

# The Mathematician

December - Advanced

In this new December Mathematician, we have a theme: zero. Now zero is a very interesting number, because it has qualities that many numbers don't have. For example, it is the only number that is neither positive nor negative. Well now let's talk about  $0^0$ . Now most of the time during school they say that  $0^0$  is undefined because 0 to the power of anything is zero, and anything to the power of 0 is one, but is that true? Why?

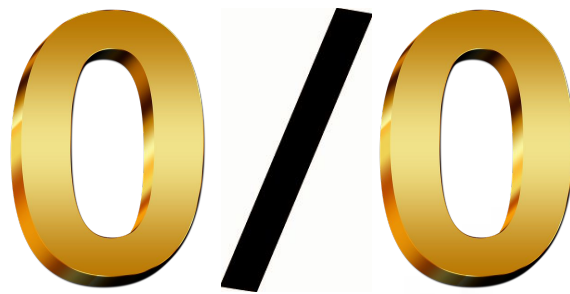
$$0^0 = \begin{matrix} 0? \\ 1? \\ \text{undefined?} \end{matrix}$$

Well, one way to think about it is to use something called **Limits**. Basically, we could get really close to zero, but we'll never reach it. So therefore we could make a estimation to this unsolvable question. So what is  $0.1^{0.1}$ ? Well this is about 0.794. But we can go even smaller. What about  $0.01^{0.01}$ ? Well,  $0.01^{0.01}$  is 0.954.  $0.001^{0.001}$  is 0.99311604842. If we continue, these values will get closer and closer to 1. It seems as if  $0^0$  is 1. Using this, we see that  $0^0$  is 1, and although some people would say otherwise, we believe the answer to this controversial question is 1.

# What is $0/0$ ?

## December - Intermediate

Now you might've noticed that the title of this page is pretty basic. You probably will learn in school that the  $0/0$  is undefined. But let's hear three pieces of evidence to prove why  $0/0$  is undefined.

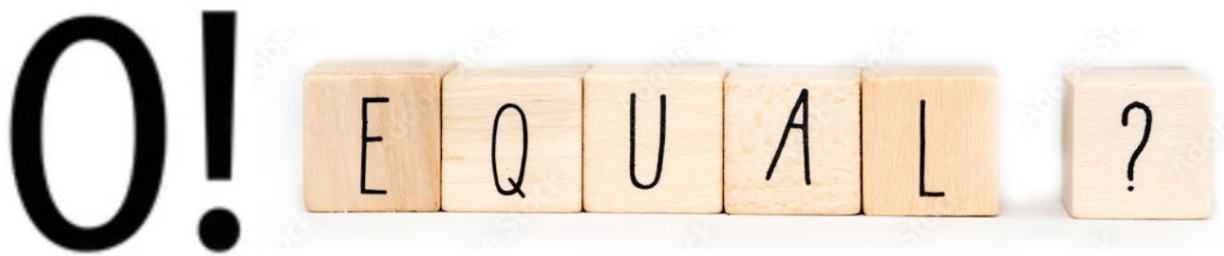


why undefined?

1. Imagine splitting zero pebbles with zero friends. You wouldn't be sharing anything with anyone, which doesn't make sense.
2. We know that  $x/y$  can be changed as  $y * \text{something} = x$ . However, we find infinite answers:  $0 * 0 = 0$ ,  $0 * 1 = 0$ ,  $0 * 4145 = 0$ , and so on for every single number.
3. We can use limits, and find that as we get closer to zero on the denominator, it gets gradually bigger. But we get the same outcome for every other number, and that would mean that since that is not true, we must leave this question with an undefined answer.

# Zero Factorial?

Zero factorial? Let's see what the answer is.



