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 $1, 2, 3, 4, \ldots$, 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)
  - $(3x^4y^3)^2 =$
  - $(-4x^2y^5)^3 =$

$(-4)^3(x^2)^3(y^5)^3$

$(-4)(-4)(-4)x^6y^{15}$

$\boldsymbol{-64x^6y^{15}}$

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)
  - $\left(\frac{x^3}{y^4}\right)^5 =$
  - $\left(\frac{3x^4y^5}{-2xy^3}\right)^4 =$

$$\frac{81x^{16}y^{20}}{16x^4y^{12}}$$

$$\mathbf{\frac{81x^{12}y^8}{16}}$$

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:

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

There is NO Sum to a Power Rule or Difference to a Power Rule

- $(5x)^2 = 5^2x^2$, **BUT** $(5+x)^2 \neq 5^2 + x^2$
- $\left(\frac{6}{y}\right)^3 = \frac{6^3}{y^3}$, **BUT** $(6-y)^3 \neq 6^3 - y^3$
- 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)
  - $(5+x)^2 = (5+x)(5+x)$
  - $(6-y)^3 = (6-y)(6-y)(6-y)$
  - feel free to use numbers to show that there is no Sum to a Power Rule or Difference to a Power Rule
    - $(5+10)^2 \neq 5^2 + 10^2$

      $(15)^2 \neq 25 + 100$

      $225 \neq 125$
    - $(6-4)^3 \neq 6^3 - 4^3$

      $(2)^3 \neq 216 - 64$

      $8 \neq 152$

Example 1: Simplify each expression **COMPLETELY**.

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

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

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. $-8y^2(3y^3)^4$

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

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

$64 \cdot y^2 \cdot 9 \cdot y^{10}$

$\mathbf{576y^{12}}$

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

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

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

$\frac{8x^{22}}{4y^{33}}$

$\boldsymbol{\frac{2x^{22}}{y^{33}}}$

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

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

$-1 \cdot \frac{125}{64} + \frac{1}{64}$

$-\frac{125}{64} + \frac{1}{64}$

$-\frac{124}{64}$

$\boldsymbol{-\frac{31}{16}}$

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.* $-\frac{31}{16}$;