Hi, my name is Anthony Varela. And today, I'm going to talk about substitution in multi-step linear equations. So we're going to review basic substitution where we have a value for a variable that we can substitute. Then we're going to extend this for equivalent expressions that we can substitute for variables in equations. And then we'll use that whole idea then to solve some equations that involve this type of substitution.

So remember, substitution allows us to substitute equivalent values for variables in two equations. So I think a really nice way to review this idea is to talk about Fahrenheit and Celsius. So here's an equation that relates the two degrees.

And let's say I'm reading my weather report, and it says it's 8 degrees Celsius outside. Well, I don't really know what that means. I don't usually operate in Celsius. So I'd like to convert this into degrees Fahrenheit.

So I can substitute. I know that c equals 8. So due to the substitution property of equality, any time I see the variable c in this equation, I can replace that or substitute it with 8. So I'm going to do that right now. And then to get into Fahrenheit, I can multiply 8 by 9/5 and then add 32. So 8 degrees Celsius is 46.4 degrees Fahrenheit. That's much more meaningful to me.

Well, now let's talk about substituting entire expressions in for variables. We can do that too with substitution. So here we have one equation that says p equals 8.2x plus 180. And I have a second equation that says x equals 3n plus 2.

So I could substitute then this entire expression for x, 3n plus 2, into this equation for every instance of x. So here I have made that substitution where I'm not substituting a single value, but an entire expression. So now to simplify this equation, this often involves then doing distribution and some combining of like terms. So I have to distribute the 8.2 into 3n and then into the plus 2.

And then I can't forget then to bring down my plus 180 from my original equation. Now I have some constant terms I can combine. And here is my fully simplified equation now written in terms of n. 24.6n plus 196.4 equals p.

So now I'd like to return to my example with temperatures to see how we can put all of this together in a final example. So there is a factory that produces these products that need to be cooled before they can be packaged and delivered to consumers. And there is an equation that relates the temperature to how much time it takes to cool.

So the equation is t equals 0.6y plus 20. And t stands for the time in minutes required to cool down that product. And y is the temperature in degrees Fahrenheit. So if a product takes 230 minutes to cool down before it can be packaged, that equation then would be 230 equals 0.6y plus 20.

And if I solve this equation for y, that will tell me how hot the product is in degrees Fahrenheit. What I'd actually like to know, the temperature of this product in degrees Celsius.

So I'm going to be using that equation that we saw earlier, y equals 9/5 x plus 32. And here then y is temperature in Fahrenheit. So x would be temperature in degrees Celsius.

So here are my two equations. And notice in this equation over here on the left that the only variable we see is y. And in this equation here, we have an equivalent expression for what y is. So I'm going to rewrite this equation.

But anytime I see the variable y, I'm going to write what y equals. So I've made that substitution right here. So now I need to distribute the 0.6 into every term in parentheses here.

So 0.6 multiplied by 9/5 x equals 1.08 x. And then when I distribute the 0.6 into our plus 32, I get plus 19.2. And then I need to bring down my plus 20 because that's in my original equation.

So I've done my distribution. I see some common terms or like terms that can be combined. So 19.2 and 20 can be added together. So here is my equation now written in terms of x or degrees Celsius. 230 equals 1.08x plus 39.2.

So here's my equation. We know how to solve this. What I'm going to do first is subtract 39.2 from both sides of the equation. So that gets me 190.8 equals 1.08x.

Then I need to divide both sides of my equation by 1.08. So now I have x equals 176.67. We round to the nearest hundredth. And remember, x equals degrees Celsius. So this product had a temperature of 176.67 degrees Celsius.

So let's review substitution and multi-step linear equations. Well, substitution lets us replace equivalent values for variables into equations due to the substitution property of equality. We could also replace equivalent expressions for variables into equations if we have that relationship established. And this usually requires distribution, combining like terms and some other steps in order to simplify your equation after you substitute. Well, thanks for watching this tutorial on substitution and multi-step linear equations. Hope to see you next time.