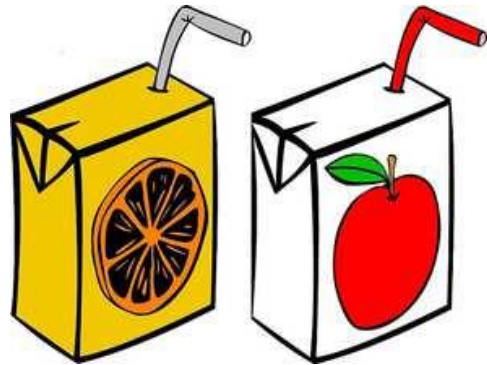


Performing Calculations - BODMAS

We all need to solve numerical problems in our everyday life from time to time. Let's look at a practical example.

Example 1

Cartons of juice have been donated to a school for their Christmas party. Cartons of orange juice come in packs of six, and cartons of apple juice come in packs of four. There are three packs of orange juice, and five packs of apple juice. How many cartons are there altogether?



Solution

number of orange juice cartons is: $3 \times 6 = 18$

number of apple juice cartons is: $5 \times 4 = 20$

giving a total of $18 + 20 = 38$ cartons.

If we had done this calculation in one step, we could have written that the total number of cartons is given by

$$3 \times 6 + 5 \times 4 = 38$$

In this calculation it is necessary to multiply the number of packs by the number of cartons in a pack before adding together the number of apple cartons and orange cartons. This is OK because this is exactly what the rules for ordering mathematical operations state.

Ordering Mathematical Operations

In the example above, we have applied some of the basic rules of mathematics. The rules can be summed up using the phrase BODMAS, which tells us the order in which operations, such

as addition and subtraction, multiplication and division should be carried out. **You cannot just work from left to right as you would when reading.**

Calculations within brackets should always take precedence, followed by powers and roots, and multiplication and division should be done before addition and subtraction.

B	O	D	M	A	S
Brackets	Order / Operations	Division	Multiplication	Addition	Subtraction
(...)	powers and roots	÷	×	+	-

Example 2

So, when performing a calculation, such as

$$2 + 3 \times 4$$

it is important that the operations are done in the correct order.

Solution

In this example, we would first need to multiply 3 by 4 before adding 2:

$$2 + 3 \times 4 = 2 + 12 = 14.$$

Brackets

Brackets are useful for specifying that a part of a calculation should be carried out first.

Example 3

If in the previous example we had wanted to add 2 and 3, before multiplying the result by 4, we could have written

$$(2 + 3) \times 4$$

Solution

$$(2 + 3) \times 4 = 5 \times 4 = 20$$

Notice we have a different answer now that we have added the brackets.

Order or Operations

You probably understand what each term in BODMAS means, with the possible exception of Order.

For Order, you could read Power. For example, consider Einstein's famous equation

$$E = m c^2$$

It is the convention in maths, when two unknown quantities are multiplied together, to drop the times symbol. In our example, what this means is $E = m \times c^2$

The speed of light, c , is said to be squared, or raised to the power 2. What this means is that c is multiplied by itself. Another way of expressing this would be to say that c has order 2.

So, types of operations that involve Order include raising to a power, such as squaring or cubing and also taking a root, such as a square root or a cube root.

Example 4

The area of a circle is given by

$$Area = \pi r^2$$

Where r is the radius of the circle, and π is approximately 3.14.

What is the area of a circle of radius 2cm?

Solution

$$Area = 3.14 \times 2^2$$

This calculation involves two operations, a multiplication and an order operation. According to the rules of BODMAS, the order calculation should be carried out first, giving us

$$Area = 3.14 \times 4 = 12.56 \text{ cm}^2$$

Squaring and cubing

Raising to the power of 2 is also called squaring, and it means multiplying a number by itself. For example, $2^2 = 2 \times 2 = 8$ and $3^2 = 3 \times 3 = 9$.

