

Exponents indicate powers. The table below lists the properties of exponents. Assume that no denominator is equal to zero and that m and n are integers.

Take note

Properties of Exponents

- $a^0 = 1, a \neq 0$
- $\frac{a^m}{a^n} = a^{m-n}$

- $a^{-n} = \frac{1}{a^n}$
- $(ab)^n = a^n b^n$
- $(a^m)^n = a^{mn}$

- $a^m \cdot a^n = a^{m+n}$
- $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

You know you are done when each variable is written only once, and there are no negative exponents.

Example

Simplify and rewrite each expression using only positive exponents.

a. $(5a^3)(-3a^{-4})$

$$\begin{aligned} (5a^3)(-3a^{-4}) &= 5(-3)a^{3+(-4)} \\ &= -15a^{-1} \\ &= \frac{-15}{a}, \text{ or } -\frac{15}{a} \end{aligned}$$

b. $(-4x^{-3}y^5)^2$

$$\begin{aligned} (-4x^{-3}y^5)^2 &= (-4)^2(x^{-3})^2(y^5)^2 \\ &= 16x^{-6}y^{10} \\ &= \frac{16y^{10}}{x^6} \end{aligned}$$

c. $\frac{4ab^6c^3}{a^5bc^3}$

$$\begin{aligned} \frac{4ab^6c^3}{a^5bc^3} &= 4a^{(1-5)}b^{(6-1)}c^{(3-3)} \\ &= 4a^{-4}b^5c^0 \\ &= \frac{4b^5}{a^4} \end{aligned}$$

Exercises

Simplify each expression. Use only positive exponents.

1. $(2a^3)(5a^4)$

2. $(-3x^2)(-4x^{-2})$

3. $(3x^2y^3)^2$

4. $(3x^{-4}y^3)^2$

5. $\frac{4a^8}{2a^4}$

6. $\frac{12x^5y^3}{4x^{-1}}$

7. $\frac{(6x^3)^0}{3xy^2}$

8. $\left(\frac{2x^4}{3}\right)^3$

9. $(-4m^2n^3)(2mn)$

10. $(2x^3y^7)^{-2}$

11. $\frac{(3r^{-2}s^3t^0)^{-3}}{3rs}$

12. $(h^7k^3)^0$

13. $\frac{r^2s^4t^6}{r^3s^4t^{-6}}$

14. $\frac{x^2y}{4} \cdot \frac{16x}{y}$

15. $(s^4t)^2(st)$

16. $\left(\frac{1}{h^{-2}}\right)^{-1} \cdot h^3$

17. $\frac{1}{a^2b^{-3}}(a^2b^{-3})^{-1}$

18. $\left(\frac{r^{-1}s^2t^{-3}}{r^{-2}s^0t^1}\right)^{-1}$

- © 19. **Reasoning** Your friend tells you that $(k^2)^{-5} = -k^{10}$. Did she apply the properties of exponents correctly? Explain why or why not.