

GCSE MATHS

Expressions and substitution

Long workbook

Questions on GCSE Maths topics, including challenges beyond typical exam questions.

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Topic recap

Notation

$3a$ means $3 \times a$; a^2 means $a \times a$. An expression has no equals sign.

Substitution

Replace every occurrence of a letter by its value: if $x = 5$, then $3x + 8 = 3(5) + 8 = 23$. Put negative values in brackets before using powers.

Like terms

a and a^2 are different terms. Collect only terms with the same letters and powers.

Formulae

Keep the units consistent. Evaluate a numerator and denominator separately before dividing.

1. Notation and expressions

Example Problem 1

**

Each bag contains r red counters and 5 blue counters. Write an expression for the total number of counters in 3 such bags.

The idea

1. Find the total in one bag.
2. Multiply the whole total by 3.

Worked Solution

$$r + 5$$

Add the red and blue counters in one bag.

$$3(r + 5)$$

Each of the three bags contains this whole amount.

1 Notation and expressions

**

Q1 A number x is increased by 5. The result is divided by 3. Write an expression for the final result.

**

Q2 Write an expression for each of the following.

**

(a) Twice the sum of a and b .

(b) The sum of twice a and b .

Q3 Write an expression for the square of the sum of x and 3.

**

Q4 A taxi charges £4 plus £3 per kilometre. Write an expression for the fare, in pounds, for a journey of d km.

**

Q5 A school buys n boxes, each containing p pencils. It gives 3 pencils to each of 24 pupils. Write an expression for the number of pencils left.

**

Q6 Three consecutive odd numbers start with n . Write an expression for their sum, in its simplest form.

**

2. Substitution

Example Problem 2

**

Find $2a^2 - 3b$ when $a = -3$ and $b = 4$.

The idea

1. Place the negative value in brackets before squaring.

Worked Solution

$$2(-3)^2 - 3(4)$$

Substitute both values.

$$2(9) - 12 = 6$$

Square before multiplying.

2 Substitution

Q7 Find the value of each expression when $x = -2$.

**

(a) $3x + 8$

(b) $3(x + 8)$

Q8 Find $5a - 2b$ when $a = -2$ and $b = 3$.

**

Q9 Find $x^2 + 2x$ when $x = -4$.

**

Q10 Find $\frac{a+b}{c}$ when $a = 7$, $b = -1$ and $c = 3$.

**

Q11 Find $2p^3 - q^2$ when $p = -2$ and $q = -3$.

**

Q12 Find $\sqrt{b^2 - 4ac}$ when $a = 2$, $b = -7$ and $c = 3$.

3. Collecting terms and products

Example Problem 3

**

Simplify $4x^2 + 3x - 2x^2 + 5x$.

The idea

1. Collect the square terms separately from the linear terms.

Worked Solution

$$(4 - 2)x^2 + (3 + 5)x$$

Group like terms.

$$2x^2 + 8x$$

Simplify the coefficients.

3 Collecting terms and products

Q13 Simplify $4a + 3 + 2a - 8$.

**

Q14 Simplify $4x + 3y - 7x + 5y$.

**

Q15 Simplify $6p^2 - 2p + 3p^2 + 7p$.

**

Q16 Simplify $3a \times 4ab$.

**

Q17 Simplify $\frac{18x^3y}{6xy}$ for non-zero x and y .

**

Q18 Simplify $2a \times 3b - 4ab + 5ab$.

4. Formulae and reasoning

Example Problem 4

$T = \frac{a^2 - b}{c}$. Find T when $a = -4$, $b = 7$ and $c = 3$.

The idea

1. Finish the entire numerator before dividing.

Worked Solution

$$T = \frac{(-4)^2 - 7}{3}$$

Substitute with brackets.

$$T = \frac{16 - 7}{3} = 3$$

Square, subtract, then divide.

4. Formulae and reasoning

Example Problem 5

Simplify $(4n + 7) - (2n - 3)$.

The idea

1. Subtract every term in the second bracket, including its negative constant.

Worked Solution

$$4n + 7 - 2n + 3$$

Removing a subtracted bracket reverses both signs.

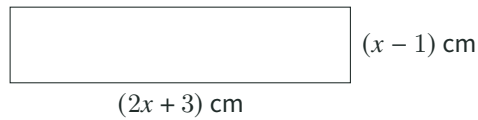
$$2n + 10$$

Collect the terms.

4 Formulae and reasoning

Q19 A rectangle has length $2x + 3$ cm and width $x - 1$ cm. Write its perimeter in terms of x .

**

**Q20** $v = u + at$. Find v when $u = 12$, $a = -1.5$ and $t = 8$.

**

Q21 $s = ut + \frac{1}{2}at^2$. Find s when $u = 3$, $a = 2$ and $t = 5$.

**

Q22 $E = \frac{1}{2}m(v^2 - u^2)$. Find E when $m = 4$, $v = 7$ and $u = 5$.

**

Q23 Two expressions are $A = 3n + 2$ and $B = 2n + 5$. Find $A - B$ in terms of n .

**

Q24 For a positive integer n , compare $A = (n + 1)^2$ with $B = n(n + 2)$. Which is greater, and by how much?

Solving principles

1. Translate in order

Decide what the words say happens first.

2. Keep brackets

Brackets show which terms are multiplied or squared together.

3. Collect like terms

Add or subtract their coefficients; keep the same letters and powers.

4. Check the meaning

Test an expression with a simple value and interpret the result.