Student Learning Centre

Substitution

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What is Substitution?

Substitution is when symbols in formulas are replaced by actual numerical values. We have learned that in an algebraic expression, letters can stand for numbers. When we substitute a specific value for each variable, and then perform the operations, it's called evaluating the expression.

1. Replace each letter in the expression with the assigned value.

First, replace each letter in the expression with the value that has been assigned to it. To make your calculations clear and avoid mistakes, always enclose the numbers you're substituting inside parentheses.

The value that's given to a variable stays the same throughout the entire problem, even if the letter occurs more than once in the expression. However, variables will "vary" when assigned to a different problem/expression.

2. Perform the operations in the expression using the correct order of operations.

Once you've substituted the value for the letter, do the operations to find the value of the expression.

Here's an example. Let's evaluate the expression. $2x^3 - x^2 + y$ for $x = 3$ and $y = -2$

Make sure the equation is clear and you know which variable is which. It's a good idea to write the expression down and what each variable is. Leave yourself enough room to work out the problem line by line, with each step right below the previous one.

$2x^3 - x^2 + y$
when $x = 3, y = -2$

Step 1: Replace each variable in the expression with its value. In this example, each x becomes a 3 and each y becomes a -2. It's a good idea to use parentheses (brackets) to keep track of this. $2(3)^3 - (3)^2 + (-2)$

Step 2: Perform operations with exponents. $2(27) - 9 + (-2)$

Step 3: Perform operations with multiplication and division. $54 - 9 + (-2)$

Step 4: Perform operations with addition and subtraction. 43

Worked Examples:

Example 1) Find the value of $A = xy$ when $x = 8$ and $y = 4$

Replace the letter x and y by their numerical values. Remember that xy means the product of x and y. That means we multiply x and y together: $A = xy = (8)(4) = 32$

Example 2) Find the value of $\dfrac{(1+i)^n - 1}{i(1+i)^n}$ when $i = 0.03$ and $n = 5$

We replace the letters i and n by their numerical values: $\dfrac{(1+0.03)^5-1}{0.03(1+0.03)^5}$

Perform operations with exponents: $\dfrac{(1.03)^5-1}{0.03(1.03)^5}$

Perform operations with multiplication, division, addition and subtraction: $\dfrac{0.15927}{0.347}$

Solution: 4.58 *Corrected to two decimal places.*

For more information on converting fractions to decimals, see study guide "Different forms of numbers: Percentages, Fractions & Decimals"

Find the value of these formulas.

Formulas (Remember to perform any operation in brackets *first* and then where required, adjust your answer to the power)	**Workings**	**Answers** (corrected to two decimal places)
1. $\boldsymbol{I = P\,i\,n}$ when $\boldsymbol{P = 100,\ i = 0.05\ \&\ n = 3}$	$I = (100)(0.05)(3)$	15.00
2. $\boldsymbol{V = \pi r^2 h}$ when $\boldsymbol{r = 3\ \&\ h = 7}$	$V = \pi(3)^2(7) = 63\pi$	197.92
3. $\boldsymbol{S = P(1+i)^n}$ when $\boldsymbol{P = 500,\ i = 0.075\ \&\ n = 4}$	$S = 500(1 + 0.075)^4$	667.73
4. $\boldsymbol{(1+i)^{-n}}$ when $\boldsymbol{i = 0.03\ \&\ n = 8}$	$(1 + 0.03)^{-8} = 1.03^{-8}$	0.78
5. $\boldsymbol{(1+i)^n - 1}$ when $\boldsymbol{i = 0.015\ \&\ n = 9}$	$(1 + 0.015)^9 - 1 = 1.015^9 - 1$	0.14
6. $\boldsymbol{\frac{i}{(1+i)^n - 1}}$ when $\boldsymbol{n = 10\ \&\ i = 0.11}$	$\frac{0.11}{(1 + 0.11)^{10} - 1} = \frac{0.11}{1.11^{10} - 1}$	0.06
7. $\boldsymbol{\frac{(1+i)^n - 1}{i(1+i)^n}}$ when $\boldsymbol{i = 0.02\ \&\ n = 12}$	$\frac{1.02^{12} - 1}{0.02(1.02)^{12}}$	10.57

Try these yourself, then check your answer below.

1. $\boldsymbol{\frac{xy}{z}}$ **When** $\boldsymbol{x = 7,\ y = 6\ \&\ z = 2}$		
2. $\boldsymbol{P(1 + i)^n}$ **when** $\boldsymbol{P = 1500,\ i = 0.05\ \&\ n = 5}$		
3. $\boldsymbol{(a - b)^{-n}}$ **when** $\boldsymbol{a = 6,\ b = 2.5\ \&\ n = 2}$		
4. $\boldsymbol{\frac{4}{3}\pi r^3}$ **when** $\boldsymbol{r = 9}$		
5. $\boldsymbol{\frac{5x3+y}{z}}$ **when** $\boldsymbol{x = 5,\ y = -3}$ **and** $\boldsymbol{z = 4}$		
6. $\boldsymbol{p(m.n)^{-q}}$ **when** $\boldsymbol{m = -4,\ n = -5,\ p = 12\ \&\ q = 2}$		

Answers:
1. 21.00
2. 1914.42
3. 0.08
4. 3053.65
5. 155.50
6. 0.03

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