

What is algebra?

Algebra (n): 1. (Math.) That branch of mathematics which treats of the relations and properties of quantity by means of letters and other symbols. It is applicable to those relations that are true of every kind of magnitude. (Webster's Dictionary)

Why do we use algebra?

Consider rectangles of different sizes we need to work out a general rule or formula. We can use the formula to "plug in" numbers to get an answer rather than doing something "the long way". The symbols we use are called variables because they represent a quantity that can change or vary.

Variables

Variables are just shorthand ways of describing things we understand which can have changing values. For example:

area	=	length x width or $A = L \times W$
force	=	mass x acceleration or $f = m$
quantity	=	$3 \times \text{price} + 5$ or $q = 3p + 5$
area of a circle	=	$\pi \times r^2$ or $A = \pi r^2$
equation of a line	=	$y = 4x + 7$

Like terms

In algebra it is common to be able to manipulate like terms. Like terms are those where both the variable and the power on the variable are identical.

Examples: These are like terms: x^2 and $3x^2$
 These are not like terms x^2 and $2x^3$ or $2xy$ and xy^2

Addition and Subtraction with Algebra and collecting like terms

Examples:

<i>Simplify</i> $A + A + A$	<i>Simplify</i> $2b + 2b - 3b$
$A + A + A$ = 3A (collecting like terms)	$2b + 2b - 3b$ = $4b - 3b$ (remember, work left to right) = b (by convention, we would write the answer as just 'b' and not '1b')
<i>Simplify</i> $3a + 4a + 2b + 3b + 10a$	<i>Simplify</i> $3x + 4y + 7x + 3x^2 + 9y + 2x^2$
$3a + 4a + 2b + 3b + 10a$ = 17a + 5b	$3x + 4y + 7x + 3x^2 + 9y + 2x^2$ = $10x + 13y + 5x^2$ (like term is where the symbol is the same AND the power is the same) = $5x^2 + 10x + 13y$ (by convention, we often write the symbols in descending order of power, and the like symbols collected together)
<i>Simplify</i> $2x^3 + 4x^2 + 4 + 2x + 6x + 6x^2 + 12x^3 + 3x^4 + 3$	
$2x^3 + 4x^2 + 4 + 2x + 6x + 6x^2 + 12x^3 + 3x^4 + 3$ = $14x^3 + 10x^2 + 7 + 8x + 3x^4$ = $3x^4 + 14x^3 + 10x^2 + 8x + 7$	

Multiplication and Division with Algebra

Firstly, when using multiply (e.g. \times , $*$, \bullet) and divide (e.g. \div , $/$) with symbols and exponents, the following rules apply:

Rule	Example
$a^x * a^y = a^{x+y}$	Simplify: $x^3 * x^4$ $= x^{3+4}$ $= x^7$ (adding the exponents)
$a^x \div a^y = a^{x \div y}$	Simplify: $x^2 \div x$ $= x^{2-1}$ (subtracting the exponents) $= x$

Further, we must multiply and divide coefficients (i.e. number in front) and symbols. Here are two examples:

Simplify:

$$\begin{aligned} 3x(4x) + 5x(6y) + 2(13x) + 3(5x^2) \\ = 12x^2 + 30xy + 26x + 15x^2 \\ = 27x^2 + 30xy + 26x \text{ (adding 'like terms')} \end{aligned}$$

Simplify:

$$\begin{aligned} x^4(x^3) + 3x^2/x - 7x^3/(x(x)) + 4xy/y - 10xyz(xz) - x^5(x^2) \\ = x^7 + 3x - 7x + 4x - 10y - x^7 \\ = x^7 - x^7 + 3x - 7x + 4x - 10y \text{ (combining the } x^7 \text{ terms together)} \\ = 3x - 7x + 4x - 10y \text{ (working left to right)} \\ = -4x + 4x - 10y \\ = -10y \end{aligned}$$

Practice Questions

Simplify the following equations-:

Q1: $3a - 9 - 2a + 9a$

Q2: $7a + 4b + 3a - 2a + 3b + 3ab = 0$

Q3: $3(a + b) + 4b - 2a = 0$

Q4: $-2a(3 - 4b) - 2b + 3a + 5 = 0$

Calculate the numerical value of x in the following equations-:

Q5: $13x = 39$

Q6: $-10x + 42 = -2x$

Q7: $12x \div 3x + 4x = 0$

Rewrite the following equations, to make y the subject of the equation-:
(i.e. make $y = ??$)

Q8: $3x + 2y = 7$

Q9: $0 = 10x + 4(y - 7x)$

Answers:

1. $10a - 9$
2. $8a + 7b + 3ab = 0$
3. $a + 7b = 0$
4. $3a + 8ab - 2b + 5 = 0$
5. $x = 3$
6. $x = 5.25$
7. $x = -1$
8. $y = (7 - 3x) / 2$
9. $y = 4.5x$

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