

I Simplifying Using the Rules of Exponents

The properties or rules of exponents are used to simplify exponential expressions. An exponential expression is simplified when

- No parentheses appear. Use $(ab)^n = a^n b^n$ or $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$
- No powers are raised to powers. Use $(b^m)^n = b^{mn}$
- Each base occurs only once. Use $b^m b^n = b^{m+n}$ or $\frac{b^m}{b^n} = b^{m-n}$
- No negative or zero exponents appear. Use $b^{-n} = \frac{1}{b^n}$ or $\frac{1}{b^{-n}} = b^n$ or $\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$ or $b^0 = 1$

Use the steps above to simplify.

Ex 1: $(x^4 y^{-2})^3 (4xy^5)^{-1} =$

Ex 2: $\left(\frac{-2a^4 b^{-1} a^4}{3b^{-8} b a^{-4}}\right)^{-2} =$

Ex 3: $\frac{(3x^2yz^5)^{-2}x^{-2}z^3}{x^4(y^2z^{-3})^2} =$

Ex 4: $\left(\frac{2x^{-3}}{y^2}\right)^3(3^{-1}x^{-4}y^2) =$

Ex 5: True or False?

- a) $2^{-4} = -16$
- b) $x^4 = 4x$
- c) $(-3)^4 = -81$
- d) $3^{-4} = \frac{1}{81}$
- e) $(-5)^{-2}$ is negative.
- f) $(-4a)^3 = -4a^3$
- g) $-8x^2 = 64x^2$

Ex 6: Evaluate.

$$4^0 + 3^{-1} + \left(\frac{1}{2}\right)^2$$

II Writing Numbers in Scientific Notation

A number is written in **scientific notation** when it is in the form $a \times 10^n$ where $1 \leq |a| < 10$ and n is an integer. If the original number is 10 or greater, the exponent of the base 10 will be positive. If the original number is less than 1, the exponent of the base 10 will be negative. If the original number is at least 1, but less than 10, the exponent of the base 10 will be zero.

A positive exponent of 10 corresponds to a 10 or larger number. A negative exponent of 10 corresponds to a decimal number (less than 1).

Ex 7: Write each standard number in scientific notation.

- a) It has been estimated that in the year 2020, the world population will be approximately 7,516,000,000 (Source: U.S. Bureau of the Census, International Data Base)

- b) A grain of sand has a mass of 0.0648 grams.

Ex 8: Write each scientific notation number as a standard number.

- a) The lightest known particle in the universe, a neutrino has a maximum mass of 1.8×10^{-36} kg. (Source: Guinness Book of World Records, 2004)

- b) A ton of 5-dollar bills is worth $\$4.54 \times 10^6$.