

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

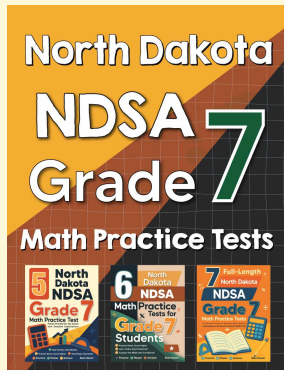
Step-by-Step Explanations

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