Exponential Notation:

\[ x^n \]

- the expression above is read “\( x \) to the power of \( n \)”, where \( x \) is the base and \( n \) is the exponent
- when the exponent \( n \) is a positive integer, such as 1, 2, 3, 4, ... , exponential notation represents the product of repeated factors (the base times itself some number of times)
  - anytime you have an exponent that is a positive integer you can write the base that number of times
  - another option is to use the rules we’ve covered so far (Product, Quotient, and Power), or the rules we’re about to cover (Product to a Power and Quotient to a Power)

Product to a Power Rule:

- when a product is raised to a power, the exponent is distributed to each factor (don’t forget the coefficients)
  - \((3x^4y^3)^2 = \) \( (-4x^2y^5)^3 = \)

\[ (-4)^3(x^2)^3(y^5)^3 \]

\[ (-4)(-4)(-4)x^6y^{15} \]

\[ -64x^6y^{15} \]
**Quotient to a Power Rule:**
- when a quotient is raised to a power, the exponent is distributed to each factor in the numerator and denominator (don’t forget the coefficients)

\[
\frac{x^3}{y^4}^5 = \frac{(3x^4y^5)^4}{(-2xy^3)} = \frac{81x^{16}y^{20}}{16x^4y^{12}}
\]

\[
\frac{81x^{12}y^8}{16}
\]

Keep in mind that once again, the exponent rules are just shortcuts. If you prefer not to use those shortcuts, you should still get the same answer:

\[
\left(\frac{3x^4y^5}{-2xy^3}\right)^4 = \left(\frac{3x^4y^5}{-2xy^3}\right)\left(\frac{3x^4y^5}{-2xy^3}\right)\left(\frac{3x^4y^5}{-2xy^3}\right) = \frac{81x^{16}y^{20}}{16x^4y^{12}} = \frac{81x^{12}y^8}{16}
\]

**There is NO Sum to a Power Rule or Difference to a Power Rule**
- \((5x)^2 = 5^2x^2, \quad \text{BUT} \quad (5 + x)^2 \neq 5^2 + x^2\)
- \(\left(\frac{6}{y}\right)^3 = \frac{6^3}{y^3}, \quad \text{BUT} \quad (6 - y)^3 \neq 6^3 - y^3\)

- when a sum or difference is raised to a power, the power is **NOT** distributive; if the power is a positive integer (such as 2 or 3), we simply write the sum or difference that number of times and then multiply the expressions (this will be covered in Lesson 5)

\[
\cdot (5 + x)^2 = (5 + x)(5 + x) \quad \cdot (6 - y)^3 = (6 - y)(6 - y)(6 - y)
\]

- feel free to use numbers to show that there is no Sum to a Power Rule or Difference to a Power Rule

\[
\begin{align*}
(5 + 10)^2 & \neq 5^2 + 10^2 & (6 - 4)^3 & \neq 6^3 - 4^3 \\
(15)^2 & \neq 25 + 100 & (2)^3 & \neq 216 - 64 \\
225 & \neq 125 & 8 & \neq 152
\end{align*}
\]
Example 1: Simplify each expression **COMPLETELY**.

a. \(-9y^3 (3y^3)^2\)

b. \(\left(\frac{-6}{y}\right)^2 \left(\frac{y^4}{3}\right)^3\)

For help using the TI-30Xa calculator, take a look at the Calculator Tips document in Brightspace.
Example 2: Simplify each expression COMPLETELY. Do NOT leave negative exponents in your answers.

a. \(-8y^2 (3y^3)^4\)

\((-8)^2 (y)^2 (3)^2 (y^5)^2\)

\(64 \cdot y^2 \cdot 9 \cdot y^{10}\)

\(576y^{12}\)

d. \(\left(\frac{2x^4}{y^7}\right)^3 \left(\frac{-x^5}{2y^6}\right)^2\)

\(\frac{8x^{12}}{y^{21}} \cdot \frac{x^{10}}{4y^{12}}\)

\(\frac{8x^{22}}{4y^{33}}\)

\(2x^{22}\)

\(\frac{y^{33}}{y^{33}}\)

e. \(\left(-\frac{3}{2}\right)^4 - \frac{9^2}{16}\)

\(-1 \cdot \frac{125}{64} + \frac{1}{64}\)

\(- \frac{125}{64} + \frac{1}{64}\)

\(- \frac{124}{64}\)

\(- \frac{31}{16}\)
Answers to Examples:
1a. \(-81y^9\); 1b. \(\frac{4y^{10}}{3}\); 2a. \(-648y^{14}\); 2b. \(576y^{12}\); 2c. \(\frac{x^{20}y^{30}}{32}\);
2d. \(\frac{2x^{22}}{y^{33}}\); 2e. 0; 2f. \(-\frac{31}{16}\);