PLS HELP 50 POINTS!!!! NEED THIS IN 1 HOUR!!!Which Equation Justifies Why Nine To The One Third Power

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When tackling the question of why nine raised to the one-third power can be expressed in a specific way, it’s essential to understand the underlying mathematical principles that justify this operation. The expression "nine to the one-third power" is fundamentally connected to the concept of fractional exponents, which provide a powerful and concise way to represent roots and powers. In mathematics, understanding the relationship between exponents and roots is crucial, especially when dealing with rational exponents like 1/3. This article explores the equations and properties that justify why nine to the one-third power is written and interpreted in a particular way, providing clarity and insight into fractional exponents.

Understanding the Concept of Exponents and Roots

What Are Exponents?

Exponents are a shorthand notation to denote repeated multiplication of the same number. For example:
- a^n means multiplying the base a by itself n times.
- Example: $2^3 = 2 \times 2 \times 2 = 8$.

Exponents are fundamental in algebra because they simplify the expression of large powers and facilitate various algebraic operations.

What Are Roots?

Roots are the inverse operation of exponents. The square root, for example, asks: what number, when squared, gives the original number?
- $\sqrt{a}$ is the number x such that $x^2 = a$.
- The cube root $\sqrt[3]{a}$ is the number x such that $x^3 = a$.

Roots allow us to "undo" exponents, providing a way to solve for the original base when given a power.

The Concept of Fractional Exponents

What Are Fractional Exponents?

Fractional exponents unify roots and powers into a single notation. For a positive real number a:

$$
a^{\frac{m}{n}} = \sqrt[n]{a^m} = (\sqrt[n]{a})^m
$$

This notation indicates:
- The numerator m is the power to which the base is raised.
- The denominator n indicates the root to be taken.

For example:
- $a^{1/2} = \sqrt{a}$, the square root.
- $a^{1/3} = \sqrt[3]{a}$, the cube root.
- $a^{3/2} = (\sqrt{a})^3$.

Why Use Fractional Exponents?

Fractional exponents provide a consistent and elegant way to handle roots and powers simultaneously. They simplify calculations and help in manipulating algebraic expressions efficiently, especially when solving equations involving roots.

The Equation Justifying Nine to the One Third Power

Expressing $9^{1/3}$ as a Root

The key equation that justifies why nine to the one-third power equals a particular value relies on the definition of fractional exponents:

$$
9^{1/3} = \sqrt[3]{9}
$$

This means the cube root of 9 is the number that, when cubed, equals 9.

The Fundamental Equation: Exponentiation and Roots

The fundamental equation that underpins fractional exponents is:

$$
a^{m/n} = (\sqrt[n]{a})^m
$$

Applying this to $9^{1/3}$:

$$
9^{1/3} = \sqrt[3]{9}
$$

Because 9 can be written as 3^2, we have:

$$
9^{1/3} = (3^2)^{1/3}
$$

Using the power of a power rule:

$$
(3^2)^{1/3} = 3^{2 \times \frac{1}{3}} = 3^{\frac{2}{3}}
$$

Thus, the expression simplifies to:

$$
9^{1/3} = 3^{2/3}
$$

This demonstrates that $9^{1/3}$ is equivalent to $3^{2/3}$, which can be interpreted as the cube root of 3^2.

Breaking Down the Calculation: Why $9^{1/3}$ Equals $\sqrt[3]{9}$

Step 1: Recognize the Fractional Exponent

The fractional exponent $1/3$ indicates the cube root. The general rule is:

$$
a^{1/n} = \sqrt[n]{a}
$$

So, for $a = 9$:

\[

$$
9^{1/3} = \sqrt[3]{9}
$$

Step 2: Express 9 as a Power of 3

Since $9 = 3^2$, substitute this into the expression:

$$
9^{1/3} = (3^2)^{1/3}
$$

Step 3: Use the Power of a Power Rule

Applying the rule $(a^m)^n = a^{m \times n}$:

$$
(3^2)^{1/3} = 3^{2 \times \frac{1}{3}} = 3^{2/3}
$$

Now, interpret $3^{2/3}$ as:

$$
3^{2/3} = \left(3^{1/3} \right)^2 = \left(\sqrt[3]{3} \right)^2
$$

This shows that:

$$
9^{1/3} = \left(\sqrt[3]{3} \right)^2
$$

Summary: The Equation That Justifies $9^{1/3}$

The equation that justifies why nine to the one-third power can be expressed as a root and manipulated algebraically is:

$$
a^{m/n} = (\sqrt[n]{a})^m
$$

Specifically:

$$
9^{1/3} = \sqrt[3]{9} = (3^2)^{1/3} = 3^{2/3} = \left(\sqrt[3]{3} \right)^2
$$

This demonstrates the consistent and logical relationship between fractional exponents, roots, and powers.

