Chapter 3: Order of Operations

In mathematics, the order that you do the adding, subtracting, multiplying, and/or dividing is important to getting the correct answer. Let's take a look at a simple problem.

$$4 + 3 \times 6$$

Student 1 might look at the problem and do "4 + 3 = 7 and 7 x 6 = 42. So the answer to the problem is 42!" Student 2 might do "3 x 6 = 18 and 4 + 18 = 22. So my answer is 22!"

Both students did all the work and got different answers. Then who has the correct answer? Mathematicians long ago came to this same dilemma. So they argued to who has the correct answer. Do you add first, and then multiply OR do you multiply first and then add? So they got together and came up with the Order of Operations.

In order to simplify an expression, you have to follow these steps in a certain order.

- First, perform all calculations within parentheses or other grouping symbols.
- Then, do all calculations involving exponents.
- Next, multiply OR divide in order from left to right.
- Lastly, add OR subtract in order from left to right.

Most of you might remember the word acronym "PEMDAS". I don't like referring to this acronym because people always confuse the order. Since Multiplication comes before Division in PEMDAS, they think that Multiplication always has to be done before Division. THIS IS WRONG!!! If we go back to the rules, it says "in order from left to right". If the multiplication is seen before division, multiply. If division is seen before the multiplication, divide.

EXAMPLE 1

Simplify using the order of operations: $12 \div 3 \times 7 + 4$

SOLUTION TO EXAMPLE 1

1.	There are no parentheses.	$12 \div 3 \times 7 + 4$
2.	There are no exponents	$12 \div 3 \times 7 + 4$
3.	Division comes first, so $12 \div 3 = 4$.	$4 \times 7 + 4$
4.	Multiplication is next. $4 \times 7 = 28$.	$28 + 4$
5.	Add the two numbers	32

EXAMPLE 2

Simplify using the order of operations: $5(20 \div 5 + 6) - 51$

SOLUTION TO EXAMPLE 2

1.	Do the parentheses first. Notice there are two operations in the parentheses. So we need to do the division before adding in the parentheses. $20 \div 5 = 4$	$5(4 + 6) - 51$
2.	There is still a parentheses so we need to do the operation in the parentheses. $4 + 6 = 10$ **NOTE**: At this point we do not need the parentheses any more since there is just a value. But if we remove the parentheses, there would be two numbers without an operation.	$5(10) - 51$
3.	When a number is next to a parentheses, it is implied to be a multiplication.	$5 \times 10 - 51$
4.	Multiplication is next. $5 \times 10 = 50.$	$50 - 51$
5.	Subtract. $50 - 51 = -1$	-1

EXAMPLE 3

Simplify using the order of operations: $2(5 - 3(40 \div 10 \times 2 + 2) + 1)^2$

SOLUTION TO EXAMPLE 3

1.	Before you go crazy, remember to break it down. We need to do the parentheses. Since there are two sets of parentheses, you simplify the inside parentheses before the outside. So we have to simplify the part that reads "$(40 \div 10 \times 2 + 2)$". Division comes before multiplication so divide. $40 \div 10 = 4$	$2(5 - 3(4 \times 2 + 2) + 1)^2$
2.	Next comes the multiplication. $4 \times 2 = 8$	$2(5 - 3(8 + 2) + 1)^2$
3.	Then add.	$2(5 - 3 \times (10) + 1)^2$
4.	I still have the outer parentheses. So let's multiply. $3 \times 10 = 30$	$2(5 - 30 + 1)^2$
5.	Subtract. $5 - 30 = -25$	$2(-25 + 1)^2$
6.	Add. $-25 + 1 = -24$	$2(-24)^2$
7.	Now we have to square the parentheses. Since the negative sign is inside the parentheses, $(-24)^2 = (-24) \times (-24) = 576$	2×576
8.	Multiply to get the final answer.	1152

TRY THESE – Order of Operations

1. $3^3 + 5 \div 5 \times 6^2 - (-9)$

2. $\frac{1}{2} + 40 \div 2 + 5^2$

3. $5\big(3 - 6(4 + 2 \times 4)\big) + 2$

4. $2 - 3(4 - 4 \div 4 \times 2 + 2)^3$

5. $\left[\frac{1}{4} \div \frac{3}{4}\right]^2 + 3$

6. $\left[\frac{3}{5} \div \frac{3}{4} + \frac{1}{2}\right]^2$