



What Is The Order of Operations in Math? - Definition & Examples

Contributors: Stephen Mee, Chad Sorrells

What is the order of operations? Learn the mathematical order of operations. See steps on how to do order of operations and examples of the order of operations

Table of Contents

- What is the Order of Operations?
- Steps in Order of Operations
- How to Remember the Order of Operations?
- Example 1

Show more

What is the Order of Operations?

The order in which we solve math equations can get pretty complicated, considering there are six main operations that can be performed on numbers. These are:

- Addition
- Subtraction
- Multiplication
- Division
- Exponents
- Parentheses

The order in which these operations are performed is referred to as the **order of operations**. When faced with a long, complicated math problem, knowing the order that these should be performed is crucial. Doing them in any other order will certainly lead to a wrong answer.

Steps in Order of Operations

Re-ordering the list from the last section, the order in which these operations should be performed is:

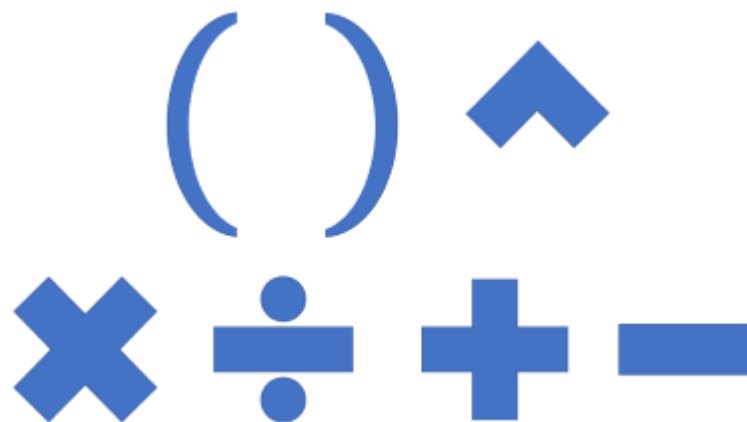
1. Parentheses
2. Exponents
3. Multiplication/Division
4. Addition/Subtraction

Written out, this means that first, make sure to resolve any operations inside a set of parentheses. Next, apply any exponents. Multiplication and division are next, followed by addition and subtraction. It is important that multiplication and division are always performed from **left to right**, just like one would read a sentence. This means that for a problem like $1/3 * 5$, the $1/3$ should be solved and then multiplied by 5, as opposed to the other way around.

How to Remember the Order of Operations?

The order of operations can be easily recalled using the acronym **PEMDAS**. This stands for:

- **P**arentheses
- **E**xponents
- **M**ultiplication
- **D**ivision
- **A**ddition
- **S**ubtraction



The order in which you read the acronym is the order that these operations are performed. When faced with a long, complicated math problem, using this acronym to remember the order of operations can be crucial.

Example 1

Consider the following problem.

$$(2 * 4)^2 + 20/4$$

In parentheses, there is 2 times 4, which is raised to the second power. This is then added to 20 divided by 4. As learned earlier, the first thing to solve is the parentheses. This can initially be confusing, since the parentheses contain two numbers being multiplied, which the order of operations says should normally come later. Regardless of the operation inside the parentheses, just remember those are always solved first. $2 * 4$ is 8, so the next step would be:

$$8^2 + 20/4$$

Next in PEMDAS is "exponents". 8 squared is 64, so:

$$64 + 20/4$$

After exponents is multiplication/division, then addition/subtraction. Dividing 20 by 4 gives 5, then adding 64 and 5 gives **69**, which is the final answer!

$$\begin{array}{r} 64 + 5 \\ 69 \end{array}$$

Doing the Wrong Order

Consider the same problem, but now the operations are done in the incorrect order. Starting the same way:

$$(2 * 4)^2 + 20/4$$

$$8^2 + 20/4$$

$$64 + 20/4$$

$$84/4$$

$$21$$

In this example, the parentheses and exponent were done in the proper order, but the 64 was added to 20 before division took place, which is a clear violation of the PEMDAS rules. Doing the problem in this order gives us a completely different and wrong answer.

