Properties of Exponents

Name: _____	Date: _____	Score: _____ / 26

Quick Review

The **exponent rules**: **(1) Product rule**: $x^a \cdot x^b = x^{a+b}$ (same base → add exponents). **(2) Quotient rule**: $\frac{x^a}{x^b} = x^{a-b}$ (same base → 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

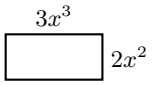
Simplify each expression.

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

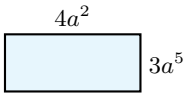
Use the graph, table, chart, or diagram to answer the question.

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 ex

_____

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Answer Keys

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

Step-by-Step Tutor Notes

1. Work one inverse operation at a time and keep both sides balanced. Add exponents: $3 + 4 = 7$. After simplifying, the answer is x^7.
2. This is a good place to slow down, check the notation, and simplify cleanly. $2 + 5 = 7$. So the answer is y^7.
3. 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.
4. 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.
5. Start with the definition the problem is testing, then apply it directly. $(2)^3 \cdot x^3 = 8x^3$. So the answer is $8x^3$.
6. Start with the definition the problem is testing, then apply it directly. Negative exponent flips to denominator. So the answer is $\frac{1}{x^2}$.
7. 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.
8. 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.
9. Take it one clear step at a time and keep the original question in mind. $9 \cdot x^4$. So the answer is $9x^4$.
10. 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 $\frac{x^3}{8}$.
11. Take it one clear step at a time and keep the original question in mind. $5 + (-2) = 3$. So the answer is x^3.
12. 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 $x^{-4} = \frac{1}{x^4}$.
13. 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.
14. Work one inverse operation at a time and keep both sides balanced. Multiply: $3 \cdot (-1) = -3$. After simplifying, the answer is $\frac{1}{x^3}$.
15. 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 $3x^3$.
16. 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 $16x^{12}$.
17. Focus on the main idea of the problem, then simplify carefully. $3 + (-5) = -2$, so $\frac{1}{x^2}$. So the answer is $\frac{1}{x^2}$.
18. This is a good place to slow down, check the notation, and simplify cleanly. Square top and bottom. So the answer is $\frac{4x^4}{9}$.
19. 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.
20. Start with the definition the problem is testing, then apply it directly. $(-3)^3 = -27$, x^6. So the answer is $-27x^6$.
21. 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 $6x^5$.
22. 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 $12a^7$.
23. Set up the model from the story, then calculate carefully. Doubling 5 times: $x \cdot 2^5 = 32x$.
24. Both factors have the same base, so add the exponents: $\left(\frac{1}{2}\right)^3 \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^5 = \frac{1}{32}$.
25. 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.
26. $1000 = 10^3$, 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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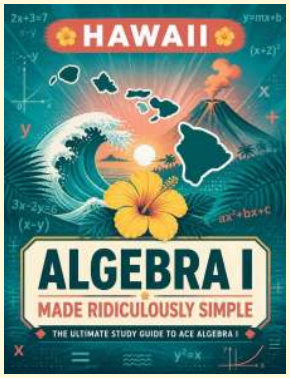

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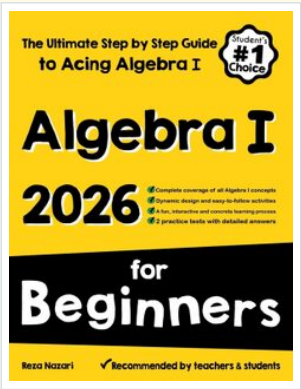

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