BODMAS

THE MNEMONIC

Introduction

BODMAS is a mnemonic that represents a mathematical rule which tells us how to solve a mathematical expression, specifically it gives us the order of operations in the expression. In BODMAS, each letter stands as follows:

B - Brackets
O - Order
D - Division
M - Multiplication
A - Addition
S - Subtraction

This convention gives us the order sequence of operations and is based on the precedence i.e. the rank of one operation over other. Consider a basic mathematical expression as follows:

According to the BODMAS rule, we will first solve the brackets, in this case there are two operations defined inside the bracket, namely order i.e. exponent and subtraction. Conventionally, order operation is evaluated first followed by subtraction as it is still inside the bracket and the bracket is yet to be solved. The above equation will become: 6+2*8 which with the same convention become 6+16 and finally 22.

6 + 2 * (3^2 - 1)	8 - [3 * (2 + 4)]
= 6 + 2 * (9 - 1)	= 8 - [3 * 6]
= 6 + 2 * 8	= 8 - 18
= 6 + 16	= -10
= 22	

Note: The first letter B, that stands for brackets, has its own convention i.e. the inner most brackets must be evaluated first. For example, consider the second expression in the above picture.

Why BODMAS?

BODMAS is not a mathematical concept which has a thorough proof rather it is a standard

notation or convention that is used to avoid ambiguity and confusion. Let us assume if this order of operations does not exist, we will have different alternatives to solve the same expression, but each alternative will have variants of answer that can cause confusion and inconsistency. Because mathematics is applied to a large spectrum of fields, such inconsistency can be problematic.

Consider a non-mathematical example, suppose there are two people, say A and B and A is to convey an address to B. The twist is that A must convey the address by encoding it as a code and B must decode the code. To decode the code there is a key which is common for both. This key makes the decoding easy and the same thing can happen vice versa the key is common. Consider the following:

KEY:	North	South	East	West
CODE:	4	0	2	3

The above key along with code states that the place is 4km in north, no south direction, 2km in east and 3km in west. Because they have the same key, they both are aware which place what direction are there and hence, the address will be conveyed correctly.

Suppose there are other two people, say C and D and they use the same way to convey the address except they don't have a common key. This will create ambiguity and confusion and neither of the two will be able to decode the code because of uncommon ground. Consider the two following keys, each one with C and D respectively. If C sends the code, for C the first direction is north conveying 1km in north but on the other end south is the first direction and hence, D will take 1km in south. Because of these two different keys, misinterpretation can happen and the address decoded will be incorrect.

KEY:	North	South	East	West
CODE:	1	3	0	2

KEY:	South	North	West	East
CODE:	3	1	2	0

Likewise, if we consider the SI unit which is the standard metric system used internationally as a standard for measurement is also meant to maintain consistency. Therefore, BODMAS is significant for solving any mathematical expressions as it keeps the notation consistent and on common grounds.

Loopholes and Potential Mistakes

Like BODMAS, some countries follow the PEMDAS rule which is like BODMAS but in this rule the order of multiplication and division is interchanged. One can interpret that multiplication and division can be given the same precedence as it won't affect the final answer. With both mnemonics, we can say that division and multiplication have a higher precedence over addition and subtraction. Apart from that the P stands for parenthesis and E stands for exponent which is same as bracket and order respectively.

A very common misunderstanding regarding BODMAS is that we think that addition is evaluated before subtraction and division is evaluated before multiplication, which is not the case. Multiplication and division are given the same precedence and so is the case with addition and subtraction i.e. if at all these operations come together without any specified brackets then we must solve them left to right. Consider the following example:

4 + 4 - 4 + 4	3 * 2 / 2 * 3
= 8- 4 + 4	= 6 / 2 * 3
= 4 + 4	= 3 * 3
= 8	= 9

BODMAS on mixed fractions is also challenging and can potentially give rise to mistakes. The most common mistake can be misapplying fraction rules to maintain the order of operations. The mixed fraction should not be misinterpreted as a division problem and should be first converted to improper fraction followed by applying BODMAS to it. Consider the following example:

$$6 + \left\{\frac{4}{3} + \left(\frac{3}{4} - \frac{1}{3}\right)\right\}$$

$$6 + \left\{\frac{4}{3} + \left(\frac{3}{4} - \frac{1}{3}\right)\right\}$$

$$= 6 + \left\{\frac{4}{3} + \frac{3}{4} - \frac{1}{3}\right\} = \frac{6}{1} + \frac{4}{3} + \frac{3}{4} - \frac{1}{3}$$

$$= \frac{72 + 16 + 9 - 4}{12} \quad \text{(LCM of 3, 4 = 12)}$$

$$= \frac{97 - 4}{12} = \frac{93}{12} = \frac{31}{4} = 7\frac{3}{4}$$

Use of BODMAS in Programming Languages and Calculators

Programming languages uses some aspects of BODMAS when it come to precedence of brackets and other operations i.e., they do follow some order of operations. But it may not always coincide with the standard order as the readability and reliability may fall for some expressions. Therefore, specifying proper brackets in the expression is important as it will increase the readability of the programming languages.

Some of the basic calculators often don't handle the complex BODMAS well as they mostly evaluate the expressions in the sequence in which it is entered, this might give incorrect results and hence, proper use of brackets is important in this case too. Apart from that if we consider scientific calculator, they handle mathematical expressions using BODMAS provided the expression is entered correctly. Some of the calculator may vary in some aspects of the operations provided the expression is entered correctly then we are good to go.