Math Plus

Unit 3 Lesson 1 and 2 Notes - Exponent Rules

Review

Exponents are used to show repeated Multiplication.

Example: $4 \cdot 4 \cdot 4 \cdot 4 \cdot 4 =$ 4^5

$3 \cdot 3 \cdot 3 \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y =$ $3^3x^2y^4$

Base → x^n ← Exponent/Power

When you raise a negative number to a power you need to make sure to put the number in parentheses and place the exponent on the outside.

Question 1: In the expression 8^{10}, which is the base and which is the exponent?

8 is the base, 10 is the exponent

Question 2: Which is the correct way to rewrite $-2 \cdot -2 \cdot -2 \cdot -2$? Circle one: $(-2)^4$ or -2^4

Question 3: How do the answers for $(-2)^4$ vs. -2^4 differ?

$(-2)^4$ is +16 where -2^4 is -16. Base in 1st expression is -2 where base in 2nd expression is 2.

II. Zero Exponents

Example:

Expression	Value
5^4	625
5^3	125
5^2	25
5^1	5
5^0	1

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Zero Exponent Property:

For any non-zero number a,

$a^0 = 1$

Examples:

1. $(4.7)^0$ 1
2. $(-6)^0$ 1
3. $-(6)^0$ 1
4. $(3ab)^0$ 1
5. $3ab^0$ 3a
6. $5x^0y$ 5y

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III. Negative Exponents

Example:

Expression	Value
5^4	625
5^3	125
5^2	25
5^1	5
5^0	1
5^{-1}	1/5
5^{-2}	1/25
5^{-3}	1/125

Negative Exponent Property:

For all real numbers a and n where $a \neq 0$,

$$a^{-n} = \frac{1}{a^n}$$

Examples:

1. 2^{-7} $\quad \frac{1}{2^7} = \frac{1}{128}$

2. $x^{-5}y^7$ $\quad \frac{y^7}{x^5}$

3. $4^{-2}m^{-11}$ $\quad \frac{1}{4^2m^{11}} = \frac{1}{16m^{11}}$

4. $7^{-3}s^{13}y^0$ $\quad \frac{s^{13}}{7^3} = \frac{s^{13}}{343}$

5. $\frac{-8a^{-1}b}{c^{-5}}$ $\quad \frac{-8bc^5}{a}$

Product of Powers (Multiplying with Exponents)

Example:

$$x^3 \cdot x^4$$
$$x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$$
$$x^7$$

Product of Powers Property:

For all numbers a, m, and n where $a \neq 0$,

$$a^m \cdot a^n = a^{m+n}$$

STEPS:

1. Multiply the coefficients.
2. Keep each Base and Add the exponents for that base.
3. Write the expression using positive exponents.

Examples:

1. $(8u^7v^2)(-2u^3)(5v^{-4})$

$-80u^{10}v^{-2}$

$\hookrightarrow \frac{-80u^{10}}{v^2}$

2. $(4c^2de^{-1})\left(\frac{1}{2}c^4d^{-3}e\right)$

$2c^6d^{-2}$

$\hookrightarrow \frac{2c^6}{d^2}$

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V. Power of a Power (Exponents with Exponents)

Example:

$(x^3)^2$
$(x^3)(x^3)$
$x \cdot x \cdot x \cdot x \cdot x \cdot x$
x^6

Power of a Power:

For all numbers $a, b, m,$ and n where $a \neq 0$,

$(a^m)^n = a^{mn}$

Examples:

1. $(x^2)^4$ x^8
2. $(c^{-3})^{-4}$ c^{12}
3. $(m^5)^{-6}$ $m^{-30} \Rightarrow \frac{1}{m^{30}}$

VI. Power of a Product

Example:

$(x^5y^4)^3$
$(x^5)^3(y^4)^3$
$x^{5\cdot3}y^{4\cdot3}$
$x^{15}y^{12}$

Power of a Product:

For all numbers $a, b, m,$ and n where $a \neq 0$ and $b \neq 0$

$(ab)^m = a^m b^m$

Examples:

1. $(2x^3)^7$ $2^7x^{21} \Rightarrow 128x^{21}$
2. $(a^3b^{-2})^5$ $a^{15}b^{-10} \Rightarrow a^{15}/b^{10}$
3. $(-2rs^4)^4$ $-2^4r^4s^{16} \Rightarrow 16r^4s^{16}$

VII. Putting it all together

1. $(3a^3b^{-10})^2(5a^4b^{-2})$

$(3^2a^6b^{-20})(5a^4b^2)$
$(9a^6b^{-20})(5a^4b^2)$
$45a^{10}b^{-18}$
$\frac{45a^{10}}{b^{18}}$

2. $(2m^5n)^3(3m^2n^3)^2$

$(2^3m^{15}n^3)(3^2m^4n^6)$
$(8m^{15}n^3)(9m^4n^6)$
$72m^{19}n^9$

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