Division by Zero Encyclopedia Article

Division by Zero

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Division by Zero

The number 0 has unique properties, including when a number is multiplied or divided by 0. Multiplying a number by 0 equals 0. For example, 256 × 0 = 0. Dividing a number by 0, however, is undefined.

Why is dividing a number by 0 undefined? Suppose dividing 5 by 0 produces a number x:

From it follows that $0 \times x$ must be 5. But the product of 0 and any number is always 0. Therefore, there is no number x that works, and division by 0 is undefined.

A False Proof

If division by 0 were allowed, it could be proved—falsely—that 1 = 2. Suppose $x = y$. Using valid properties of equations, the above equation is rewritten

$x^2 = xy$ (after multiplying both sides by x)

$x^2 - y^2 = xy - y^2$ (after subtracting y^2 from both sides)

$(x - y)(x + y) = y(x - y)$ (after factoring both sides)

$(x + y) = y$ (after dividing both sides by $(x - y)$)

$2y = y$ ($x = y$, based on the original supposition)

2 = 1 (after dividing both sides by y)

This absurd result (2 = 1) comes from division by 0. If $x = y$, dividing by $(x - y)$ is essentially dividing by 0 because $x - y = 0$.

Approaching Limits

It is interesting to note that dividing a number such as 5 by a series of increasingly small numbers (0.1, 0.01, 0.001, and so on) produces increasingly large numbers (50, 500, 5000, and so on). This division sequence can be written as where x approaches but never equals 0. In mathematical language, as x approaches 0, increases without limit or that **infinity**.

See Also

Consistency; Infinity; Limit.

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