



# Dividing Powers of 10

Let's explore patterns with exponents when we divide powers of 10.

## 3.1 A Surprising One

What is the value of the expression? Be prepared to explain your reasoning.

$$\frac{2^5 \cdot 3^4 \cdot 3^2}{2 \cdot 3^6 \cdot 2^4}$$



## 3.2 Dividing Powers of Ten

1. a. Complete the table to explore patterns in the exponents when dividing powers of 10. Use the “expanded” column to show why the given expression is equal to the single power of 10. 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 |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| $10^4 \div 10^2$       | $\frac{10 \cdot 10 \cdot 10 \cdot 10}{10 \cdot 10} = \frac{10 \cdot 10}{10 \cdot 10} \cdot 10 \cdot 10 = 1 \cdot 10 \cdot 10$                            | $10^2$             |
|                        | $\frac{10 \cdot 10 \cdot 10 \cdot 10 \cdot 10}{10 \cdot 10} = \frac{10 \cdot 10}{10 \cdot 10} \cdot 10 \cdot 10 \cdot 10 = 1 \cdot 10 \cdot 10 \cdot 10$ |                    |
| $10^6 \div 10^3$       |                                                                                                                                                          |                    |
| $10^{43} \div 10^{17}$ |                                                                                                                                                          |                    |

- 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  $\frac{10^n}{10^m}$  as an equivalent expression with a single exponent, like  $10^{\square}$ .
3. It is predicted that by 2050, there will be  $10^{10}$  people living on Earth. At that time, it is predicted there will be approximately  $10^{12}$  trees. How many trees will there be for each person?

### Are you ready for more?

| expression       | expanded | single power of 10 |
|------------------|----------|--------------------|
| $10^4 \div 10^6$ |          |                    |

### 3.3 Zero Exponent

So far we have looked at powers of 10 with exponents greater than 0. Consider what would happen to our patterns if we included 0 as a possible exponent?

1. a. Write  $10^{12} \cdot 10^0$  as a single power of 10. Explain or show your reasoning.  
  
b. What number could you multiply  $10^{12}$  by to get this same answer?
2. a. Write  $\frac{10^8}{10^0}$  as a single power of 10. Explain or show your reasoning.  
  
b. What number could you divide  $10^8$  by to get this same answer?
3. In order for the exponent rules we found to work even when the exponent is 0, what does the value of  $10^0$  have to be?

### 3.4 Making Millions

Write as many expressions as you can that have the same value as  $10^8$ . Focus on using exponents, multiplication, and division.



## Lesson 3 Summary

In this lesson, we developed a rule for dividing powers of 10: Dividing powers of 10 is the same as subtracting the exponent of the denominator from the exponent of the numerator. To see this, take  $10^5$  and divide it by  $10^2$ .

| Rule                           | Example showing how it works                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\frac{10^n}{10^m} = 10^{n-m}$ | $\frac{10^5}{10^2} = \frac{10 \cdot 10 \cdot 10 \cdot 10 \cdot 10}{10 \cdot 10} = \frac{10 \cdot 10}{10 \cdot 10} \cdot 10 \cdot 10 \cdot 10 = 1 \cdot 10^3 = 10^3$ <p style="text-align: center;"> <span style="color: blue;">five factors</span><br/> <span style="color: blue;">that are ten</span> <math>\div</math> <span style="color: red;">two factors</span><br/> <span style="color: red;">that are ten</span> <math>=</math> <span style="color: blue;">three factors</span><br/> <span style="color: blue;">that are ten</span> </p> |

We know that  $10^5$  has 5 factors that are 10, and 2 of these factors can be divided by the 2 factors of 10 in  $10^2$  to make 1. That leaves  $5 - 2 = 3$  factors of 10, or  $10^3$ .

This will work for other powers of 10, too. For example  $\frac{10^{56}}{10^{23}} = 10^{56-23} = 10^{33}$ .

This rule also extends to  $10^0$ . If we look at  $\frac{10^6}{10^0}$ , using the exponent rule gives  $10^{6-0}$ , which is equal to  $10^6$ . So dividing  $10^6$  by  $10^0$  doesn't change its value. That means if we want the rule to work when the exponent is 0, then  $10^0$  must equal 1.

| Rule       | Example showing how it works                                                                                                                                                                                                           |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $10^0 = 1$ | $\frac{10^6}{10^0} = 10^{6-0} = 10^6$ <p style="text-align: center;"> <br/> <span style="color: red;">this value must<br/>be equal to 1</span> </p> |