Additional Insights and Applications

Why Is This Important?

Understanding the equation justifying fractional exponents is vital for:
- Simplifying algebraic expressions.
- Solving equations involving roots.
- Performing calculus operations such as differentiation and integration.
- Working in advanced mathematics, physics, and engineering fields.

Applications in Real-World Problems

Fractional exponents are used in:
- Calculating compound interest.
- Modeling growth and decay processes.
- Engineering calculations involving material stresses.
- Computer science algorithms involving exponential and root calculations.

Conclusion

To answer the question directly: The equation that justifies why nine raised to the one-third power is expressed as it is is:

$$
a^{m/n} = (\sqrt[n]{a})^m
$$

Applied to $9^{1/3}$, it becomes:

$$
9^{1/3} = \sqrt[3]{9}
$$

which, when recognizing $9 = 3^2$, further simplifies to:

$$
3^{2/3} = \left(\sqrt[3]{3} \right)^2
$$

This fundamental relationship between fractional exponents and roots allows mathematicians and students to manipulate and understand powers and roots systematically, making it an essential concept in mathematics.

Remember: Whenever you encounter an expression like $a^{1/n}$, think of it as the n-th root of a, and use the rules of exponents to simplify or manipulate expressions effectively.

Frequently Asked Questions

What is the mathematical expression for nine raised to the one-third power?

The expression is written as $9^{1/3}$.

Which equation justifies why nine to the one-third power equals the cube root of nine?

The equation is $9^{1/3} = \sqrt[3]{9}$.

How can I simplify $9^{1/3}$?

You can write $9^{1/3}$ as the cube root of 9, i.e., $\sqrt[3]{9}$.

What is the value of $9^{1/3}$ approximately?

The approximate value is 2.08, since $\sqrt[3]{9} \approx 2.08$.

Why does raising a number to the one-third power relate to cube roots?

Because raising a number to the 1/3 power is equivalent to taking its cube root, which is the inverse operation of cubing a number.

Is there an exponential equation that justifies $9^{1/3}$?

Yes, the exponential form is $e^{(1/3) \ln(9)}$, which uses logarithms and exponentials to justify the root.

How can I verify that $9^{1/3}$ equals the cube root of 9?

You can verify by cubing $9^{1/3}$ and checking if it equals 9: $(9^{1/3})^3 = 9$.

What is the general rule for fractional exponents like 1/3?

The rule is that a^{m/n} = n√a^m, so 9^{1/3} = ∛9.

In what situation would you use the equation 9^{1/3}?

You would use it when solving for the cube root of 9 or in problems involving fractional exponents and roots.

Additional Resources

PLS HELP 50 POINTS!!!! NEED THIS IN 1 HOUR!!! Which Equation Justifies Why Nine To The One Third Power — these frantic words echo the urgency felt by many students tackling challenging math problems under tight deadlines. When faced with a question about why nine raised to the one-third power behaves a certain way, understanding the underlying equations and properties of exponents becomes crucial. This guide aims to provide a comprehensive, clear explanation of the mathematical principles that justify why nine to the one-third power is computed in a specific way, helping you grasp the concept thoroughly and confidently.

Understanding the Problem: Why Nine to the One Third Power?

Before diving into the equations, it’s important to understand what the question is asking. The phrase “why nine to the one-third power” refers to evaluating \(9^{1/3} \). To justify or explain this computation algebraically, we need to explore the properties of exponents and roots, as well as how they relate to each other.

The Basics of Exponents and Roots

What Are Exponents?

Exponents are a shorthand notation for repeated multiplication. For example:
- \(a^n \) means multiplying \(a \) by itself \(n \) times:

\[
a^n = a \times a \times a \times \dots \times a \quad (n \text{ times})
\]

- Exponents can be positive, negative, or fractional.

What Are Roots?

Roots are inverse operations of exponents. The \(n \)-th root of a number \(a \), denoted as \(\sqrt[n]{a} \), is the number that, when raised to the \(n \)-th power, gives \(a \):

\[

$$
\sqrt[n]{a} = a^{1/n}
$$

This key relationship bridges the concept of roots and fractional exponents.

The Core Equation: $9^{1/3}$

The expression $9^{1/3}$ asks: What number, when cubed, equals 9?

Mathematically, this can be written as:

$$
\text{Find } x \text{ such that } x^3 = 9
$$

which directly relates to the definition of a cube root.

