## 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: Raising Powers of 10 to Another Power

* 1. 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
 |
| --- | --- | --- |
| * + $\left(10^{3}\right)^{2}$
 | * + $\left(10⋅10⋅10\right)\left(10⋅10⋅10\right)$
 | * + $10^{6}$
 |
| * + $\left(10^{2}\right)^{5}$
 | * + $\left(10⋅10\right)\left(10⋅10\right)\left(10⋅10\right)\left(10⋅10\right)\left(10⋅10\right)$
 |  |
|  | * + $\left(10⋅10⋅10\right)\left(10⋅10⋅10\right)\left(10⋅10⋅10\right)\left(10⋅10⋅10\right)$
 |  |
| * + $\left(10^{4}\right)^{2}$
 |  |  |
| * + $\left(10^{8}\right)^{11}$
 |  |  |

* 1. If you chose to skip one entry in the table, which entry did you skip? Why?
1. Use the patterns you found in the table to rewrite $\left(10^{m}\right)^{n}$ as an equivalent expression with a single exponent, like $10^{}$.
2. 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 $10^{2}⋅10^{2}⋅10^{2}$ with a single exponent.

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

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.

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

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.



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