

# Laws of Exponents

Name: \_\_\_\_\_

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Think of the **laws of exponents** as cheat codes for simplifying—they let you combine or reduce powers without writing out every single factor! The *Product of Powers* rule says add the exponents when you multiply like bases; the *Quotient of Powers* rule says subtract when you divide; and the *Power of a Power* rule says multiply the exponents when one power is raised to another. You will also meet rules for the power of a product, the power of a quotient, the zero exponent, and negative exponents. Learn these shortcuts now and you will breeze through algebra, scientific notation, and any problem where exponents pop up!

## Key Concepts & Quick Review

Law	Rule	Example
Product of Powers	$a^m \cdot a^n = a^{m+n}$	$3^2 \cdot 3^4 = 3^6$
Quotient of Powers	$\frac{a^m}{a^n} = a^{m-n}$	$\frac{5^7}{5^3} = 5^4$
Power of a Power	$(a^m)^n = a^{mn}$	$(2^3)^2 = 2^6$
Power of a Product	$(ab)^n = a^n \cdot b^n$	$(4 \cdot 3)^2 = 4^2 \cdot 3^2$
Power of a Quotient	$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$	$\left(\frac{2}{5}\right)^3 = \frac{8}{125}$
Zero Exponent	$a^0 = 1$ ( $a \neq 0$ )	$7^0 = 1$
Negative Exponent	$a^{-n} = \frac{1}{a^n}$	$2^{-3} = \frac{1}{8}$

### Examples

① Simplify  $\frac{4^5 \cdot 4^2}{4^3}$ .

**Think It Through:** First use the Product of Powers in the numerator:  $4^5 \cdot 4^2 = 4^7$ . Then use the Quotient of Powers:  $\frac{4^7}{4^3} = 4^{7-3} = 4^4 = 256$ .

**Answer:**  $4^4 = 256$

② Simplify  $(3^2)^3 \cdot 3^{-4}$ .

**Think It Through:** Power of a Power:  $(3^2)^3 = 3^6$ . Product of Powers:  $3^6 \cdot 3^{-4} = 3^{6+(-4)} = 3^2 = 9$ .

**Answer:**  $3^2 = 9$



 **Practice Problems**

Simplify each expression using the laws of exponents.

- |                                   |       |                          |       |
|-----------------------------------|-------|--------------------------|-------|
| 1. $2^3 \cdot 2^4 =$              | _____ | 9. $\frac{6^8}{6^5} =$   | _____ |
| 2. $5^6 \div 5^2 =$               | _____ | 10. $(4^3)^2 =$          | _____ |
| 3. $(3^2)^3 =$                    | _____ | 11. $2^{-4} =$           | _____ |
| 4. $(2 \cdot 5)^3 =$              | _____ | 12. $(3 \cdot 2)^4 =$    | _____ |
| 5. $\left(\frac{3}{4}\right)^2 =$ | _____ | 13. $\frac{9^4}{9^4} =$  | _____ |
| 6. $7^0 =$                        | _____ | 14. $5^3 \cdot 5^{-1} =$ | _____ |
| 7. $4^{-2} =$                     | _____ | 15. $(10^2)^3 =$         | _____ |
| 8. $10^5 \cdot 10^{-3} =$         | _____ |                          |       |

**Study Tips**

-  The bases must be the **same** before you can add or subtract exponents.  $2^3 \cdot 3^2$  cannot be combined with the Product of Powers rule.
-  A **negative exponent** flips the base to a fraction — it does NOT make the answer negative.
-  When in doubt, expand the expression to verify your shortcut:  $2^3 \cdot 2^2 = (2 \cdot 2 \cdot 2)(2 \cdot 2) = 2^5$ .

 **Word Problems**

16. A computer stores data in bits. A kilobyte is  $2^{10}$  bytes and a megabyte is  $2^{20}$  bytes. How many kilobytes are in one megabyte? Express your answer as a power of 2. \_\_\_\_\_
17. A savings programme triples its value every year. After 2 years the value is  $3^2$  times the original. After another 4 years, the total is  $3^2 \cdot 3^4$  times the original. Use the laws of exponents to write this as a single power and evaluate it. \_\_\_\_\_



## Answer Keys

1)  $2^7 = 128$

2)  $5^4 = 625$

3)  $3^6 = 729$

4) 1,000

5)  $\frac{9}{16}$

6) 1

7)  $\frac{1}{16}$

8)  $10^2 = 100$

9)  $6^3 = 216$

10)  $4^6 = 4096$

11)  $\frac{1}{16}$

12) 1,296

13) 1

14) 25

15) 1,000,000

16) 1,024 kilobytes

17) 729 times the original value

### Step-by-Step Explanations

*Tutoring notes not found for this topic.*



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