Order of Operations
PEMDAS

Operations

"Operations" mean things like add, subtract, multiply, divide, squaring, etc. If it isn't a number it is probably an operation.

But, when you see something like ...

$$7 + (6 \times 5^2 + 3)$$

... what part should you calculate first?

Start at the left and go to the right?
Or go from right to left?

Warning: Calculate them in the wrong order, and you will get a wrong answer !

So, long ago people agreed to follow rules when doing calculations, and they are:

Order of Operations

Do things in Parentheses First

✓ $6 \times (5 + 3) = 6 \times 8 = \mathbf{48}$

✗ $6 \times (5 + 3) = 30 + 3 = 33$ (wrong)

Exponents (Powers, Roots) before Multiply, Divide, Add or Subtract

✓ $5 \times 2^2 = 5 \times 4 = \mathbf{20}$

✗ $5 \times 2^2 = 10^2 = 100$ (wrong)

Multiply or Divide before you Add or Subtract

✓ $2 + 5 \times 3 = 2 + 15 = \mathbf{17}$

✗ $2 + 5 \times 3 = 7 \times 3 = 21$ (wrong)

Otherwise just go left to right

✓ $30 \div 5 \times 3 = 6 \times 3 = \mathbf{18}$

✗ $30 \div 5 \times 3 = 30 \div 15 = 2$ (wrong)

How Do I Remember It All ... ? PEMDAS !

P	**P**arentheses first
E	**E**xponents (ie Powers and Square Roots, etc.)
MD	**M**ultiplication and **D**ivision (left-to-right)
AS	**A**ddition and **S**ubtraction (left-to-right)

Divide and Multiply rank equally (and go left to right).

Add and Subtract rank equally (and go left to right)

So do it this way:

1. P
2. E
3. M or D
4. A or S

After you have done "P" and "E", just go from left to right doing any "M" ***or*** "D" as you find them.

Then go from left to right doing any "A" ***or*** "S" as you find them.

You can remember by saying "**P**lease **E**xcuse **M**y **D**ear **A**unt **S**ally".

Or ...

Pudgy Elves May Demand A Snack
Popcorn Every Monday Donuts Always Sunday
Please Eat Mom's Delicious Apple Strudels
People Everywhere Made Decisions About Sums

Note: in the UK they say BODMAS (Brackets,Orders,Divide,Multiply,Add,Subtract), and in Canada they say BEDMAS (Brackets,Exponents,Divide,Multiply,Add,Subtract). It all means the same thing! It doesn't matter how you remember it, just so long as you get it right.

Examples

Example: How do you work out **3 + 6 × 2** ?

Multiplication before **A**ddition:

First **6 × 2 = 12**, then **3 + 12 = 15**

Example: How do you work out **(3 + 6) × 2** ?

Parentheses first:

First **(3 + 6) = 9**, then **9 × 2 = 18**

Example: How do you work out **12 / 6 × 3 / 2** ?

Multiplication and **D**ivision rank equally, so just go left to right:

First **12 / 6 = 2**, then **2 × 3 = 6**, then **6 / 2 = 3**

A practical example:

Example: Sam threw a ball straight up at 20 meters per second, how far did it go in 2 seconds?

Sam uses this special formula that includes the effects of gravity:

$$\text{height} = \text{velocity} \times \text{time} - (1/2) \times 9{,}8 \times \text{time}^2$$

Sam puts in the velocity of 20 meters per second and time of 2 seconds:

$$\text{height} = 20 \times 2 - (1/2) \times 9{,}8 \times 2^2$$

Now for the calculations!

Start with:	$20 \times 2 - (1/2) \times 9{,}8 \times 2^2$
Parentheses first:	$20 \times 2 - 0{,}5 \times 9{,}8 \times 2^2$
Then Exponents (2^2=4):	$20 \times 2 - 0{,}5 \times 9{,}8 \times 4$
Then the Multiplies:	$40 - 19{,}6$
Subtract and DONE !	**20,4**

The ball reaches 20,4 meters after 2 seconds

Exponents of Exponents ...

What about this example?

$$4^{3^2}$$

Exponents are special: **they go top-down** (do the exponent at the top first). So we calculate this way:

Start with:	4^{3^2}
$3^2 = 3\times3$:	4^9
$4^9 = 4\times4\times4\times4\times4\times4\times4\times4\times4$:	262144

And finally, what about the example from the beginning?

Start with:	$7 + (6 \times 5^2 + 3)$
Parentheses first and then *Exponents*:	$7 + (6 \times 25 + 3)$
Then *Multiply*:	$7 + (150 + 3)$
Then *Add*:	$7 + (153)$
Parentheses completed:	$7 + 153$
Last operation is an *Add*:	**160**

Your turn:

Question 1 Question 2 Question 3 Question 4 Question 5 Question 6
Question 7 Question 8 Question 9 Question 10
Order of Operations Worksheets