Expressions with Exponents

Let's use the meaning of exponents to decide if equations are true.

13.1 Which Three Go Together: Twos

Which three go together? Why do they go together?

A. $2 \cdot 2 \cdot 2 \cdot 2$

B. 16

C. 2^4

D. $4 \cdot 2$

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13.2 Is the Equation True?

Decide whether each equation is true or false. Explain or show how you know.

1. $2^4 = 2 \cdot 4$

2. $3 + 3 + 3 + 3 + 3 = 3^5$

3. $5^3 = 5 \cdot 5 \cdot 5$

4. $2^3 = 3^2$

5. $16^1 = 8^2$

6. $\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} = 4 \cdot \frac{1}{2}$

7. $\left(\frac{1}{2}\right)^4 = \frac{1}{8}$

8. $8^2 = 4^3$

13.3 What's Your Reason?

Take turns with your partner to find two equivalent expressions in each list.

- For each two that you find, explain to your partner how you know they are equivalent.
- For each two that your partner finds, listen carefully to their explanation. If you disagree, discuss your thinking and work to reach an agreement.

1. a. $5 \cdot 5$
   b. 2^5
   c. 5^2
   d. $2 \cdot 5$

2. a. 4^3
   b. 3^4
   c. $4 \cdot 4 \cdot 4$
   d. $4 + 4 + 4$

3. a. $6 + 6 + 6$
   b. 6^3
   c. 3^6
   d. $3 \cdot 6$

4. a. 11^5
   b. $11 \cdot 11 \cdot 11 \cdot 11 \cdot 11$
   c. $11 \cdot 5$
   d. 5^{11}

5. a. $\frac{1}{5} \cdot \frac{1}{5} \cdot \frac{1}{5}$

   b. $\left(\frac{1}{5}\right)^3$

   c. $\frac{1}{15}$

   d. $\frac{1}{125}$

6. a. $\left(\frac{5}{3}\right)^2$

   b. $\left(\frac{3}{5}\right)^2$

   c. $\frac{10}{6}$

   d. $\frac{25}{9}$

Are you ready for more?

What is the last digit of $3^{1,000}$ written as a whole number? Explain or show your reasoning.

Lesson 13 Summary

When adding or multiplying numbers, the order of the numbers doesn't affect the result of addition or multiplication. When working with exponents, each number means something specific, so its placement does matter.

$3 + 4$ equals $4 + 3$.	$a + b$ always equals $b + a$.
$3 \cdot 4$ equals $4 \cdot 3$.	$a \cdot b$ always equals $b \cdot a$.
3^4 does not equal 4^3.	a^b does not always equal b^a.

3^4 means $3 \cdot 3 \cdot 3 \cdot 3$, while 4^3 means $4 \cdot 4 \cdot 4$.

It is also important to remember that we use multiplication as a quicker way to express repeated addition and we use exponent as a quicker way to express repeated multiplication.

$$3 + 3 + 3 + 3 = 4 \cdot 3$$

$$3 \cdot 3 \cdot 3 \cdot 3 = 3^4$$

When working with exponents, the numbers being multiplied don't have to always be whole numbers. They can also be other kinds of numbers, like fractions, decimals, and even variables. For example, we can use exponents in each of the following ways:

$$\left(\frac{2}{3}\right)^4 = \frac{2}{3} \cdot \frac{2}{3} \cdot \frac{2}{3} \cdot \frac{2}{3}$$

$$(1.7)^3 = (1.7) \cdot (1.7) \cdot (1.7)$$

$$x^5 = x \cdot x \cdot x \cdot x \cdot x$$