

## Larger Order of Operations Expressions

When you're working with large expressions, you will not only have to pay attention to following the correct order of operations, but you will also need to make sure you do each step in the correct order. To review, the order of operations is first, grouping symbols, next, exponents, followed by multiplication and division, then addition and subtraction.

Let's look a little closer at grouping symbols, though. You will see several different types of grouping symbols. The most common is parentheses, but you will also often see brackets and braces, which serve the exact same purpose.

Absolute value bars are treated like grouping symbols, but unlike parentheses, brackets, and braces, absolute value bars can actually change the value of what is inside them. The other three only group numbers and operators together.

Often, you will have grouping symbols nested inside other grouping symbols. When grouping symbols are nested, simplify the innermost grouping symbols first. Let's look at what that means in practice.

In this equation, this is the innermost set of grouping symbols, so we evaluate it first, applying the order of operations as normal. Six squared becomes 36, and 36 divided by 9 becomes 4, so now we have simplified the expression inside the innermost grouping symbols. Now this is the only pair of grouping symbols we have. Simplifying what is inside that set gives us a 5. So now this expression has just become 5 times 3, which is 15. Let's go over to the whiteboard to work on a few more examples.

This first question asks us to simplify  $18 \div 3 \times \frac{1}{2} - 14 + 4^2$ . So the first thing we need to do is simplify what's inside this set of grouping symbols applying the normal order of operations, and that tells us that we need to do the exponent first, so this becomes  $18 \div 3 \times \frac{1}{2} - 14 + 16$ . Alright, now we do the addition inside the parentheses. So, that simplifies to  $18 \div 3 \times \frac{1}{2} - 14 + 16$  is 30. Now we have no more grouping symbols left and no more exponents, so the next thing to do is multiplication and division which we do by moving from left to right. So the first thing we come to is  $18 \div 3$ , and  $18 \div 3$  is 6 so this becomes  $6 \times \frac{1}{2} - 14 + 16$ . Again moving from left to right doing multiplication you get  $6 \times \frac{1}{2}$  which is 3, so this becomes  $3 - 14 + 16$  which is negative 27. Let's look at another example.

This one asks us to simplify  $4 \times 7^2 + 54 \div 9$  notice that here we have nested grouping symbols. Here we have our outer grouping symbols but here we have our inner set that we need to solve first. So let's do that. When we do that we get  $4 \times 49 + 54 \div 9$ , is 6. Now we just have one set of grouping symbols and we just apply the normal order of operations, which tells us to do exponents first, so this becomes  $4 \times 49 + 6$ . solving that addition gives us  $4 \times 55$ , which is equal to 220. Alright, let's look at one last example.

This one asks us to simplify  $-3 \times 4 - 6 \times 8 \div 11 + 12^2 \div 6$ . Again, we have nested grouping symbols here. These brackets are our outer grouping symbols, and these parentheses are our inner grouping symbols. Since these are our innermost set of symbols, we need to solve what's inside of this set first, so this becomes  $-3 \times 4 - 6 \times 8$ . Well, we need to apply the normal of order of operations, which tells us that we need to do this multiplication

first, so it becomes 4 minus 48 divided by 11 plus 12 squared divided by 6. Alright, we still have an inner set of grouping symbols, so we still need to work with that. That gives us negative 3 times 4 minus 48, is negative 44. Divided by 11, plus 12 squared divided by 6. Now we only have one set of grouping symbols, these brackets, and we need to solve that first. So we have negative three times negative 44 divided by 11 is negative 4 plus 12 squared divided by 6. We can rewrite this here as just a multiplication, this is just negative 3 times negative 4 plus 12 squared divided by 6. Now, with no more grouping symbols, the thing we need to do first is exponents, and we do have one exponent here: 12 squared. So this becomes negative 3 times negative 4 plus 144 divided by 6. With no more exponents and no more grouping symbols, now we deal with multiplication and division, moving from left to right. Negative three times negative four is positive 12, plus 144 divided by 6. Now we have this division to do here. 144 divided by 6 is 24, so this simplifies to 12 plus 24, which is 36. And that is this long expression simplified.