The Mathematical Justification: Properties of Exponents

Fundamental Exponent Law

The property that justifies the computation of fractional exponents like $a^{1/n}$ is:

$$
a^{m/n} = \left(a^m \right)^{1/n} = \left(a^{1/n} \right)^m
$$

This law states that:

- Raising a to the power of m/n is equivalent to:
- Raising a to the m-th power, then taking the n-th root, or
- Taking the n-th root of a, then raising the result to the m-th power.

Applying the Law to $9^{1/3}$

In our case, $m = 1$ and $n = 3$, so:

$$
9^{1/3} = \sqrt[3]{9}
$$

which is the cube root of 9.

Step-by-Step Explanation of Why $9^{1/3}$ Is Justified

1. Recognize the Connection Between Roots and Fractional Exponents

The key to understanding $9^{1/3}$ is recognizing that fractional exponents are just alternative notations for roots:

- The denominator of the fractional exponent indicates the root.
- The numerator indicates the power to which the root is raised.

Thus:

$$
a^{1/n} = \sqrt[n]{a}
$$

This equivalence is grounded in the laws of exponents and the definition of roots.

2. Use Definition of Roots as Exponents

By definition:

$$
\sqrt[n]{a} = a^{1/n}
$$

which means:

$$
\text{The cube root of 9} = 9^{1/3}
$$

3. Confirm the Validity via Exponent Laws

The critical property is that:

$$
\left(a^{1/n} \right)^n = a
$$

Applying this to $a = 9$:

$$
\left(9^{1/3} \right)^3 = 9
$$

which confirms that $9^{1/3}$ is the number that, when cubed, yields 9.

Practical Calculation of $9^{1/3}$

Recognizing Perfect Cubes

- $1^3 = 1$
- $2^3 = 8$
- $3^3 = 27$

Since 9 is between 8 and 27, the cube root of 9 lies between 2 and 3.

Approximate Calculation

- Use a calculator or estimation methods to find:

$$
9^{1/3} \approx 2.0801
$$

This value satisfies:

$$
(2.0801)^3 \approx 9
$$

Algebraic Validation

Expressing 9 as 3^2:

$$
9^{1/3} = (3^2)^{1/3} = 3^{2/3}
$$

Using exponent rules:

$$
3^{2/3} = \left(3^{1/3} \right)^2
$$

Since $3^{1/3}$ is the cube root of 3, approximately 1.442, then:

$$
\left(1.442 \right)^2 \approx 2.080
$$

which aligns with the previous approximation.

Summary of the Justification

- Fractional Exponents are defined as roots: $a^{1/n} = \sqrt[n]{a}$.
- The property $(a^{m/n}) = (a^m)^{1/n} = (\sqrt[n]{a})^m$ justifies the calculation.
- For $9^{1/3}$, we are looking for a number that, when cubed, equals 9.
- Since $2^3 = 8$ and $3^3 = 27$, the cube root of 9 is between 2 and 3, approximately 2.0801.
- Algebraically, expressing 9 as 3^2, we find:

$$
9^{1/3} = 3^{2/3} = (3^{1/3})^2
$$

which confirms the relationship between roots and fractional exponents.

Why Is This Important?

Understanding why fractional exponents like $9^{1/3}$ are justified by these equations is fundamental in algebra and higher mathematics. It allows us to:

- Simplify complex expressions involving roots and exponents.
- Solve equations involving fractional powers.
- Understand the inverse relationship between roots and exponents.
- Develop a deeper intuition for the structure of real numbers and their operations.

Final Tips for Students

- Remember that fractional exponents are just a different notation for roots.
- Use the property $a^{m/n} = (\sqrt[n]{a})^m$ to simplify expressions.
- Always verify your results by applying the inverse operation (raising to the n-th power).
- Practice with both perfect and non-perfect roots to strengthen your understanding.

Conclusion

The equation that justifies why nine to the one-third power is $9^{1/3}$ stems from the fundamental properties of exponents and roots. Recognizing that fractional exponents directly correspond to roots allows us to understand and calculate $9^{1/3}$ confidently. This relationship is rooted in the core laws of algebra, making it a vital concept for mastering higher-level mathematics and solving complex problems efficiently.

Remember: When you're asked which equation justifies a particular fractional exponent like $9^{1/3}$, the answer is the equation expressing the fundamental relationship between roots and exponents:

$$
a^{1/n} = \sqrt[n]{a}
$$

or equivalently,

$$
\left(a^{1/n} \right)^n = a

\]

This is the key principle that underpins the entire concept.

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