Well, first we have to define  $0!$  (! is the mathematical symbol for factorials.) What is a factorial? Well, say we have a number,  $N$ .  $N!$  would be  $N$  times  $N-1$  times  $N-2$  times  $N-3$  and so on until we reach one. In other words,  $4!$  would be 4 times 3 times 2 times 1, which is 24. However, there is another way of describing  $N!$ .  $N!$  is  $N$  times  $(N-1)!$ . We can see this pattern easily.  $2!$  is 2 times  $1!$ .  $3!$  is 3 times  $2!$ .  $4!$  is  $3!$  times 4, and so on and so forth. But what is  $1!$  then? 1 factorial is just 1, and from our pattern we can find that 1 factorial should be 1 times 0 factorial! Because 1 factorial is 1, and the only factor of 1 is 1,  $0!$  must be equal to 1.

# GAME TIME!

Well, what is today's fun game? During today's Game Time you'll be playing a game called the 24 game. This game gives you 4 numbers, and your goal is to make 24 with those four numbers and those four only, and you are NOT allowed to add any extra numbers. This very basic game not only allows you to switch order, but limits you to only the four operations: Addition, Subtraction, Multiplication, and Division. You can play this game with your family, friends, and anywhere and try to beat them by solving the puzzles before them. Enjoy!

Challenging 24 game puzzles:

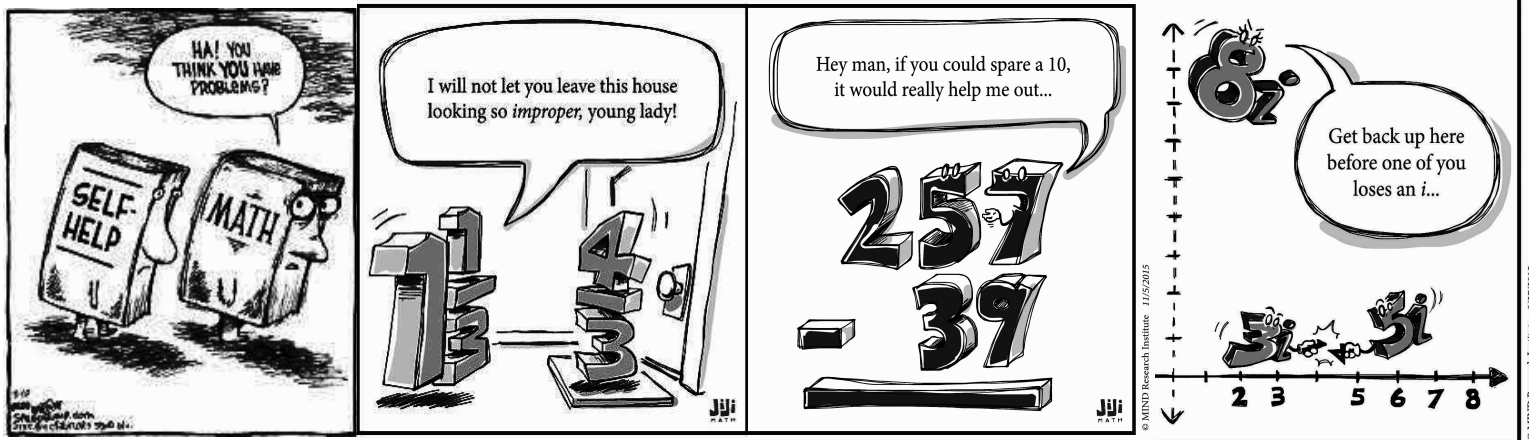
- $2 \quad 4 \quad 2 \quad 4 = 24$

- $3 \quad 8 \quad 3 \quad 8 = 24$

- $1 \quad 3 \quad 4 \quad 6 = 24$

# Comics!

They're comics.... But math related. Enjoy.



## About the Author

Daniel Pei and Brooks Wang wrote this particular article as the December Math Club newspaper. We came up with its amazing theme : ZERO. This article talked about  $0^0$ ,  $0/0$ , and  $0!$  as 0-themed math topics. All authors in our club collaborated to make this article. This article wants everyone to know that they can sign up and write an article themselves! Unfortunately, the Halloween Edition newspaper didn't come out because Math Club decided that it was too close to when the Thanksgiving newspaper was coming out. Anyway, feel free to give feedback on this amazing article! Also, make sure to have fun! (all newspapers after this one are to be gotten at the Math Club brown table during recess and lunch. (playtime only)