# Powers

If you have the same number multiplied together a bunch of times, you can use powers to express all that multiplication

$$\underbrace{a \times a \times \ldots \times a}_{n \text{ factors}} = a^n$$

*"a" – the base*

*"n" – the exponent*

*"$a^n$" – the power*

Examples:

$3^2 = 3 \times 3 = 9$,

$3^3 = 3 \times 3 \times 3 = 27$,

$(-3)^3 = (-3) \times (-3) \times (-3) = -27$

# RULES (MEMORIZE)!

***$a^1 = a$*** *Any number to the power of 1 is just itself!*

*Ex: $5^1 = 5$, $20^1 = 20$, $(-6242)^1 = -6242$*

***$a^0 = 1$*** *Any number to the power of 0 is 1.*

*Ex: $5^0 = 1$, $45^0 = 1$, $(-6242)^0 = 1$*

Watch is what happens if you're lazy and you forget about the brackets!

- $3^{2 = ?}$ Take 30 seconds…work it out!

*The exponent only "sees" the number right next to it. If the brackets are missing, the exponent doesn't "see" the negative sign.*

- $3^2 = -(3)(3) = -9$ Compare with $(-3)^2 = 9$

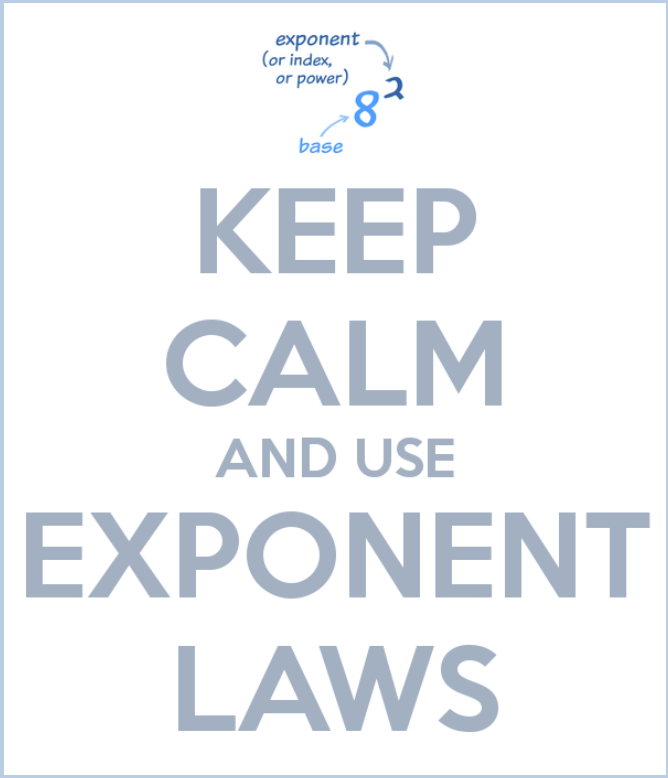
# Summary

- $a^n$ = a x a x a x a….x a (a multiplied by itself *n* times)
- $a^1 = a$
- $a^0 = 1$
- $(-a)^n \neq -a^n$ (Brackets are *really* important!)

**PRACTICE:** Page 5 in workbook #1, #2, #3

*- We will correct them together before the end of class.*

# 1.4 Exponent Laws for Multiplication and Division



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# RULES TO KNOW!

***Try:***

$5^1$ =__ $20^1$ = _____ $(-6242)^1$ = _____

$a^1 = a$ *Any number to the power of 1 is just itself!*

***Try:***

$5^0$ = _____ $45^0$=_____ $(-6242)^0$ = ____

$a^0 = 1$ *Any number to the power of 0 is 1.*

Watch is what happens if you're lazy and you forget about the brackets!

