Name: _____ Date: _____

EXPONENTS AS REPEATED MULTIPLICATION

We've used exponents a little so far, but they will become much more important to us as our studies in algebra progress. So, in the next few lessons we are going to work with some basic exponents. Recall that an exponent is a way to indicate **repeated multiplication by the same number**.

EXPONENTS AS REPEATED MULTIPLICATION

By definition, if n is a **positive integer**, i.e. $\{1, 2, 3, ...\}$, then $x^n = \underbrace{x \cdot x \cdot x \cdots x}_{\text{multiplied } n \text{ times}}$

***Exercise* #1:** Write out what each of the following exponents means as an extended product and find its value.

(a) 2^4 $2 \cdot 2 \cdot 2 \cdot 2$

(b) 3^2 $3 \cdot 3$

(c) 5^3 $5 \cdot 5 \cdot 5$

Of course, just as with numbers, variables can also be raised to exponents (other than 1).

***Exercise* #2:** Write out what each of the following terms involving exponents means as an extended product. Consider carefully your order of operations and remember that exponents come before multiplication.

(a) x^3 $x \cdot x \cdot x$

(b) x^2y^4 $x \cdot x \cdot y \cdot y \cdot y \cdot y$

(c) $(2x)^2$ the quantity $2x$ squared ← this is NOT the same $2x \cdot 2x$

(d) $4x^4y^3$ $4 \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y$

(e) $(9x^2)^3$ $9x^2 \cdot 9x^2 \cdot 9x^2$

(f) $(-4x^3)^2$ $-4x^3 \cdot -4x^3$ $-4 \cdot -4 \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$ COMMUTATIVE!

One of the nice aspects of exponents is that they follow very predictable patterns, often known as **exponent rules** (and they DO RULE!). Let's figure out the simplest one in the next exercise.

***Exercise* #3:** Write out each of the following products and then express them in the form x^n.

(a) x^2x^3 $x \cdot x \cdot x \cdot x \cdot x$ x^5

(b) x^5x^2 x^7

(c) x^4x^4 x^8

x^2 $(x)^2$

$x \cdot x$ $x \cdot x$

$(2x)^2$

$(2x) \cdot (2x)$

***Exercise* #4:** So, what's the pattern? Can you give a generic rule for what happens when we multiply two terms that have the same **base**?

EXPONENT RULE #1: $x^a \cdot x^b =$ x^{a+b}

When the bases are the same, ADD exponents

This exponent rule allows us to multiply larger powers of variables without actually having to write out the products. Make sure to **internalize this rule**. In other words, think about it until you are absolutely sure you understand why it works. Eventually, we will extend exponent rules to weird situations with all sorts of exponents.

***Exercise* #5:** Quickly write each of the following products as a variable raised to a single power.

(a) x^4x^9 x^{13}

(b) $x^2x^3x^4$ x^9

(c) y^2y^6 y^8

Now. Something a little bit different! What do we call those numbers in front of the x's? coefficient

***Exercise* #6:** Rewrite each of the following as equivalent expressions in simplest exponential form.

(a) $2x^7 \cdot 8x^5$

$16x^{12}$

$2 \cdot x^7 \cdot 8 \cdot x^5$

(b) $(-4x^3)(2x^2)$

$-4 \cdot x^3 \cdot 2 \cdot x^2$

$-8 \cdot x^5$

$-8x^5$

(c) $(-6x^3)^2$

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EXPONENTS AS REPEATED MULTIPLICATION
HOMEWORK

1. Rewrite each of the following terms as an extended product. Consider carefully your order of operations and remember that exponents come before multiplication. You do not need to simplify the products.

(a) 4^3 (b) $3^2 \cdot 3^3$ (c) $\left(2^3\right)^4$

(d) x^3y^4 (e) $8x^2y^5$ (f) $\left(9x^2\right)^2$

2. Write out each of the following products and then express them in simplest exponential form.

(a) x^4x^7 (b) y^3y^6 (c) $x^3y^2x^5y^2$

3. Rewrite each of the following as equivalent expressions in simplest exponential form. There is one that cannot be simplified. Identify it.

(a) $4x^3 \cdot 7x^6$ (b) $x^5y^3x^2$ (c) $\left(-x^2\right)\left(3x^{10}\right)$

(d) $x^2y^3z^3$ (e) $\left(4x\right)^3$ (f) $\left(-3x^2\right)^2$