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

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

Step-by-Step Explanations

1. Same base, so add the exponents: $3^{2+3} = 3^5 = 243$.
2. Add the exponents: $5^{4+2} = 5^6 = 15625$.
3. Dividing like bases subtracts exponents: $7^{6-2} = 7^4 = 2401$.
4. Subtract the exponents: $10^{8-5} = 10^3 = 1000$.
5. A power of a power multiplies exponents: $2^{3 \cdot 2} = 2^6 = 64$.
6. Multiply the exponents: $4^{2 \cdot 3} = 4^6 = 4096$.
7. Any nonzero base to the zero power equals 1.
8. Even with a negative base, the zero power gives 1 (the base is not 0).
9. A negative exponent flips the base: $2^{-3} = \frac{1}{2^3} = \frac{1}{8}$.
10. Flip it: $5^{-2} = \frac{1}{5^2} = \frac{1}{25}$.
11. Add the exponents: $x^{4+5} = x^9$.
12. Subtract the exponents: $y^{10-3} = y^7$.
13. Multiply: $a^{3 \cdot 4} = a^{12}$.
14. Subtract: $3^{2-5} = 3^{-3} = \frac{1}{3^3} = \frac{1}{27}$.
15. Add the exponents: $4^{3+(-1)} = 4^2 = 16$.
16. A product to a power: $(2 \cdot 5)^2 = 10^2 = 100$.
17. Raise top and bottom: $\frac{2^3}{3^3} = \frac{8}{27}$.
18. Subtract: $6^{4-4} = 6^0 = 1$.
19. Multiply exponents: $3^{-4} = \frac{1}{3^4} = \frac{1}{81}$.
20. Add on top: $2^{-1+4} = 2^3$. Then divide: $2^{3-2} = 2^1 = 2$.
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.
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.
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.
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.

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