## Properties of Exponents

| Property Name | Property Statement | Examples |
|---|---|---|
| Zero Exponent | $b^0 = 1$ | $2^0 = 1$, $x^0 = 1$ |
| Negative Exponent | $b^{-n} = \frac{1}{b^n}$ | $X^{-3} = \frac{1}{X^3}$, $a^{-4}b = \frac{b}{a^4}$, $\frac{1}{k^{-3}} = \frac{1}{\frac{1}{k^3}} = k^3$, $\frac{x^3y^{-2}}{z^{-4}} = \frac{x^3z^4}{y^2}$ |
| Product of Powers | $b^m \cdot b^n = b^{m+n}$ | $g^3 \cdot g^5 = g^8$, $a \cdot a^3 \cdot a^4 = a^8$, $c^3r^4 \cdot c^2r^6t = c^5r^8t$ |
| Quotient of Powers | $\frac{b^m}{b^n} = b^{m-n}$ | $\frac{3^6}{3^2} = 3^4$, $\frac{x^2y^4}{y^2} = x^2y^2$, $\frac{w^3x^2}{wx^5} = w^2x^{-3}$ |
| Power of a Power | $(b^m)^n = b^{mn}$ | $(a^3)^4 = a^{12}$, $(p^{-2})^3 = p^{-6}$ |
| Power of a Product | $(ab)^n = a^nb^n$ | $(kt)^4 = k^4t^4$, $(a^2g^4)^3 = a^6g^{12}$, $(4v^2y^3)^2 = 16v^4y^6$ |
| Power of a Quotient | $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$ | $\left(\frac{h}{k}\right)^4 = \frac{h^4}{k^4}$, $\left(\frac{3x^3}{y^4z^2}\right)^5 = \frac{243x^{15}}{y^{20}z^{10}}$ |

The properties shown above are the main ones shown in any textbook. The following, although not a property, is something helpful that can be shown from the other properties:
$\left(\frac{a}{b}\right)^{-n} = \frac{a^{-n}}{b^{-n}} = \frac{b^n}{a^n} = \left(\frac{b}{a}\right)^n$. In other words, if a fraction has a negative exponent, then you can simply flip over the fraction and change the negative exponent to a positive exponent of the same value.

Further examples:
(Note: expressions with negative exponents are not considered simplified.)

Ex. 1: $\left(\frac{3a^2b^3}{a^5b}\right)^3 = \left(\frac{3b^2}{a^3}\right)^3 = \frac{3^3b^6}{a^9} = \frac{27b^6}{a^9}$

Ex. 2: $\left(x^{-3}y^4z^{-1}\right)^3 = \left(\frac{y^4}{x^3z}\right)^3 = \frac{y^{12}}{x^9z^3}$

Ex. 3: $\left(\frac{3m^{-2}t^2}{12}\right)^3 = \left(\frac{m^{-2}t^2}{4}\right)^3 = \left(\frac{t^2}{4m^2}\right)^3 = \frac{t^6}{4^3m^6} = \frac{t^6}{64m^6}$

Ex. 4: $\left(\frac{2b^{-2}c^3d^{-2}}{6c^7d^5}\right)^{-2} = \left(\frac{1}{3b^2c^4d^2d^5}\right)^{-2} = \left(\frac{1}{3b^2c^4d^7}\right)^{-2} = \left(\frac{3b^2c^4d^7}{1}\right)^2 = 9b^4c^8d^{14}$