NAME DATE PERIOD

Unit 7, Lesson 3: Powers of Powers of 10

Let's look at powers of powers of 10.

3.1: Big Cube

What is the volume of a giant cube that measures 10,000 km on each side?

3.2: Taking Powers of Powers of 10

1. a. Complete the table to explore patterns in the exponents when raising a power of 10 to a power. You may skip a single box in the table, but if you do, be prepared to explain why you skipped it.

expression	expanded	single power of 10
$(10^3)^2$	$(10 \cdot 10 \cdot 10)(10 \cdot 10 \cdot 10)$	10^6
$(10^2)^5$	$(10 \cdot 10)(10 \cdot 10)(10 \cdot 10)(10 \cdot 10)(10 \cdot 10)$	
	$(10 \cdot 10 \cdot 10)(10 \cdot 10 \cdot 10)(10 \cdot 10 \cdot 10)(10 \cdot 10 \cdot 10)$	
$(10^4)^2$		
$(10^8)^{11}$		

   b. If you chose to skip one entry in the table, which entry did you skip? Why?

2. Use the patterns you found in the table to rewrite $(10^m)^n$ as an equivalent expression with a single exponent, like $10^{\square}$.

NAME DATE PERIOD

3. If you took the amount of oil consumed in 2 months in 2013 worldwide, you could make a cube of oil that measures 10^3 meters on each side. How many cubic meters of oil is this? Do you think this would be enough to fill a pond, a lake, or an ocean?

3.3: How Do the Rules Work?

Andre and Elena want to write $10^2 \cdot 10^2 \cdot 10^2$ with a single exponent.

- Andre says, “When you multiply powers with the same base, it just means you add the exponents, so $10^2 \cdot 10^2 \cdot 10^2 = 10^{2+2+2} = 10^6$.”
- Elena says, “10^2 is multiplied by itself 3 times, so $10^2 \cdot 10^2 \cdot 10^2 = (10^2)^3 = 10^{2+3} = 10^5$.”

Do you agree with either of them? Explain your reasoning.

Are you ready for more?

$2^{12} = 4{,}096$. How many other whole numbers can you raise to a power and get 4,096? Explain or show your reasoning.

Lesson 3 Summary

In this lesson, we developed a rule for taking a power of 10 to another power: Taking a power of 10 and raising it to another power is the same as multiplying the exponents.

See what happens when raising 10^4 to the power of 3.

$$\left(10^4\right)^3 = 10^4 \cdot 10^4 \cdot 10^4 = 10^{12}$$

This works for any power of powers of 10. For example, $\left(10^6\right)^{11} = 10^{66}$. This is another rule that will make it easier to work with and make sense of expressions with exponents.

NAME DATE PERIOD

Unit 7, Lesson 3: Powers of Powers of 10

1. Write each expression with a single exponent:

   a. $(10^7)^2$

   b. $(10^9)^3$

   c. $(10^6)^3$

   d. $(10^2)^3$

   e. $(10^3)^2$

   f. $(10^5)^7$

2. You have 1,000,000 number cubes, each measuring one inch on a side.

   a. If you stacked the cubes on top of one another to make an enormous tower, how high would they reach? Explain your reasoning.

   b. If you arranged the cubes on the floor to make a square, would the square fit in your classroom? What would its dimensions be? Explain your reasoning.

NAME DATE PERIOD

c. If you layered the cubes to make one big cube, what would be the dimensions of the big cube? Explain your reasoning.

3. An amoeba divides to form two amoebas after one hour. One hour later, each of the two amoebas divides to form two more. Every hour, each amoeba divides to form two more.

   a. How many amoebas are there after 1 hour?

   b. How many amoebas are there after 2 hours?

   c. Write an expression for the number of amoebas after 6 hours.

   d. Write an expression for the number of amoebas after 24 hours.

   e. Why might exponential notation be preferable to answer these questions?

(from Unit 7, Lesson 1)

4. Elena noticed that, nine years ago, her cousin Katie was twice as old as Elena was then. Then Elena said, “In four years, I’ll be as old as Katie is now!” If Elena is currently e years old and Katie is k years old, which system of equations matches the story?

   A. $\begin{cases} k - 9 = 2e \\ e + 4 = k \end{cases}$

   B. $\begin{cases} 2k = e - 9 \\ e = k + 4 \end{cases}$

NAME DATE PERIOD

C. $\begin{cases} k = 2e - 9 \\ e + 4 = k + 4 \end{cases}$

D. $\begin{cases} k - 9 = 2(e - 9) \\ e + 4 = k \end{cases}$

(from Unit 4, Lesson 15)