

# 1 Order of Operations

It is important to recognise in complex calculations what we can do and when. We will first concentrate on combinations of the following operations:

- Addition
- Subtraction
- Multiplication
- Division.

These can happen directly, for example  $4 \times 5 + 2$ , or with brackets, for example  $4 \times (5 + 2)$ . These calculations have different results as the order in which the operations take place changes. We will consider the BODMAS hierarchy of operations:

B	rackets	We perform calculations inside brackets first
O	f	
D	ivision	
M	ultiplication	Third are Division and Multiplication, which can happen at the same time
A	ddition	
S	ubtraction	Finally, Addition and Subtraction take place, which can also happen at the same time

In the examples mentioned this would work as follows:

- $4 \times 5 + 2 = 20 + 2 = 22$ . Here we carry out the multiplication first and the addition second.
- $4 \times (5 + 2) = 4 \times 7 = 28$ . Here we carry out the addition inside the brackets first and then the multiplication as brackets always go first.

Let's look at some more examples.

## Example 1.1.

$3 \times 4 + 6 \div 2$	$=$	$12 + 3$	We carry out the division and multiplication at the same time first
	$=$	$15$	Next we carry out the addition

## Example 1.2.

$7 \times (6 - 4)$	$=$	$7 \times 2$	We carry out the subtraction inside the brackets first
	$=$	$14$	Next we carry out the multiplication

## Example 1.3.

$(5 - 2) \times (1 + 12)$	$=$	$3 \times 13$	We carry out the addition and subtraction inside the brackets first
	$=$	$39$	Next we carry out the multiplication

**Example 1.4.**

$$\begin{aligned}
8 \times (7 - 3) + 5 \times 2 &= 8 \times 4 + 5 \times 2 && \text{We carry out the subtraction inside the brackets first} \\
&= 32 + 10 && \text{Next we carry out both multiplications} \\
&= 42 && \text{Finally we carry out the addition}
\end{aligned}$$

**Example 1.5.**

$$\begin{aligned}
6 \times (18 - 11) - 12 \div (2 \times 2) &= 6 \times 7 - 12 \div 4 && \text{We carry out the addition and multiplication inside the brackets first} \\
&= 42 - 3 && \text{Next we carry out the multiplication and division at the same time} \\
&= 39 && \text{Finally we carry out the subtraction}
\end{aligned}$$

**Example 1.6.**

$$\begin{aligned}
5 \times (21 - (5 + 6)) &= 5 \times (21 - 11) && \text{We carry out the addition inside the inner brackets first} \\
&= 5 \times 10 && \text{Next we carry out the subtraction inside the remaining brackets} \\
&= 50 && \text{Finally we carry out the multiplication}
\end{aligned}$$

**1.1 Exercises**

1.  $3 \times 8 - 9 =$
2.  $5 \times (7 - 3) =$
3.  $(1 + 3) \times (15 - 6) =$
4.  $2 \times (3 + 7) - 18 \div (5 + 4) =$
5.  $12 \div (1 + 2) + 2 \times (3 \times 5) =$
6.  $3 \times (14 - (6 + 2)) =$