

# 4.2 Properties of Exponents

- I can simplify a multiplication, division, and powers of powers
- I can simplify a power of a product or quotient
- I can simplify powers with negative or zero exponents

Our number system is called "Base 10" because our place values are powers of 10.

<u>10000</u>	<u>100</u>	<u>10</u>	<u>1</u>	<u>1/10</u>	<u>1/100</u>	<u>1/1000</u>
$10^3$	$10^2$	$10^1$	$10^0$	$10^{-1}$	$10^{-2}$	$10^{-3}$

<p><b>ZERO Exponent:</b></p> <p>Anything to the <u>0</u> power equals <u>1</u> with the exception of <u>0</u>.</p> $a^0 = 1$	<p><b>NEGATIVE Exponent:</b></p> <p>Is the <u>multiplicative</u> <u>inverse</u> or reciprocal → <u>FLIP</u> it!</p> $a^{-n} = \frac{1}{a^n}$
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1.  $\left(\frac{-5x^2y}{x^4}\right)^0 = \boxed{1}$       2.  $\frac{2x^{-3}y}{5z^{-2}} = \boxed{\frac{2yz^2}{5x^3}}$       3.  $\frac{12a^4b^4c^{-2}}{36d^{-3}} = \boxed{\frac{a^4d^3}{3c^2}}$

<p><b>Product of Powers Property:</b> <u>ADD</u> the exponents</p> $a^m \cdot a^n = a^{m+n}$	<p>ex: <math>x^2 \cdot x^3</math> XX · XXX <math>\boxed{x^5}</math></p>
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4.  $(-5)(-5)^6 = \boxed{(-5)^7}$       5.  $x^4 \cdot x^3 \cdot x^1 = \boxed{x^8}$       6.  $(4.2 \times 10^3)(5.3 \times 10^{-7}) = \boxed{2.226 \times 10^{-3}}$   
22,26 × 10<sup>-4+1</sup>      TOO BIG BY 1 → ADD 1 TO EXPONENT

<p><b>Quotient of Powers Property:</b> <u>SUBTRACT</u> the exponents</p> $\frac{a^m}{a^n} = a^{m-n}$	<p>ex: <math>\frac{x^6}{x^2}</math> <del>XXXXXX</del> XX <math>\boxed{x^4}</math></p>
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7.  $\frac{8^{10}}{8^4} = \boxed{8^6}$       8.  $\frac{(-3)^2}{(-3)^7} = (-3)^{-5} = \boxed{\frac{1}{(-3)^5}}$       9.  $\frac{3.2 \times 10^4}{4 \times 10^{-1}} = \overset{8}{\underbrace{3.2}_{4++}} \times 10^5 = \boxed{8 \times 10^4}$   
\* no negative exponents \*      TOO SMALL BY 1 → SUBTRACT 1 FROM EXPONENT

Power of a Power Property: MULTIPLY the exponents

ex:  $(x^2)^3$

$$(a^m)^n = a^{mn}$$

$$\begin{array}{c} x^2 \cdot x^2 \cdot x^2 \\ \times \times \times \times \times \\ \boxed{x^6} \end{array}$$

$$10. [(-6)^2]^5 = \boxed{(-6)^{10}}$$

$$11. [(y+2)^6]^2 = \boxed{(y+2)^{12}}$$

$$12. (2^1)^{-2} = 2^{-6} = \frac{1}{2^6} = \boxed{\frac{1}{64}}$$

Power of a Product or Quotient: Raise EVERYTHING to the power!

$$(ab)^m = a^m b^m$$

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$$

- Simplify anything in the parentheses first!
- Raise numbers to the exponent and evaluate (may need calculator)
- Raise variables using Power of a Power property → Multiplied Exponents

$$13. (2x^5)^3 = \boxed{8x^{15}}$$

$$(2)^3 (x^5)^3$$

$$14. \left(\frac{-7x}{y^3}\right)^2 = \boxed{\frac{49x^2}{y^6}}$$

$$15. (2.3 \times 10^{-4})^3 = \boxed{12.167 \times 10^{-12+1}}$$

$$(2.3)^3 (10^{-4})^3 \quad \boxed{1.2167 \times 10^{-11}}$$

### Suggested Steps to Simplify:

1. **INSIDE** parentheses
  - a. Flip any negative exponents
  - b. Simplify numbers
  - c. Simplify like bases
2. **OUTSIDE** parentheses
  - a. Flip if a negative exponent
  - b. Simplify numbers
  - c. Simplify like bases

You are **DONE** when...

1. No parentheses
2. No negative or zero exponents
3. Numbers are reduced
4. Each base appears only once

### Do & Discuss

$$A. \frac{8a^2 b^{-5} c^6}{2b^3 c^{-2}} = \frac{8a^2 c^2}{2b^3 b^5} = \boxed{\frac{4a^2 c^2}{b^8}}$$

$$B. (3x^4 y^5)^3 \cdot (-2xy^6)^2 = (27x^{12} y^{15})(4x^2 y^{12}) = \boxed{108x^{14} y^{27}}$$

$$C. \left(\frac{3x^4}{y^7}\right)^3 \cdot \left(\frac{y}{2x}\right)^2 = \frac{27x^{12}}{y^{21}} \cdot \frac{y^2}{4x^2} = \boxed{\frac{27x^{10}}{4y^{19}}}$$

$$D. \frac{(3a)^{-2} b^{10}}{-2a^4 b^6} = \frac{b^{10}}{(3a)^2 (-2a^4 b^6)} = \frac{b^{10}}{9a^2 (-2a^4 b^6)} = \boxed{-\frac{b^4}{18a^6}}$$

$$E. \left(\frac{3x^5 y}{9x^{-2} y^6}\right)^{-3} = \left(\frac{3x^5 x^2 y}{9 y^6}\right)^{-3} = \left(\frac{x^7}{3y^5}\right)^{-3} = \left(\frac{3y^5}{x^7}\right)^3 = \boxed{\frac{27y^{15}}{x^{21}}}$$

Additional Resources:

- Textbook: Chapter 5.1 pg.330