

Properties of Exponents

Name: _____

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Quick Review

The **exponent rules**: (1) **Product rule**: $x^a \cdot x^b = x^{a+b}$ (same base \rightarrow add exponents). (2) **Quotient rule**: $\frac{x^a}{x^b} = x^{a-b}$ (same base \rightarrow subtract). (3) **Power rule**: $(x^a)^b = x^{ab}$ (multiply). (4) **Zero exponent**: $x^0 = 1$ (for any $x \neq 0$). (5) **Negative exponent**: $x^{-a} = \frac{1}{x^a}$ (flip to denominator and negate). (6) **Power of product**: $(xy)^a = x^a y^a$. (7) **Power of quotient**: $\left(\frac{x}{y}\right)^a = \frac{x^a}{y^a}$.
Memorize these and most simplification problems become straightforward substitutions.

PRACTICE

Simplify each expression.

1. $x^3 \cdot x^4$ _____

2. $y^2 \cdot y^5$ _____

3. $\frac{x^8}{x^3}$ _____

4. $(x^2)^4$ _____

5. $(2x)^3$ _____

6. x^{-2} _____

7. x^0 _____

8. $\frac{x^4 \cdot x^2}{x^3}$ _____

9. $(3x^2)^2$ _____

10. $\left(\frac{x}{2}\right)^3$ _____

11. $x^5 \cdot x^{-2}$ _____

12. $\frac{x^2}{x^6}$ _____

13. $(xy^3)^2$ _____

14. $(x^3)^{-1}$ _____

15. $\frac{6x^5}{2x^2}$ _____

16. $(2x^3)^4$ _____

17. $x^3 \cdot x^{-5}$ _____

18. $\left(\frac{2x^2}{3}\right)^2$ _____

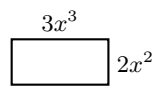
19. $\frac{x^{a+1}}{x^{a-1}}$ _____

20. $(-3x^2)^3$ _____

VISUAL PRACTICE

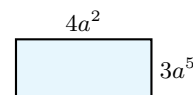
Use the graph, table, chart, or diagram to answer the question.

21. Find the area of the rectangle.



Answer: _____

22. Find the area of the rectangle.



Answer: _____

Word Problems

23. A bacteria population doubles every hour. If it starts at x , write the population after 5 hours. _____

24. A design file is compressed to $\left(\frac{1}{2}\right)^3$ of its original size, then compressed again to $\left(\frac{1}{2}\right)^2$ of that result. What fraction of the original file remains? _____

25. A storage box has side lengths $2x$ inches, $3x$ inches, and x^2 inches. Write a simplified expression for its volume. _____

26. A sensor records one reading every $\frac{1}{1000}$ second. Write the time between readings as a power of 10 with a negative exponent. _____



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Answer Keys

- | | |
|------------------------------|----------------------|
| 1. x^7 | 14. $\frac{1}{x^3}$ |
| 2. y^7 | 15. $3x^3$ |
| 3. x^5 | 16. $16x^{12}$ |
| 4. x^8 | 17. $\frac{1}{x^2}$ |
| 5. $8x^3$ | 18. $\frac{4x^4}{9}$ |
| 6. $\frac{1}{x^2}$ | 19. x^2 |
| 7. 1 | 20. $-27x^6$ |
| 8. x^3 | 21. $6x^5$ |
| 9. $9x^4$ | 22. $12a^7$ |
| 10. $\frac{x^3}{8}$ | 23. $32x$ |
| 11. x^3 | 24. $\frac{1}{32}$ |
| 12. $x^{-4} = \frac{1}{x^4}$ | 25. $6x^4$ |
| 13. x^2y^6 | 26. 10^{-3} second |

