>> We're about to start discovering some rules for exponents. And I hope I can make it make sense to you so that if you're off somewhere working some homework or working on a quiz or an exam, you can figure these rules out for your own if you forget them. You'll see what I mean. Let's look at the following. I want to simplify this expression. I have x squared times x cubed. Now, I do know x squared means two factors of x. And I know x cubed means three factors of x. So notice, I just wrote out using the meaning of an exponent. There's two factors of x. There's three factors of x. So how many factors of x do I have? one, two, three, four, five. Can you agree then that this is the same as x raised to the fifth power? Now, we don't want to do this every time. I don't want to write out certainly if one of my factors is, say, x to the 20th. I do not want to write all that out. What can you come up with as a shortcut for going from x squared times x cubed to going directly to x to the fifth? Well, notice I'm multiplying. Notice the bases are the same. And notice I just ended up adding the exponents. And that's what we will call our product rule.

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So this is our product rule for exponents. If m and n are positive integers and a is a real number, then a raised to the nth power times a raised to the nth power is equal to a raised to the power of m plus n. So basically, we add the exponents and we keep the common base.

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So that is our product rule. And I hope it made sense to you as we discovered it together. So let's practice using this product rule. Use the product rule to simplify the expression. I have y cubed times y squared times y raised to the seventh power. Now notice I am multiplying, and all of these bases are the same. So since all the bases are the same, I basically use the product rule for exponents. I keep the common base and I add the exponents. So this is y raised to a power of 3, plus 2, plus 7, which is y raised to power of, let's see. 3 plus 2 is 5. 5 plus 7 is 12. This is y to the 12th power.

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Keep that in mind. Let's use the product rule to simplify each of these expressions. So I'm just using the product rule. I'm not trying to evaluate, for example, negative 5, in parentheses, to the seventh power. I have negative 5, in parentheses, to the seventh power, times negative 5, in parentheses, to the eighth power. Notice the bases are the same each time being negative 5, so I just simply add the exponents, 7 plus 8 is 15. And this becomes negative 5 raised to the, in parentheses, raised to the 15th power.

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Let's continue. Here I have 5y to the fourth times 3y. Now, we won't need to do this every single time. But 5y to the fourth is 5 times y to the fourth times 3 times y. And then remember, multiplication is associative and commutative. So this is 5 times 3 times y to the fourth times y. And I do have a question for you. I've got y sitting there without an exponent on it. So what is the understood exponent?

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The understood exponent is an exponent of 1. See how things keep coming back when you're learning math. So keep those notes. I would suggest those video notebook sheets because it's so easy to keep up with me with the exercises and examples, and also the rules and properties and all of that. So that's y to an understood power of 1, so let's write that down.

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I think that'll help you. So how can we simplify? Well, I know 5 times 3 is 15. And then y to the fourth times y to the 1, I'm multiplying. I keep that base and I add the exponents.

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I'm going to write it over here so you can see it better. Or 15y to the fifth power. There we go. Now, do you need to take some of these intermediate steps? No. You can look right here and say 5 times three is 15. [Variable] y to the fourth times y to the 1, that's y to the 4 plus one or y to the fifth. Let's keep working on that product rule. Let's use the product rule to simplify this expression. Now it's up to you. You can write this as x to the 9 times y to what power? [Variable] y to the 1 times x to the 10th, times y to the fifth. You can take a moment and rearrange these factors. But I know this base and this base, those are the same. So that's x raised to power of 9 plus 10, or 19. And then y raised power of 1 plus 5, or 6. So my result is -- and let me rewrite that so it looks nicer for you -- x to the 19th, y to the 6. There we go. And I used what rule? I used the product rule.