

KEY CONCEPT OVERVIEW

Welcome to Grade 8! In the first topic of Module 1, students will be learning about operations (mathematical processes such as addition and subtraction) with terms that have **exponents**. They will learn how to use definitions and properties, often referred to as the laws of exponents, to perform these operations. Students will start by investigating the properties of exponents using only positive exponents (e.g., 8^2 or $(-7)^4$), and then they will extend their knowledge to exponents of zero (e.g., 8^0) and **negative exponents** (e.g., 5^{-2} or $(-3)^{-4}$).

You can expect to see homework that asks your child to do the following:

- Write a **repeated multiplication representation** using exponents.
- Recognize when standard numbers are showing an exponential pattern. For example, 2, 4, 8, 16, and 32 are equal to 2^1 , 2^2 , 2^3 , 2^4 , and 2^5 , respectively.
- Change a given number to an **exponential expression** with a given **base**. For example, 25 to 5^2 .
- Determine whether an exponential expression is positive or negative.
- Simplify expressions using the properties/laws of exponents, including the **zeroth power** and negative powers.
- Explain his work, and prove that two expressions are equivalent by referencing the definition or property/law used.

SAMPLE PROBLEM (From Lesson 6)

$$\begin{aligned}
 (5^{-3})^4 &= \left(\frac{1}{5^3}\right)^4 && \text{By definition of negative exponents} \\
 &= \left(\frac{1}{5^3}\right) \times \left(\frac{1}{5^3}\right) \times \left(\frac{1}{5^3}\right) \times \left(\frac{1}{5^3}\right) && \text{By definition of exponential notation} \\
 &= \frac{1}{5^{3+3+3+3}} && \text{By 1st law of exponents} \\
 &= \frac{1}{5^{12}} \\
 &= 5^{-12} && \text{By definition of negative exponents}
 \end{aligned}$$

Properties of Exponents/Laws of Exponents

For any numbers x, y and all integers (0, and positive and negative numbers that are not fractions) a, b , the following rules apply:		
Name of Rule	General Example	Another Example
1 st Law of Exponents	$x^a \cdot x^b = x^{a+b}$	$3^6 \times 3^8 = 3^{6+8} = 3^{14}$
2 nd Law of Exponents- Power to a Power	$(x^a)^b = x^{ab}$	$((-6)^4)^2 = (-6)^{4 \cdot 2} = (-6)^8$
3 rd Law of Exponents	$(xy)^a = x^a y^a$	$(5g)^3 = 5^3 \cdot g^3$
Division of Exponents; Consequence of 1 st Law for Division	$\frac{x^a}{x^b} = x^{a-b}$	$\frac{x^{10}}{x^2} = x^{10-2} = x^8$
Fraction to a Power; Consequence of 3 rd Law for Division	$\left(\frac{x}{y}\right)^a = \frac{x^a}{y^a}$	$\left(\frac{2}{3}\right)^4 = \frac{2^4}{3^4}$
For any positive number x , and all integers b , the following rule applies:		
Definition of Negative Exponents	$x^{-b} = \frac{1}{x^b}$	$5^{-2} = \frac{1}{5^2}$

Additional sample problems with detailed answer steps are found in the *Eureka Math Homework Helpers* books. Learn more at GreatMinds.org.

HOW YOU CAN HELP AT HOME

You can help at home in many ways. Here are just a few tips to help you get started:

- Study the exponent law or definition your child learned in class each night. Teamwork is powerful!
- Hold a race with your child. Write a variety of numbers that can be written as exponential expressions, like 16, 25, and 27, on index cards and place the cards face down. As you take turns flipping over the cards, race to be the first to convert each number into an exponential expression. For example, 16 to 4^2 or 2^4 , 25 to 5^2 , 27 to 3^3 , 81 to 9^2 or 3^4 , and 125 to 5^3 .

TERMS

Associative property of multiplication: You can change the grouping of terms being multiplied without changing the resulting value, or product. For example, $3 \cdot (x \cdot y) = (3 \cdot x) \cdot y$.

Base: In the term $3y^6$, the y is the repeating factor, or base, and may be a number or a variable.

Coefficient: A constant factor (not to be confused with a “constant”) in a variable term. For example, in the term $3y^6$, the 3 represents the coefficient, and is multiplied by y^6 .

Commutative property of multiplication: You can multiply terms in any order and not change the resulting value, or product. For example, $3 \cdot y = y \cdot 3$.

Exponent: In the term $3y^6$, the 6 is the exponent or power. The exponent tells you how many times to multiply the base (y) by itself.

Exponential expression: A mathematical term with a base, exponent, and sometimes a coefficient. For example, the term $3y^6$ is an exponential expression and it means $3 \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y$.

Exponential notation: The method used to write a repeated multiplication expression. $\frac{9}{7} \times \frac{9}{7} \times \frac{9}{7} \times \frac{9}{7}$ can be written as $\left(\frac{9}{7}\right)^4$. When your base is a fraction or a negative number, the base should be placed inside parentheses.

Negative exponents: When a base, x , is raised to a negative power, $-y$, it is equivalent to the fraction $\frac{1}{x^y}$. For example, $3^{-2} = \frac{1}{3^2}$.

Ratio: A comparison of the sizes of two values. Ratios are written as $A:B$ (e.g., 1:4), or “ A to B ” (e.g., 1 to 4) where the number A is first and the number B is second.

Value of the ratio: The value of the ratio $A:B$ is the quotient $\frac{A}{B}$ as long as B is not zero. For example, the ratio 6:10 has a value of $\frac{6}{10}$ or 0.6.

Zerth power: Any base raised to the power of zero has a value of 1. For example, $x^0 = 1$, $\left(\frac{4}{7}\right)^0 = 1$, $(-2)^0 = 1$.

MODELS

Repeated Multiplication Representation: $(-2.3)^9 = \underbrace{((-2.3) \times \dots \times (-2.3))}_{9 \text{ times}}$