

Properties of Exponents

Product of Powers	Power of a Product	Power of a Power	
$a^m \cdot a^n = a^{m+n}$ Add exponents.	$(ab)^m = a^m b^m$ Find the power of each factor.	$(a^m)^n = a^{mn}$ Multiply exponents.	
Quotient of Powers	Power of a Quotient	Negative Exponent	Zero Exponent
$\frac{a^m}{a^n} = a^{m-n}, a \neq 0$ Subtract exponents.	$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}, b \neq 0$ Find the power of the numerator and the power of the denominator.	$a^{-n} = \frac{1}{a^n}, a \neq 0$	$a^0 = 1, a \neq 0$

Example 1 Evaluate (a) $4 \cdot 9^0$ and (b) $(-3)^{-4}$.

a. $4 \cdot 9^0 = 1$ Definition of zero exponent

b. $(-3)^{-4} = \frac{1}{(-3)^4}$ Definition of negative exponent
 $= \frac{1}{81}$ Evaluate power.

Example 2 Simplify each expression. Write your answer using only positive exponents.

a. $2^3 \cdot 2^4 = 2^7 = 128$

b. $\frac{5^9}{5^6} = 5^{9-6} = 5^3 = 125$

c. $\frac{12y^0}{x^{-7}} = 12y^0 x^7 = 12x^7$

d. $\frac{x^6 \cdot x^2}{x^5} = \frac{x^{6+2}}{x^5} = x^{8-5} = x^3$

e. $(z^4)^2 = z^{4 \cdot 2} = z^8$

f. $(6mn)^3 = 6^3 \cdot m^3 \cdot n^3 = 216m^3 n^3$

g. $\left(\frac{y}{3}\right)^4 = \frac{y^4}{3^4} = \frac{y^4}{81}$

h. $\frac{10x^6 y^{-2}}{5x^3 y} = \frac{10}{5} x^{(6-3)} y^{(-2-1)} = 2x^3 y^{-3} = \frac{2x^3}{y^3}$

Practice

Check your answers at BigIdeasMath.com.

Evaluate the expression.

1. $(-9)^0$

2. -8^{-1}

3. 4^{-3}

4. $\frac{-5^0}{3^{-2}}$

Simplify the expression. Write your answer using only positive exponents.

5. $2^9 \cdot 2^{-6}$

6. $-\frac{10^8}{10^{12}}$

7. $y \cdot y^{-5}$

8. $\frac{x^7}{x^{-7}}$

9. $-5x^7 \cdot x^{-11} \cdot 2x^4$

10. $\frac{x^{-2}}{5z^0}$

11. $(w^2)^{-3}$

12. $(8xy)^2$

13. $3x^5 \cdot (-2x)^4$

14. $(-5m^2 n^{-1})^3$

15. $\frac{z^8}{z^{-2} \cdot z^9}$

16. $\frac{(x^5)^3}{x^6}$

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

18. $\left(\frac{6x^4}{5y}\right)^{-2}$

19. $\frac{xy^{-2}}{x^4 y^{-3}}$

20. $\frac{8xy}{6x^5 y z^{-2}}$

21. **METRIC SYSTEM** There are 10^6 micrometers in a meter and 10^3 meters in a kilometer. How many micrometers are there in 10^6 kilometers?