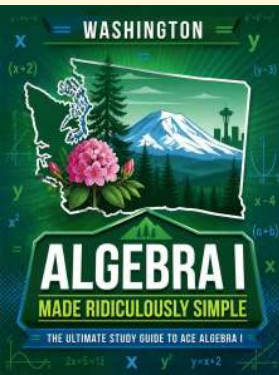
Step-by-Step Tutor Notes

- Work one inverse operation at a time and keep both sides balanced. Add exponents: $3 + 4 = 7$. After simplifying, the answer is x^7 .
- This is a good place to slow down, check the notation, and simplify cleanly. $2 + 5 = 7$. So the answer is y^7 .
- Keep the order of operations in view, then simplify without skipping the sign check. Subtract: $8 - 3 = 5$. After simplifying, the answer is x^5 .
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Multiply: $2 \cdot 4 = 8$. After simplifying, the answer is x^8 .
- Start with the definition the problem is testing, then apply it directly. $(2)^3 \cdot x^3 = 8x^3$. So the answer is $8x^3$.
- Start with the definition the problem is testing, then apply it directly. Negative exponent flips to denominator. So the answer is $\frac{1}{x^2}$.
- Use the structure of the expression to find the important point, then check that it fits the context. Anything (nonzero) to the 0 is 1. That leads to 1.
- Work one inverse operation at a time and keep both sides balanced. Combine top: x^6 . Divide: $x^{6-3} = x^3$. After simplifying, the answer is x^3 .
- Take it one clear step at a time and keep the original question in mind. $9 \cdot x^4$. So the answer is $9x^4$.
- Start with the definition the problem is testing, then apply it directly. $\frac{x^3}{2^3} = \frac{x^3}{8}$. So the answer is $\frac{x^3}{8}$.
- Take it one clear step at a time and keep the original question in mind. $5 + (-2) = 3$. So the answer is x^3 .
- This is a good place to slow down, check the notation, and simplify cleanly. $2 - 6 = -4$. Or write as $\frac{1}{x^4}$. So the answer is $x^{-4} = \frac{1}{x^4}$.
- Use the structure of the expression to find the important point, then check that it fits the context. Each factor gets the exponent. That leads to x^2y^6 .
- Work one inverse operation at a time and keep both sides balanced. Multiply: $3 \cdot (-1) = -3$. After simplifying, the answer is $\frac{1}{x^3}$.
- Use the clue in the question first, then let the arithmetic finish the job. Numbers: $6/2 = 3$. Variables: $x^{5-2} = x^3$. So the answer is $3x^3$.
- Take it one clear step at a time and keep the original question in mind. $2^4 = 16$ and $x^{3 \cdot 4} = x^{12}$. So the answer is $16x^{12}$.
- Focus on the main idea of the problem, then simplify carefully. $3 + (-5) = -2$, so $\frac{1}{x^2}$. So the answer is $\frac{1}{x^2}$.
- This is a good place to slow down, check the notation, and simplify cleanly. Square top and bottom. So the answer is $\frac{4x^4}{9}$.
- This is a good place to slow down, check the notation, and simplify cleanly. $(a + 1) - (a - 1) = 2$. So the answer is x^2 .
- Start with the definition the problem is testing, then apply it directly. $(-3)^3 = -27$, x^6 . So the answer is $-27x^6$.
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Multiply coefficients and add exponents: $(3x^3)(2x^2) = 6x^5$. After simplifying, the answer is $6x^5$.
- Work one inverse operation at a time and keep both sides balanced. Multiply the coefficients and add exponents: $4a^2 \cdot 3a^5 = 12a^7$. After simplifying, the answer is $12a^7$.
- Set up the model from the story, then calculate carefully. Doubling 5 times: $x \cdot 2^5 = 32x$.
- Both factors have the same base, so add the exponents: $(\frac{1}{2})^3 (\frac{1}{2})^2 = (\frac{1}{2})^5 = \frac{1}{32}$.
- Multiply: $2 \cdot 3 \cdot 1 = 6$ for the coefficients. For variables: $x \cdot x \cdot x^2 = x^4$. Volume = $6x^4$ cubic inches.
- $1000 = 10^3$, so $\frac{1}{1000} = 10^{-3}$. The negative exponent is a compact way to show a small fraction of a second.



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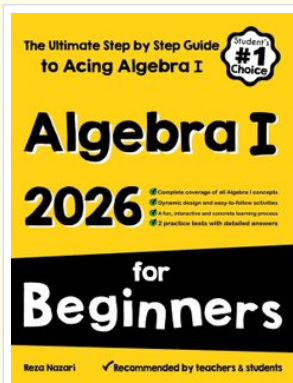
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