

Properties of Integer Exponents

Name: _____ Date: _____ Score: _____ / 24

Quick Review

An **exponent** tells you how many times to multiply a base by itself, so $2^3 = 2 \cdot 2 \cdot 2 = 8$. A few friendly rules do most of the work. When you *multiply* powers with the same base, **add** the exponents: $a^m \cdot a^n = a^{m+n}$. When you *divide*, **subtract** them: $\frac{a^m}{a^n} = a^{m-n}$. A **power of a power** multiplies the exponents: $(a^m)^n = a^{mn}$. Finally, $a^0 = 1$ for any nonzero base, and a **negative exponent** means “flip it”: $a^{-n} = \frac{1}{a^n}$.

◇ **Example:** Simplify $\frac{2^5 \cdot 2^3}{2^4}$.

⇒ Let us take this one step at a time. On top we are multiplying powers with the same base, so we **add** the exponents: $2^5 \cdot 2^3 = 2^{5+3} = 2^8$. Now the fraction is $\frac{2^8}{2^4}$, and dividing means we **subtract** the exponents: $2^{8-4} = 2^4$. Last step, just evaluate: $2^4 = 16$. See how the rules let you avoid writing out all those twos?

Answer: $2^4 = 16$

PRACTICE

Simplify each expression. Write answers with positive exponents.

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|------------------------|-------|------------------------------------|-------|
| 1. $3^2 \cdot 3^3$ | _____ | 11. $x^4 \cdot x^5$ | _____ |
| 2. $5^4 \cdot 5^2$ | _____ | 12. $\frac{y^{10}}{y^3}$ | _____ |
| 3. $\frac{7^6}{7^2}$ | _____ | 13. $(a^3)^4$ | _____ |
| 4. $\frac{10^8}{10^5}$ | _____ | 14. $\frac{3^2}{3^5}$ | _____ |
| 5. $(2^3)^2$ | _____ | 15. $4^3 \cdot 4^{-1}$ | _____ |
| 6. $(4^2)^3$ | _____ | 16. $(2 \cdot 5)^2$ | _____ |
| 7. 6^0 | _____ | 17. $(\frac{2}{3})^3$ | _____ |
| 8. $(-9)^0$ | _____ | 18. $\frac{6^4}{6^4}$ | _____ |
| 9. 2^{-3} | _____ | 19. $(3^{-2})^2$ | _____ |
| 10. 5^{-2} | _____ | 20. $\frac{2^{-1} \cdot 2^4}{2^2}$ | _____ |

Word Problems

21. A single bacterium splits into 2 every hour. After t hours there are 2^t bacteria. How many bacteria are there after 6 hours, and how many more is that than after 4 hours? _____
22. A square garden has side length 3^2 feet. Write its area as a single power of 3, then find the area in square feet. _____
23. A computer file is 2^{10} kilobytes. A second file is 2^7 kilobytes. How many times larger is the first file than the second? _____
24. A recipe is shared so that each person passes it to 5 new people. Round 1 reaches 5^1 people and round 3 reaches 5^3 people. Using exponent rules, how many times more people does round 3 reach than round 1? _____



Answer Keys

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| <p>1. $3^5 = 243$</p> <p>2. $5^6 = 15625$</p> <p>3. $7^4 = 2401$</p> <p>4. $10^3 = 1000$</p> <p>5. $2^6 = 64$</p> <p>6. $4^6 = 4096$</p> <p>7. 1</p> <p>8. 1</p> <p>9. $\frac{1}{8}$</p> <p>10. $\frac{1}{25}$</p> <p>11. x^9</p> <p>12. y^7</p> | <p>13. a^{12}</p> <p>14. $\frac{1}{27}$</p> <p>15. 16</p> <p>16. 100</p> <p>17. $\frac{8}{27}$</p> <p>18. 1</p> <p>19. $\frac{1}{81}$</p> <p>20. 2</p> <p>21. $2^6 = 64$ bacteria; $64 - 16 = 48$ more than after 4 hours</p> <p>22. $(3^2)^2 = 3^4 = 81$ square feet</p> <p>23. $\frac{2^{10}}{2^7} = 2^3 = 8$ times larger</p> <p>24. $\frac{5^3}{5^1} = 5^2 = 25$ times more</p> |
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Step-by-Step Explanations

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| <p>1. Same base, so add the exponents: $3^{2+3} = 3^5 = 243$.</p> <p>2. Add the exponents: $5^{4+2} = 5^6 = 15625$.</p> <p>3. Dividing like bases subtracts exponents: $7^{6-2} = 7^4 = 2401$.</p> <p>4. Subtract the exponents: $10^{8-5} = 10^3 = 1000$.</p> <p>5. A power of a power multiplies exponents: $2^{3 \cdot 2} = 2^6 = 64$.</p> <p>6. Multiply the exponents: $4^{2 \cdot 3} = 4^6 = 4096$.</p> <p>7. Any nonzero base to the zero power equals 1.</p> <p>8. Even with a negative base, the zero power gives 1 (the base is not 0).</p> <p>9. A negative exponent flips the base: $2^{-3} = \frac{1}{2^3} = \frac{1}{8}$.</p> <p>10. Flip it: $5^{-2} = \frac{1}{5^2} = \frac{1}{25}$.</p> <p>11. Add the exponents: $x^{4+5} = x^9$.</p> <p>12. Subtract the exponents: $y^{10-3} = y^7$.</p> <p>13. Multiply: $a^{3 \cdot 4} = a^{12}$.</p> <p>14. Subtract: $3^{2-5} = 3^{-3} = \frac{1}{3^3} = \frac{1}{27}$.</p> | <p>15. Add the exponents: $4^{3+(-1)} = 4^2 = 16$.</p> <p>16. A product to a power: $(2 \cdot 5)^2 = 10^2 = 100$.</p> <p>17. Raise top and bottom: $\frac{2^3}{3^3} = \frac{8}{27}$.</p> <p>18. Subtract: $6^{4-4} = 6^0 = 1$.</p> <p>19. Multiply exponents: $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$.</p> <p>20. Add on top: $2^{-1+4} = 2^3$. Then divide: $2^{3-2} = 2^1 = 2$.</p> <p>21. After 6 hours there are $2^6 = 64$ bacteria, and after 4 hours there are $2^4 = 16$. The difference is $64 - 16 = 48$ extra bacteria.</p> <p>22. Area of a square is side squared: $(3^2)^2$. A power of a power multiplies exponents, so $3^{2 \cdot 2} = 3^4 = 81$ square feet.</p> <p>23. "How many times larger" means divide: $\frac{2^{10}}{2^7} = 2^{10-7} = 2^3 = 8$, so the first file is 8 times larger.</p> <p>24. Divide the powers: $\frac{5^3}{5^1} = 5^{3-1} = 5^2 = 25$. Round 3 reaches 25 times as many people as round 1.</p> |
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