Example 2

$$4/8 * 4 + (9/3^2) * 4/2 * 6$$

As always, parentheses come first, so the value within them should be resolved before moving on. Inside the parentheses we have 9 divided by 3 squared. Exponents come before division, and 3 squared is also 9, so the value inside the parentheses is $9/9 = 1$.

$$4/8 * 4 + 1 * 4/2 * 6$$

Next in the order would be multiplication and division, which should always be performed from the left to the right side of the equation. The first term is 4 divided by 8, multiplied by 4. Going left to right means 4 divided by 8 is first, which is 0.5. That is then multiplied by 4, giving **2**.

The second term has 1 times 4, divided by 2, multiplied by six. Again, going left to right, 1 times 4 is just 4, dividing that by 2 gives 2, and multiplying that by 6 gives **12**.

$$4/8 * 4 + 1 * 4/2 * 6$$

$$0.5 * 4 + 4/2 * 6$$

$$2 + 2 * 6$$

$$2 + 12$$

$$14$$

Lastly is addition and subtraction, which means adding 2 and 12 gives **14**, which is the answer! Doing any of the above from right to left would give something much different. In the very first term, if 8×4 was done before $4/8$, it would then give $4/32$, which is 0.125. That is a far cry from the original answer of 2.

To prevent any confusion, that first fraction could have been written as $\frac{4}{8 \times 4}$ instead.

Lesson Summary

For long and complicated math formulas, it's very important that each operation is done in the correct order. This concept is known as the **order of operations**. The six main operations, and the order in which they should be performed, are:

1. Parentheses
2. Exponents
3. Multiplication/Division
4. Addition/Subtraction

A handy way to remember the proper order is the acronym **PEMDAS**, where each letter represents an above operation, and the order in which you read the acronym is the order of the operations.

- **P**arentheses
- **E**xponents
- **M**ultiplication
- **D**ivision
- **A**ddition
- **S**ubtraction

The other important rule is that for multiplication and division, the values should be resolved going from **left to right**. This means that for a problem like $4 \times 9/3$, the 4×9 should be resolved before dividing by 3.

Video Transcript

What Is the Order of Operations?

Hello! My name is Bob, and I live with my wonderful Aunt Sally. My Aunt Sally does a great job of raising me. She fixes my meals, cleans the house and tucks me in at night. However, Aunt Sally often gets the order of these events mixed up. For example, yesterday my Aunt Sally cleaned the house, tucked me into bed and then made my meals.

I keep telling my Aunt Sally that order is important, but she doesn't seem to understand. Just like in math, there is a particular order that we work problems. Without this order, it is possible that we could all get different answers. The order that we use to simplify expressions in math is called the **order of operations**. The order of operations is the order in which we add, subtract, multiply or divide to solve a problem.

Order of Operations Steps

The steps we use to solve any mathematical expression are:

1. *Simplify all of the parentheses.* This includes all forms of grouping symbols, such as brackets and braces, in addition to parentheses.
2. *Simplify all exponents.*
3. *Simplify all multiplication and division from left to right.* When simplifying the multiplication and division, work from left to right.
4. *Simplify all addition and subtraction from left to right.* Again, when simplifying the addition and subtraction, work from left to right.

By following this order, we can all solve the problem and get the same solution.

PEMDAS

After explaining all of those rules to my Aunt Sally, she seems a little overwhelmed. However, I do have a shortcut to help her remember these steps. It's called **PEMDAS**.

It stands for:

P - Parentheses

E - Exponents

M - Multiplication

D - Division

A - Addition

S - Subtraction

Remember that the steps for multiplication and division is one step. We work all of the multiplication and division in one step from left to right. Multiplication does not always come before division; they are worked in the order that they appear. This is also true for addition and subtraction. They are worked in the same step from left to right. An easy way for me to remember these steps is to remember the phrase *Please Excuse My Dear Aunt Sally*, where the:

P - Parentheses - Please

E - Exponents - Excuse

M - Multiplication - My

D - Division - Dear

A - Addition - Aunt

S - Subtraction - Sally

Examples

Let's show Aunt Sally how the order of operations helps us to solve problems. I want to show Aunt Sally a problem from my homework tonight. The problem is $3 + [6 (11 + 1 - 4)] \div 8 \times 2$. Remember, to work this problem, we will follow the order of operations. Let's think PEMDAS.