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# Investigation

- $3^2 \times 3^4$ = (expand this into factors)

  = 3x3x3x3x3x3

  = $3^6$

Re-write this expression using only *one* exponent. (Don't evaluate it)

$8^4 \times 8^6$ =

= $8^{10}$

# Investigation 2

$$7^6 \div 7^2 = \frac{7 \times 7 \times 7 \times 7 \times 7 \times 7}{7 \times 7}$$

$$= 7 \times 7 \times 7 \times 7$$

$$= 7^4$$

Try: $4^7 \div 4^3$

$$= \frac{4 \times 4 \times 4 \times 4 \times 4 \times 4 \times 4}{4 \times 4 \times 4}$$

$$= 4 \times 4 \times 4 \times 4$$

$$= 4^4$$

$$5^4 \div 4^2 = \frac{5 \times 5 \times 5 \times 5}{4 \times 4}$$

Nothing cancels if the bases aren't the same!

# Exponent Laws

1. Product of powers:

$a^m \times a^n = a^{(m+n)}$

2. Product of quotients:

$a^m \div a^n = a^{(m-n)}$

<u>THESE ONLY WORK IF THE BASES ARE THE SAME</u>

- Examples (together):

Simplify the following expressions:

1) $a^2 \cdot a^7 \cdot a$ = $a^{10}$

2) $5^4 \times 5^9$ = $5^{13}$

3) $\frac{4x^5}{2x^2}$ = $2x^3$

4) $(4x^3y^2)(-2xy^6)$ = $8x^4$

5) $\frac{10x^5y^2}{5x^1y^6}$ = $2x^4y^{-4}$

- Example 5

$5^3 + 5^2$

$125 + 25 = 150$

How many of you originally thought $5^5$? (3125)

**THERE IS NO SHORTCUT TO ADDITION OR SUBTRACTION OF POWERS. EVER.**

# Power of a Power

$(2^2)^4 = (2x2)^4$

$= (2x2)(2x2)(2x2)(2x2)$

$= (2x2x2x2x2x2x2x2)$

$= 2^8$

OR

$(2^2)^4 = 2^{(2x4)}$

$= 2^8$

**POWER RULE:**

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

# Power of a Product

$(a \cdot b)^n = a^n b^n$

***Power rule applies to <u>everything</u> inside the brackets.***

Examples

$(4z)^2 = 4^2 z^2$

$= 16z^2$

$(-2ab^2)^2 = (-2)^2 a^2 (b^2)^2$

$= 4a^2 b^4$

# Power of a Quotient

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$$

Example

$$\left(\frac{5a^2}{4b}\right)^2 =$$

$$= \frac{25a^4}{16b^2}$$

# Summary

POWER RULE:

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

Power of a Product

$(a \cdot b)^n = a^n b^n$

Power of a Quotient

$$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$$

Homework:

(circle these in your workbook NOW!)

**Page 7 – Power of a Power**

1, 2, 3

**Page 7 & 8 – Power of a Product**

1, 2, 3bdf

**Page 8 – Power of a Quotient**

1, 2abc,

# Lesson 1.5 - NEGATIVE POWERS?!

Let's see what a negative power means…

$$4^3 \div 4^5$$

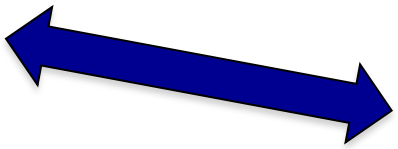
$$= 4^{3-5}$$

$$= 4^{-2}$$

$$4^3 \div 4^5$$

$$= \frac{4x4x4}{4x4x4x4x4}$$

$$= \frac{1}{4^2}$$



A base raised to a NEGATIVE power is equivalent to 1 over the original base (*the reciprocal)* with the same POWER without the negative.

eg. 2 Write as a positive power

$3^{-2} = \frac{1}{3^2}$

$p^{-3} = \frac{1}{p^3}$

$2^{-2} = \frac{1}{2^2}$

$\frac{a^3}{a^7} = a^{-4} = \frac{1}{a^4}$

$\left(10^2\right)\left(10^{-6}\right) = 10^{-4} = \frac{1}{10^4}$

$\frac{x^5 y^{-3}}{x^{10} y^{-12}} = x^{-5} y^9 = \frac{y^9}{x^5}$