Math Diversion 1086

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CONCERNING HORSES

> You cannot train a horse with shouts and
> expect it to obey a whisper.
> — Dagobert D. Runes

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Source:   https://www.youtube.com/shorts/sHuzHybS5MA
Title: Square Root Maths
 Presenter: Rachel Shorts
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1 Problem

Given the relation

$$(x-1)^x = 81\,, \tag{1}$$

solve for x in the real numbers.

2 Solution

I'll begin with two replacements First, $81 \to 9^2$ and second

$$x - 1 = 9^\alpha\,, \tag{2}$$

from which (1) becomes

$$9^{\alpha(9^\alpha+1)} = 9^2\,. \tag{3}$$

On equating exponents, we have that

$$\alpha(9^\alpha + 1) = 2\,. \tag{4}$$

Now, it jumps out at me that if we're going to make the LHS equal the RHS, we're gong to have to replace 9^α by something less than 9. So, let's try $\alpha = 1/2$.

$$\tfrac{1}{2}(9^{1/2} + 1) = \tfrac{1}{2}(3 + 1) = \tfrac{1}{2}(4) = 2\,. \tag{5}$$

And that works! Using $\alpha = 1/2$ in (2), we can solve for x, to get

$$x = 4\,. \tag{6}$$