

# 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.

- |                        |       |                                    |       |
|------------------------|-------|------------------------------------|-------|
| 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

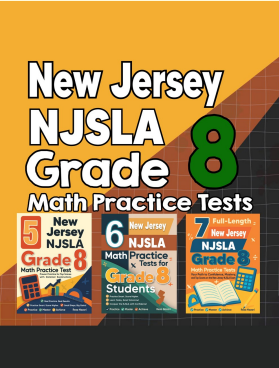
- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. <math>3^5 = 243</math></li> <li>2. <math>5^6 = 15625</math></li> <li>3. <math>7^4 = 2401</math></li> <li>4. <math>10^3 = 1000</math></li> <li>5. <math>2^6 = 64</math></li> <li>6. <math>4^6 = 4096</math></li> <li>7. <math>1</math></li> <li>8. <math>1</math></li> <li>9. <math>\frac{1}{8}</math></li> <li>10. <math>\frac{1}{25}</math></li> <li>11. <math>x^9</math></li> <li>12. <math>y^7</math></li> </ol> | <ol style="list-style-type: none"> <li>13. <math>a^{12}</math></li> <li>14. <math>\frac{1}{27}</math></li> <li>15. <math>16</math></li> <li>16. <math>100</math></li> <li>17. <math>\frac{8}{27}</math></li> <li>18. <math>1</math></li> <li>19. <math>\frac{1}{81}</math></li> <li>20. <math>2</math></li> <li>21. <math>2^6 = 64</math> bacteria; <math>64 - 16 = 48</math> more than after 4 hours</li> <li>22. <math>(3^2)^2 = 3^4 = 81</math> square feet</li> <li>23. <math>\frac{2^{10}}{2^7} = 2^3 = 8</math> times larger</li> <li>24. <math>\frac{5^3}{5^1} = 5^2 = 25</math> times more</li> </ol> |
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### Step-by-Step Explanations

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| <ol style="list-style-type: none"> <li>1. Same base, so add the exponents: <math>3^{2+3} = 3^5 = 243</math>.</li> <li>2. Add the exponents: <math>5^{4+2} = 5^6 = 15625</math>.</li> <li>3. Dividing like bases subtracts exponents: <math>7^{6-2} = 7^4 = 2401</math>.</li> <li>4. Subtract the exponents: <math>10^{8-5} = 10^3 = 1000</math>.</li> <li>5. A power of a power multiplies exponents: <math>2^{3 \cdot 2} = 2^6 = 64</math>.</li> <li>6. Multiply the exponents: <math>4^{2 \cdot 3} = 4^6 = 4096</math>.</li> <li>7. Any nonzero base to the zero power equals 1.</li> <li>8. Even with a negative base, the zero power gives 1 (the base is not 0).</li> <li>9. A negative exponent flips the base: <math>2^{-3} = \frac{1}{2^3} = \frac{1}{8}</math>.</li> <li>10. Flip it: <math>5^{-2} = \frac{1}{5^2} = \frac{1}{25}</math>.</li> <li>11. Add the exponents: <math>x^{4+5} = x^9</math>.</li> <li>12. Subtract the exponents: <math>y^{10-3} = y^7</math>.</li> <li>13. Multiply: <math>a^{3 \cdot 4} = a^{12}</math>.</li> <li>14. Subtract: <math>3^{2-5} = 3^{-3} = \frac{1}{3^3} = \frac{1}{27}</math>.</li> </ol> | <ol style="list-style-type: none"> <li>15. Add the exponents: <math>4^{3+(-1)} = 4^2 = 16</math>.</li> <li>16. A product to a power: <math>(2 \cdot 5)^2 = 10^2 = 100</math>.</li> <li>17. Raise top and bottom: <math>\frac{2^3}{3^3} = \frac{8}{27}</math>.</li> <li>18. Subtract: <math>6^{4-4} = 6^0 = 1</math>.</li> <li>19. Multiply exponents: <math>3^{-4} = \frac{1}{3^4} = \frac{1}{81}</math>.</li> <li>20. Add on top: <math>2^{-1+4} = 2^3</math>. Then divide: <math>2^{3-2} = 2^1 = 2</math>.</li> <li>21. After 6 hours there are <math>2^6 = 64</math> bacteria, and after 4 hours there are <math>2^4 = 16</math>. The difference is <math>64 - 16 = 48</math> extra bacteria.</li> <li>22. Area of a square is side squared: <math>(3^2)^2</math>. A power of a power multiplies exponents, so <math>3^{2 \cdot 2} = 3^4 = 81</math> square feet.</li> <li>23. "How many times larger" means divide: <math>\frac{2^{10}}{2^7} = 2^{10-7} = 2^3 = 8</math>, so the first file is 8 times larger.</li> <li>24. Divide the powers: <math>\frac{5^3}{5^1} = 5^{3-1} = 5^2 = 25</math>. Round 3 reaches 25 times as many people as round 1.</li> </ol> |
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