Lesson 5.7 Laws of Exponents

Goal: Apply exponent laws to simplify and evaluate exponential expressions

A ***power*** is an expression made up of two parts: the base and the exponent

$5^4 \rightarrow$ base: 5 exponent: 4 $7^{-2} \rightarrow$ base: 7 exponent: -2

$(-5)^4 \rightarrow$ base: -5 exponent: 4 $-5^4 \rightarrow$ base: 5 exponent: 4 $\leftarrow -5\times5\times5\times5$

$1x^3 \rightarrow$ base: x exponent: 3 $(3x)^3 \rightarrow$ base: $3x$ exponent: 3

Mathematically, a power is the ***repeated multiplication*** of the base an "exponent" number of times

In expanded form 5^4 = $5\times5\times5\times5$ and $(-5)^4$ = $(-5)\times(-5)\times(-5)\times(-5)$

If the exponent is not shown, its value is 1. For example… $x = x^1$ $2 = 2^1$

MULTIPLICATION LAW: When I multiply powers with the $\boxed{\text{SAME base,}}$ I add. the exponents

x^1

$5^5 \times 5^4 = 5^9$ $(2x)(4x^2) = 8x^3$

DIVISION LAW: When I divide powers with the SAME base, I subtract the exponents

$(-6)^{10} \div (-6)^{-2} = (-6)^{10-(-2)} = (-6)^{12}$ $\dfrac{3x^4y^5}{6x^2y^1} = 0.5x^2y^4$ or $\frac{1}{2}x^2y^4$

POWER OF A POWER LAW: When an exponent is raised to another exponent, I multiply exponents

$(3^4)^5 = 3^{4\times5} = 3^{20}$ $(-x^3)^7 = -x^{21}$

POWER OF A PRODUCT OR QUOTIENT LAW: To simplify a power of two (or more) items multiplied and/or divided, I apply the exponent to each item being multiplied and/or divided

$(-3x^4)^3 = (-3)^3(x^4)^3 = -27x^{12}$ $\left(\dfrac{4y^5}{6x^2}\right)^2 = \dfrac{4^2(y^5)^2}{6^2(x^2)^2} = \dfrac{16y^{10}}{36x^4} = \dfrac{4y^{10}}{9x^4}$

ZERO EXPONENT LAW: ANY base raised to an exponent of 'zero' is equal to one

$(3x^2y^{-6})^0 = 1$ $((3^2)^4)^0 = 1$

NEGATIVE EXPONENT LAW: Any base raised to a negative exponent is equal to the reciprocal (flip) of the base raised to the same positive. exponent

$3x^{-4}y^{-3}z = \dfrac{3z}{x^4y^3}$ $\left(\dfrac{1}{5}\right)^{-2} = \left(\dfrac{5}{1}\right)^2 = 5^2$

$3 \quad \dfrac{1}{x^4}$

$\dfrac{a^{-2}}{1} = \dfrac{1}{a^2}$

SUMMARY OF EXPONENT LAWS

$a^m \times a^n = a^{m+n}$	$a^m \div a^n = a^{m-n}$
$(a^m)^n = a^{m \times n}$	$a^0 = 1$
$(ab)^m = a^m b^m$	$a^{-m} = \frac{1}{a^m}$
$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$	$\left(\frac{a}{b}\right)^{-m} = \left(\frac{b}{a}\right)^m$

To SIMPLIFY means to write expressions with POSITIVE EXPONENTS only

EXAMPLES

First **simplify** each of the following and <u>then</u> **evaluate** for $a=1$, $b=-2$, and $c=3$

a) $(a^{-2}b)(a^{-3}b^4)$ multiply

$= \underbrace{a^{-2}a^{-3}}\underbrace{b^1 b^4}$

$= a^{-2+-3} b^{1+4}$

$= a^{-5} b^5$

$= \frac{1}{a^5} b^5$

$= \frac{b^5}{a^5}$

if $a=1$, $b=-2$

then, $= \frac{(-2)^5}{(1)^5}$

$= -32 = -32$

b) $\left(\frac{a^{-4}b^5c^2}{ab^3c}\right)$

$= a^{-4-1} b^{5-3} c^{2-1}$

$= a^{-5} b^2 c^1$

$= \frac{b^2 c}{a^5}$

Evaluate

$= \frac{(-2)^2(3)}{(1)^5}$

$= \frac{4(3)}{1}$

$= 12$

c) $(2a^2b)^5$

$= 2^5 (a^2)^5 b^5$

$= 32a^{10}b^5$

Evaluate:

$= 32(1)^{10}(-2)^5$

$= 32(-32)$

$= -1024$

d) $\frac{25ab}{(5a)^3b^2}$

$= \frac{25a^1b^1}{125a^3b^2}$

$= \frac{1}{5}a^{-2}b^{-1}$

$= \frac{1}{5a^2b}$

Evaluate:

$= \frac{1}{5(1)^2(-2)}$

$= \frac{1}{-10}$

$= -1/10$

Practice: Page 362 #1 – 3 (bef), 4 bce, 5 (bdfh), 6, 7b, 8ac, 10, 13