**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)
  
  - \((3x^4y^3)^2 = \)  
  - \((-4x^2y^5)^3 = \)
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)

\[
\frac{(x^3)^5}{y^4} = \quad \frac{(3x^4y^5)^4}{-2xy^3} =
\]

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 \textbf{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)
  - \((5 + x)^2 = (5 + x)(5 + x)\)
  - \((6 - y)^3 = (6 - y)(6 - y)(6 - y)\)
  - feel free to use numbers to show that there is no Sum to a Power Rule or Difference to a Power Rule
    - \((5 + 10)^2 \neq 5^2 + 10^2\)
    - \((6 - 4)^3 \neq 6^3 - 4^3\)

\[
(15)^2 \neq 25 + 100 \quad (2)^3 \neq 216 - 64
\]

\[
225 \neq 125 \quad 8 \neq 152
\]
Example 1: Simplify each expression **COMPLETELY**.

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

b. \(\left(-\frac{6}{y}\right)^2 \left(\frac{y^4}{3}\right)^3\)
**Example 2:** Simplify each expression **COMPLETELY**. Do **NOT** leave negative exponents in your answers.

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

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

c. \(\left(\frac{1}{2}x^4y^6\right)^5\) 

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

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

f. \(-\left(\frac{5}{4}\right)^3 + \left(-\frac{1}{2}\right)^6\)
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. \(-\frac{31}{16}\);