Raising to the power of 3 is also called cubing. For example, $2^3 = 2 \times 2 \times 2 = 8$ and $3^3 = 3 \times 3 \times 3 = 27$.

Finding a square or cube root

Finding a square root is the opposite of squaring. For example, finding $\sqrt{4}$ is like asking the question, what number must I multiply by itself to get 4? The answer is 2 because $2 \times 2 = 4$.

Finding a cube root is the opposite of cubing. For example, the cube root of 8, $\sqrt[3]{8}$, is 2 because $2 \times 2 \times 2 = 8$.

Non Calculator Exercises

1. At the sweet shop I buy two bars of milk chocolate at £1.10, and 3 bars of Fruit and Nut at £1.25 each. How much does this cost?
2. The store room has been out of stock of pencils for the past week, but this morning 200 pencils were delivered. Four people requested pencils last week but were unable to have any until today. If all four come to the store room today and each take away a pack of six pencils, how many pencils will be left in stock?
3. $2 + 8 \times 2$
4. $3 \times 4 + 7 \times 2$
5. $6 \div (5 - 2)$
6. $3 \times (4 + 7) \times 2$
7. $(3 + 2^2 \times 4)$
8. $\frac{2^3+4}{3^2-2 \times 3}$

Solutions

1. Cost = $2 \times 1.10 + 3 \times 1.25$ (BODMAS tells us to carry out the multiplication before the addition)
 $= £2.20 + £3.75 = £5.95$
2. number pencils remaining
 $= 200 - 4 \times 6$ (BODMAS tells us to carry out the multiplication before the subtraction)
 $= 200 - 24 = 176$
3. $2 + 8 \times 2$ (multiplication before addition)
 $= 2 + 16 = 18$
4. $3 \times 4 + 7 \times 2$ (multiplication before addition)
 $= 12 + 14 = 26$
5. $6 \div (5 - 2)$ (brackets first)
 $= 6 \div 3 = 2$
6. $3 \times (4 + 7) \times 2$ (brackets first)
 $= 3 \times 11 \times 2 = 66$
7. The rules of BODMAS tell us we must perform the calculation within brackets first of all, that is $3 + 2^2$

This calculation involves an addition operation and squaring of a number. The squaring operation takes precedence, so we must first find 2^2 before adding 3

$$\begin{aligned}(3 + 2^2) \times 4 \\ &= (3 + 4) \times 4 \\ &= 7 \times 4 = 28\end{aligned}$$

8. Although there are no brackets in this question, as it is written in fraction form, the calculations on the top and bottom need to be completed before the division can be done.

$$\frac{2^3 + 4}{3^2 - 2 \times 3} = \frac{8 + 4}{9 - 6} = \frac{12}{3} = 4$$

Using Your Calculator

Scientific calculators know the rules of BODMAS, and even allow you to enter brackets. This means you can enter calculations pretty much as you would write them and get the correct answers.

If you have a scientific calculator, you could enter

$$2 + 3 \times 4 =$$

and get the answer 14 because the calculator knows to multiply 3 and 4 before adding 2.

On a scientific calculator, you can enter calculations exactly as you would write them. Try the following exercises using the brackets buttons, fraction button, and the powers and roots buttons.

Calculator Exercises

- | | | |
|----------------------------------|---|---|
| 1. $8 \times (20 + 3) \times 14$ | 2. $4 + (2 + 7)^2 \times 2$ | 3. $(3 \times 4 + 5 \times 4) \div 2^3$ |
| 4. $(3 + 5 \times 4) \div 2^5$ | 5. $\frac{3^3 - 2^3}{3 \times (4 + 8)}$ | 6. $\frac{2^7 - 3^2 - 6}{7^2 - 4 \times 3}$ |

Solutions

- | | | |
|------------|------------------------------|------------------------------|
| 1. 2576 | 2. 166 | 3. 4 |
| 4. 0.71875 | 5. 0.528 to 3 decimal places | 6. 3.054 to 3 decimal places |