The first step to solve this problem is to work the P (parentheses). In this problem, they used both parentheses and brackets. We will need to start inside the parentheses and work out until we complete all of the grouping symbols. Also, when working inside the grouping symbols, we must follow the remaining order. To begin, we will need to add the $11 + 1$ and then subtract 4, which is 8. We still must now work inside the bracket, 6 times 8 is 48.

The next letter in our acronym is E for exponents. Since there are no exponents, we continue on. The next step is to simplify the M and the D (multiplication and division) from left to right. Since division actually comes first, we work it from left to right. We'll first divide $48 \div 8$, which is 6. There is still multiplication in our problem, so next we will need to multiply 6 times 2, which equals 12. The only step remaining is AS (addition and subtraction). There is only one thing left in this problem, which is 3 plus 12, which equals 15. So, as you can see Aunt Sally, the answer to this problem would be 15.

Let's do another problem together. Let's solve $20 - 4 + 5^2/5$.

Step 1: Check for any parentheses and there are none, so we can go step 2.

Step 2: Exponents are next and we have an exponent in 5^2 , which simplifies to 25. This changes the problem to look like $20 - 4 + 25 / 5$.

Step 3: There is no multiplication, so we can go to the next step, which is division.

Step 4: The division work we need to do is $25 / 5$, which is 5. The problem now looks like $20 - 4 + 5$.

Step 5: Addition is next and we have $-4 + 5$, which is 1. The problem simplifies to $20 + 1$ and this give us our final answer of 21.

As the old adage goes, practice makes perfect, so let's look at another example problem and solve it.

The next problem is $(6 - 5 \times 2)^2 / (3 + 7)$.

Step 1: We have work to do inside two sets of parentheses. The numerator parentheses has subtraction and multiplication.

PEMDAS tells us to do the multiplication first. This gives us $(6-10)^2$. Now we can subtract these values giving us $(-4)^2$, which is 16. This is our numerator. The denominator parentheses is addition, which results in 10. The problem now simplifies to $16/10$, which is 1.6.

Since we are getting so good at this we'll do one more problem to show off our new skills!

The new problem is $16 - 4 \times 2 + 3 / (17 - 4^2) \times 32$.

Step 1: Do we see parentheses? Yes! Let's solve that first. Inside the parentheses is 4^2 , which is 16. Finishing the math inside the parentheses gives us $17 - 16 = 1$. The problem now looks like $16 - 4 \times 2 + 3 / 1 \times 32$.

Step 2: No exponents exist anymore, so we can go to step 3.

Step 3: Multiplication is the next step. We have -4×2 and 3×32 . This makes the problem look like $16 - 8 + 96$.

Step 4: The problem's final look is $16 - 8 + 96$ and the answer is 104.

Now let's review what we have learned.

Lesson Summary

The **order of operations** is the order in which we add, subtract, multiply or divide to solve a problem. The steps that we use to solve any mathematical expression are:

1. *Simplify all of the parentheses.* This includes all forms of the grouping symbols such as brackets, braces and parentheses.
2. *Simplify all exponents.*
3. *Simplify all multiplication and division from left to right.* When simplifying the multiplication and division, make sure you work from left to right.
4. *Simplify all addition and subtraction from left to right.* Again, when simplifying the addition and subtraction, work from left to right.

A helpful way for me to remember this order is *Please Excuse My Dear Aunt Sally*, which stands for:

P - Parentheses

E - Exponents

M - Multiplication

D - Division

A - Addition

S - Subtraction

Remember that multiplication and division are included in the same step and simplified from left to right. This is also the same for addition and subtraction.

Learning Outcomes

After this lesson, you will be able to:

- List the steps involved in the order of operations for solving mathematical expressions
- Identify an acronym helpful for remembering the order of operations
- Apply the order of operations to solve a mathematical expression

Frequently Asked Questions

What is the point of order of operations?

The point of the order of operations is to ensure the correct answer is calculated from any math problem. Doing the operations in a different order will give incorrect answers.

What is the correct order of operations in math?

The order of operations is parentheses -> exponents -> multiplication/division -> addition/subtraction. The order can be easily remembered by using PEMDAS.

What are the steps of order of operations?

The steps to the order of operations:

1. Parentheses
2. Exponents
3. Multiplication/Division
4. Addition/Subtraction

Also known as PEMDAS. Multiplication and division should always be done from left to right.