Algebra and substitution

Leaving Certificate · Ordinary Level

Understand the idea

How to start

In $3x - 5$, x is the variable , 3 is its coefficient, and -5 is the constant term.

1. Evaluate means find a numerical value. Substitute means replace a letter by a given number.
2. Replace every occurrence of the letter. Use brackets around a negative replacement.
3. Calculate powers before multiplication, then finish the additions and subtractions.

Key terms & definitions

Term
A part of an expression separated by addition or subtraction.

Coefficient
The numerical factor multiplying a variable.

Variable
A symbol representing a value.

Key ideas

• A variable stands for a number that may change. A coefficient multiplies a variable. A constant has no variable.

• An expression has no equals sign. An equation states that two expressions are equal.

• Substitution means replacing every occurrence of a variable with its value. Put negative values in brackets.

• Follow the order of operations. In $3x^2$, square x before multiplying by 3.

• Use algebra to describe a situation: three euro per item and a fixed fee of two euro gives $C = 3n + 2$.

Quick reminder

• An expression has no equals sign; an equation has one.

• Replace every occurrence of the variable.

• Use brackets for negative substitutions.

Worked examples

Example 01 · Start here: what does $3x$ mean?

Find $3x + 2$ when $x = 4$.

Why this method?

$3x$ means 3 multiplied by x. Replace x by 4, then multiply before adding.

$3x + 2 = 3(4) + 2$	**Step 1** Replace the letter x with 4. The brackets show multiplication.
$= 12 + 2$	**Step 2** Multiply 3 by 4 first.
$= 14$	**Step 3** Now add 2.

Example 02 · Substitute a negative value

Evaluate $2x^2 - 3x + 1$ when $x = -2$.

Purple follows the substituted value and the results calculated from it. Brackets keep each negative value together.

Why this method?

Evaluate means find the number the expression represents when x is -2. Brackets help us keep the negative replacement together.

$2x^2 - 3x + 1$	**Step 1** Start with the expression. We will replace every x by -2.
$2\,(-2)^2 - 3\,(-2) + 1$	**Step 2** Put -2 in brackets each time. The first 2 and the coefficient -3 stay in place.

$2(4) - 3(-2) + 1$	**Step 3** Square the bracket first : $(-2) \times (-2) = 4$.
$8 + 6 + 1$	**Step 4** Multiply : $2 \times 4 = 8$ and $-3 \times (-2) = +6$.
15	**Step 5** Add the three numbers. Evaluating ends with a numerical answer.

Example 03 · Substituting into a linear rule

A taxi charges €14 to start and €7 for each km. What is the cost of a journey of 10 km?

Why this method?

Replace every variable with its given value, using brackets for negative values. Then follow the order of operations.

$7 \times 10 = 70$	**Step 1** Multiply the rate by the number
$70 + 14 = 84$	**Step 2** Add the starting amount

Think about it: Before moving on: why is the starting amount added after the multiplication, not before it?

Example 04 · Substituting into a two-variable rule

A shop sells pens for €6 each and notebooks for €8 each. What do 8 pens and 4 notebooks cost altogether?

Why this method?

Replace every variable with its given value, using brackets for negative values. Then follow the order of operations.

$6 \times 8 = 48$	**Step 1** Cost of the pens
$8 \times 4 = 32$	**Step 2** Cost of the notebooks
$48 + 32 = 80$	**Step 3** Add the two costs

Think about it: Before moving on: why does each price have to be multiplied by the number of its own items?

Example 05 · A negative value that must be squared

Find $2a^2 - 3b$ when $a = -2$ and $b = 5$.

Why this method?

The square applies to a, including its negative sign. Put the replacement value in brackets.

$2(-2)^2 - 3(5)$	**Step 1** Replace each letter. Do not square the coefficient 2.
$= 2(4) - 15$	**Step 2** Negative 2 multiplied by negative 2 is positive 4.
$= 8 - 15$	**Step 3** Multiply before subtracting.
$= -7$	**Step 4** Subtract 15 from 8.

Example 06 · Substitute a negative number

Evaluate $2a^2 - 3b$ for $a = -2$ and $b = 5$.

$2(-2)^2 - 3(5)$	**Step 1** Use brackets around the negative input.
$2(4) - 15 = -7$	**Final step** Square before multiplying and subtracting.

Common mistake

Dropping the brackets when substituting a negative value. If $x = -2$, then $x^2 = (-2)^2 = 4$, not -4. In contrast, $-x^2 = -4$ because the minus is outside the square.

Exam technique

Write the substitution line before calculating.

Try it yourself

Work on paper before checking the answers at the end. These questions are for self-checking, not submitted homework.

Question 1

A plumber charges €30 call-out plus €45 per hour. What is the charge for 3 hours?

Question 2

Adult tickets cost €6 and child tickets cost €4. How much do 2 adult tickets and 3 child tickets cost?

Question 3 · Build confidence

Find $3x + 2$ when $x = 5$.

Question 4 · Apply or explain

A learner says $2a^2 = 36$ when $a = -3$. Explain the mistake.

Before you move on

Try these without looking at a worked example. Revisit any part that is still difficult.

- Explain what a coefficient means.
- Substitute a negative value using brackets.
- Square the value before multiplying by a coefficient.

Watch an explanation

Corbettmaths — Algebra: substitution

Open the website chapter to load the embedded players. Use the rates and rules in your question for financial examples.

Self-check answers

Question 1

165

Question 2

24

Question 3

17.

Multiply 3 by 5, then add 2.

Question 4

$2(-3)^2 = 2(9) = 18$.

Only a is squared; the coefficient 2 is outside the square.

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