Math Diversion 1026

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Source: https://www.youtube.com/watch?v=FGZfZphuK_I
Title: Tricky Maths Question for Competitive Exams
 Presenter: Math Beast
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1 Problem

Given the relation

$$7 + 10 + 13 + \cdots + (x - 3) + x = 282\,, \tag{1}$$

solve for x a positive integer.

2 Solution

We'll begin by calling the number of terms on the LHS n. Next, let's add a copy of (1) to itself, but with the terms on the LHS reversed! So, let's reverse them.

$$x + (x - 3) + \cdots + 13 + 10 + 3 = 282\,, \tag{2}$$

Now, when we add these two equations term-wise, we get an interesting result:

$$(x + 7) + (x + 7) + (x + 7) + \cdots + (x + 7) + (x + 7) = 2 \cdot 282\,. \tag{3}$$

That looks promising. And since we know that there are still n terms on the LHS, we have that

$$n(x + 7) = 2 \cdot 282 = 2 \cdot 2 \cdot 3 \cdot 47\,, \tag{4}$$

where we have resolved the RHS into its prime factors. All we have to do now is to find a pair of positive integers n and x that will solve this equation. Well, n can't be 2, 3, 4, or 6 because those are obviously too few terms. It can't be 47 or higher because those are obviously too many terms. All we have left is $n = 12$, giving us

$$12(x + 7) = 12 \cdot 47\,. \tag{5}$$

This leaves us with

$$x = 40\,. \tag{6}$$