Lesson 4: Dividing Powers of 10

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

4.1: A Surprising One

What is the value of the expression?

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

4.2: 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
$10^4 \div 10^2$	$\frac{10\cdot10\cdot10\cdot10}{10\cdot10} = \frac{10\cdot10}{10\cdot10} \cdot 10 \cdot 10 = 1 \cdot 10 \cdot 10$	10^2
	$\frac{10\cdot10\cdot10\cdot10\cdot10}{10\cdot10} = \frac{10\cdot10}{10\cdot10} \cdot 10 \cdot 10 \cdot 10 = 1 \cdot 10 \cdot 10 \cdot 10$	
$10^6 \div 10^3$		
$10^{43} \div 10^{17}$		

   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 of the form $10^{\square}$.

Grade 8 Unit 7
Lesson 4

CC BY Open Up Resources. Adaptations CC BY IM.

1

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
$10^4 \div 10^6$		

4.3: Zero Exponent

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

1.   a. Write $10^{12} \cdot 10^0$ with a power of 10 with a single exponent using the appropriate exponent rule. Explain or show your reasoning.

     b. What number could you multiply 10^{12} by to get this same answer?

2.   a. Write $\frac{10^8}{10^0}$ with a single power of 10 using the appropriate exponent rule. Explain or show your reasoning.

     b. What number could you divide 10^8 by to get this same answer?

3. If we want the exponent rules we found to work even when the exponent is 0, then what does the value of 10^0 have to be?

4. Noah says, "If I try to write 10^0 expanded, it should have zero factors that are 10, so it must be equal to 0." Do you agree? Discuss with your partner.

Grade 8 Unit 7
Lesson 4

CC BY Open Up Resources. Adaptations CC BY IM.

2

4.4: Making Millions

Write as many expressions as you can that have the same value as 10^6. Focus on using exponents, multiplication, and division. What patterns do you notice with the exponents?

Lesson 4 Summary

In an earlier lesson, we learned that when multiplying powers of 10, the exponents add together. For example, $10^6 \cdot 10^3 = 10^9$ because 6 factors that are 10 multiplied by 3 factors that are 10 makes 9 factors that are 10 all together. We can also think of this multiplication equation as division:

$$10^6 = \frac{10^9}{10^3}$$

So when dividing powers of 10, the exponent in the denominator is subtracted from the exponent in the numerator. This makes sense because

$$\frac{10^9}{10^3} = \frac{10^3 \cdot 10^6}{10^3} = \frac{10^3}{10^3} \cdot 10^6 = 1 \cdot 10^6 = 10^6$$

This rule works for other powers of 10 too. For example, $\frac{10^{56}}{10^{23}} = 10^{33}$ because 23 factors that are 10 in the numerator and in the denominator are used to make 1, leaving 33 factors remaining.

This gives us a new exponent rule:

$$\frac{10^n}{10^m} = 10^{n-m}.$$

So far, this only makes sense when n and m are positive exponents and $n > m$, but we can extend this rule to include a new power of 10, 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 that if we want the rule to work when the exponent is 0, then it must be that

$$10^0 = 1$$