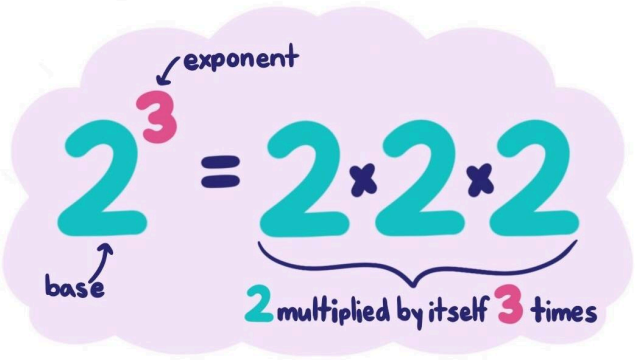
Laws of Exponents with Whole Number Exponents

Notes	Video Links & Practice Space
Vocabulary 1. **Base:** the number used as a _____ in exponential form. 2. **Exponent:** the number of times the _____ occurs as a factor. 3. **Expression:** one or more terms, may include variables, _____, operators, and grouping symbols. 4. **Factor:** one of the numbers or _____ that are multiplied together to produce a product.  **Important Note:** **Notice how** 2^3 **is not** $2 \cdot 3$	**Toolbox Tutor: Vocabulary (1:03)**

Product of Powers Law

To multiply factors that have the same base, keep the base the same and _____ the exponents.

Multiplying Powers with Same Base

$a^m \cdot a^n =$ _____

$2^3 \cdot 2^4 =$

Important Note: When multiplying powers, do not multiply or add the *bases*.

$$2^3 \cdot 2^4 = 2^{3+4} = 2^7$$

How does this work?

$$2^3 \cdot 2^4 = (2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2 \cdot 2)$$
$$= 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$$
$$= 2^7$$

Important Note: The product property can only be used for powers that have the _____ base.

We _____ use the product property to simplify $5^3 x\ 8^2$…. Why?

Because the powers have DIFFERENT bases.

The bases must be the _____ in order to _____ the exponents.

Toolbox Tutor: Product of Powers Law (2:31)

Practice Problems #1

Simplify

$5^4 \cdot 5^7 =$	$2^2 \cdot 2^9 =$
$3^4 \cdot 3^6 =$	$6^5 \cdot 6 =$

Important Note: If a number has an exponent of 1, it is usually not shown because any number with an _____ of 1 equals itself.

For example, $6^1 = 6$

Toolbox Tutor: Product of Powers Law Practice (1:29)

Quotient of Powers Law

To divide expressions that have the same base, keep the base the same and _____ the exponents.

Dividing Powers with Same Base

$$\frac{a^m}{a^n} = \_\_\_\_\_$$

$$\frac{2^5}{2^3} =$$

Important Note: When dividing powers, do not divide or subtract the *bases*.

Toolbox Tutor: Quotient of Powers Law (1:55)

How does this work?

$$\frac{2^5}{2^3} = \frac{\cancel{2}\bullet\cancel{2}\bullet\cancel{2}\bullet 2\bullet 2}{\cancel{2}\bullet\cancel{2}\bullet\cancel{2}}$$

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

We _____ use the quotient property to simplify

$4^2 \div 7^3$…. Why?

Because the powers have DIFFERENT bases.

The bases must be the _____ in order to

_____ the exponents.

Practice Problems #2

Simplify

$\frac{6^3}{6} =$	$8^9 \div 8^5 =$
$\frac{10^6}{10^4} =$	How many times larger is 3^8 than 3^3?

Toolbox Tutor: Quotient of Powers Law Practice (1:54)

Zero Exponent Law

Toolbox Tutor: Zero Exponent Law (1:14)

When the base has an exponent of zero, it is _____ to 1.

$a^0 = 1$ when $a \neq 0$

$5^0 = 1$

How does this work?

$$\frac{3^3}{3^3} = \frac{\cancel{3} \cdot \cancel{3} \cdot \cancel{3}}{\cancel{3} \cdot \cancel{3} \cdot \cancel{3}} = \frac{1}{1} = 1$$

$$\frac{3^3}{3^3} = 3^{3-3} = 3^0 = 1$$

Practice Problems #3

Toolbox Tutor: Zero Exponent Law Practice (0:53)

Simplify

$3.2^0 =$	$1200^0 =$
$(2)^0 =$	$16^{-3} \bullet 16^3 =$

Power of a Power Law

To raise an expression with an exponent to another exponent, keep the base the same and _____ the exponents.

$(a^m)^n =$

$(8^2)^5 =$

See why this works:

Product Property

$(6^2)^3 = (6^2) \cdot (6^2) \cdot (6^2) = 6^{2+2+2} = 6^6$

Expanded Form

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

$(6 \cdot 6) \cdot (6 \cdot 6) \cdot (6 \cdot 6) = 6^6$

Important Note: We do not add or multiply the base by the exponent. We only multiply the exponents.

Toolbox Tutor: Power of a Power Law (2:05)

Practice Problems #4

Simplify

$(6^2)^4 =$	$(9^0)^5 =$
$(\frac{1}{5}^3)^x =$	$-(4^5)^3 =$

Toolbox Tutor: Power of a Power Law Practice (1:18)

Power of Product Law

To raise a product to an exponent, raise each _____ to the exponent.

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

$$(7^2 \cdot 9^4)^3$$

Power of a Quotient Law

$$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m} \; b \neq 0$$

$$\left(\frac{11^4}{15^6}\right)^3 = \frac{11^{4\cdot 3}}{15^{6\cdot 3}} = \frac{11^{12}}{15^{18}}$$

Toolbox Tutor: Power of Product and Quotient Law (1:56)

Practice Problems #5

Simplify

$(2^5 \cdot 3^6)^4 =$	$(\frac{5^2}{4^3})^6 =$

More Practice

Evaluate vs Simplify

$$\left[\frac{\left(\frac{1}{4}\right)^7}{\left(\frac{1}{4}\right)^6}\right]^2$$

Equivalent Expressions

$$(6^3 \times 4^5)^4$$

Toolbox Tutor: Power of a Product Law Practice (4:57)