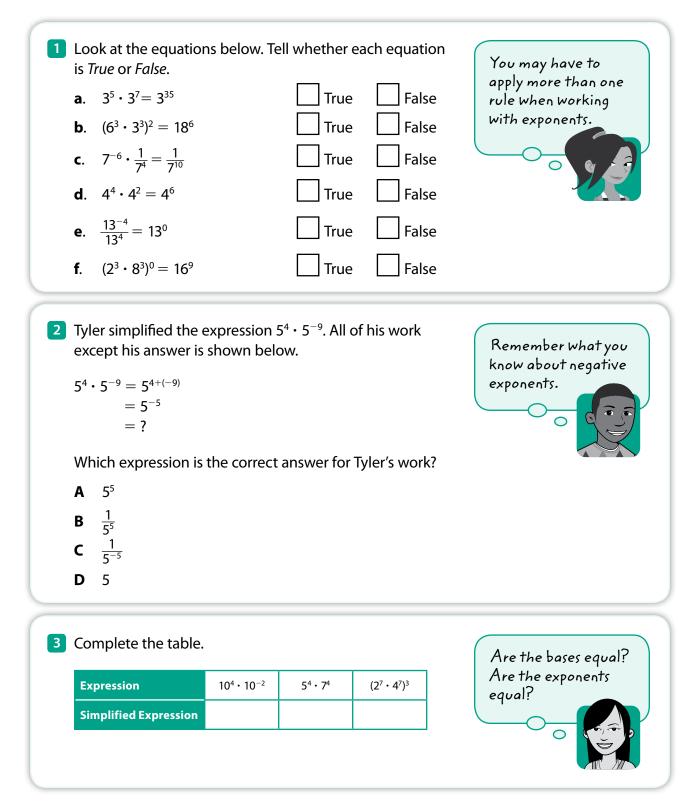
Solution: \_

12 Lizbeth says that (-12)<sup>-3</sup> 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.

#### Name:

# Simplify Expressions with Exponents

### Solve the problems.



Simplify: $\frac{32^{-1}}{32^6}$ . Write your answer with a positive exponent. Show your work.	The expression is a quotient of powers.
Solution:	
Write 9 <sup>6</sup> as a power with a base of 3.	What are the factors of 9?
Which expression is equivalent to $(3^4 \cdot 5^4)^{-3}$ ? <b>A</b> $\frac{1}{15^5}$ <b>B</b> $15^{-48}$ <b>C</b> $\frac{1}{15^{12}}$ <b>D</b> $15^5$ Tania chose <b>B</b> as the correct answer. How did she get that answer?	Remember the order of operations. Simplify the expression within the parentheses first.

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