GCSE FOUNDATION · UNIT 2

Algebra

Expressions, substitution, formulae, expanding and factorising

Name: _____ Class: _____

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Keep this booklet in your folder. Write your notes and answers in it during each lesson.

Algebra knowledge organiser

GCSE Foundation · expressions, substitution, formulae, expanding and factorising

Name _____

THE TEN LESSONS

	TOPIC	LEARNING QUESTION	KEY WORDS	HOW SURE AM I?
1	**The language of algebra**	How can you tell if a statement is true for every value, or only for some?	term, variable, coefficient, constant, expression, equation, formula, identity	○ ○ ○
2	**Collecting like terms**	Why can we add $3x$ and $4x$, but not $3x$ and $4y$?	like terms, unlike terms, simplify, collect	○ ○ ○
3	**Multiplying and dividing terms**	Why is $a \times a$ not the same as $2a$?	product, coefficient, simplify, cancel	○ ○ ○
4	**Index laws**	Why do we add the powers when we multiply, instead of multiplying them?	index, power, base, index notation	○ ○ ○
5	**Writing expressions**	Why is 5 less than x written as $x - 5$, not $5 - x$?	variable, expression, more than, less than, in terms of	○ ○ ○
6	**Substitution**	When $x = 4$, why is $3x$ equal to 12 and not 34?	substitute, value, order of operations	○ ○ ○
7	**Formulae**	What makes a formula more useful than an expression?	formula, subject, word formula, substitute	○ ○ ○
8	**Expanding brackets**	Why must everything inside the bracket be multiplied?	bracket, expand, term, multiply	○ ○ ○
9	**Expand and simplify**	Why do we expand before we collect like terms?	expand, simplify, like terms	○ ○ ○
10	**Factorising**	How can you check that a factorised answer is correct and complete?	factor, common factor, highest common factor (HCF), factorise, identity	○ ○ ○

How sure am I? Shade one circle after each lesson: 1 circle = not yet, 2 circles = getting there, 3 circles = I can explain it to someone else.

How to revise with this sheet

1. Cover the key words. Say what each one means, then check on the back.
2. Answer each learning question out loud or in writing. Use an example.
3. Copy an example from the back, cover the answer, and try it again from memory.
4. Go back to any lesson where you shaded fewer than 3 circles.

What I need to know

Key words, rules with examples, and mistakes to avoid

KEY WORDS

Variable
A letter that stands for a number. Its value can change.
x

Term
A number, a letter, or numbers and letters multiplied together.
$3x$, 7, ab

Coefficient
The number multiplying a letter.
In $3x$ it is 3

Expression
Terms joined by + or −. No equals sign.
$3x + 5$

Equation
Has an equals sign. Only true for some values.
$3x + 5 = 11$

Formula
A rule that links two or more variables.
$A = bh$

Identity
True for every value. Uses the ≡ sign.
$2n + 3n \equiv 5n$

Like terms
Same letter and same power.
$3x$ and $7x$

Substitute
Replace each letter with its number.
$x = 4$: $3x = 3 \times 4$

Expand
Multiply out the bracket.
$3(x + 2) = 3x + 6$

Factorise
Put the bracket back in. The reverse of expanding.
$3x + 6 = 3(x + 2)$

HCF
Highest common factor. The biggest factor the terms share.
HCF of 12 and 18 is 6

RULES AND EXAMPLES (THE NUMBER SHOWS THE LESSON)

2 Collect like terms

Add or subtract the like terms. Keep the sign with each term.

$3a + 6b - a - 9b = 2a - 3b$

3 Multiply and divide terms

Numbers first, then letters in alphabetical order.

$2a \times 3b = 6ab$

$a \times a = a^2$

$\frac{10x}{2} = 5x$

4 Index laws

Multiplying: add the powers.
Dividing: subtract the powers.

$x^2 \times x^4 = x^6$

$x^7 \div x^4 = x^3$

5 Write expressions

More than: add. Less than: subtract.
Lots of: multiply. Shared: divide.

6 more than x is $x + 6$

3 lots of m is $3m$

6 Substitute

Put the × back in. Replace the letters. Multiply before you add.

$a = 5, b = 2$

$4a - 2b = 4 \times 5 - 2 \times 2 = 16$

7 Use a formula

Write the formula. Replace the letters. Work it out.

$F = ma, m = 5, a = 3$

$F = 5 \times 3 = 15$

8 Expand a bracket

Multiply every term inside by the term outside.

$3(x + 2) = 3x + 6$

$-2(a + 5) = -2a - 10$

9 Expand and simplify

Expand each bracket first. Then collect like terms.

$2(x + 1) + 3(x + 2)$

$= 2x + 2 + 3x + 6$

$= 5x + 8$

10 Factorise

Find the HCF. Divide each term by it. Check by expanding.

$10y + 25 = 5(2y + 5)$

$x^2 + 5x = x(x + 5)$

MISTAKES TO AVOID

× $3x + 4y = 7xy$
✓ $3x + 4y$ cannot be simplified

× $a \times a = 2a$
✓ $a \times a = a^2$

× $x^2 \times x^3 = x^6$
✓ $x^2 \times x^3 = x^5$

× When $x = 4$, $3x = 34$
✓ $3x = 3 \times 4 = 12$

× $3(x + 2) = 3x + 2$
✓ $3(x + 2) = 3x + 6$

× $-2(x - 3) = -2x - 6$
✓ $-2(x - 3) = -2x + 6$

Name: Date:

Lesson 1: The language of algebra NOTES

Learning question: How can you tell if a statement is true for every value, or only for some?

Write the example from the board in the Example box. Then fill in each step as we work through it.

A. NAME THE PARTS OF AN EXPRESSION

Name the parts of this expression — ALL LEVELS

Example

1. Split it into **terms**. The sign in front stays with its term.
2. Find the **variables**. These are the letters.
3. Find the **coefficients**. A coefficient is the number multiplying a letter.
4. Find the **constant**. This is the number on its own.

B. ALGEBRA SHORTHAND

Multiplying — ALL LEVELS

Example

1. What is the operation?
2. Number first, then letters in alphabetical order.
3. Remove the × sign.

Dividing — LEVEL 2 AND 3

Example

1. What is the operation?
2. Write a division as a fraction. The first part goes on top.

C. WHAT TYPE IS IT?

An expression — LEVEL 1

Example

1. Look for an equals sign.
2. Decide what it is.

An equation — LEVEL 1

Example

1. Look for an equals sign.
2. Decide what it is.

A formula — LEVEL 2

Example

1. Look for an equals sign.
2. Count the different letters. Is it a rule linking them?
3. Decide what it is.

An identity — LEVEL 3

Example

1. Look for an equals sign.
2. Test it with numbers. Is it true every time?
3. Decide what it is.

Name: Date:

Lesson 1: The language of algebra

Learning question: How can you tell if a statement is true for every value, or only for some?

A. Name the parts

1. How many terms?

$5a + 2b - 9$

2. Write the coefficient of x.

$7x + 4$

3. Write the constant.

$3m - 8$

4. Write the variables.

$2p + 6q - 1$

B. Write using algebra shorthand

5. $5 \times n$

6. $k \times 3$

7. $d \times c$

8. $w \div 4$

C. Expression, equation, formula or identity?

9. $6t - 5$

10. $2x + 1 = 9$

11. $A = bh$

12. $2n + 3n = 5n$

Name: Date:

Lesson 2: Collecting like terms

Learning question: Why can we add 3x and 4x, but not 3x and 4y?

A. Like terms or unlike terms?

1. $3x$ and $7x$

2. $4a$ and $4b$

3. $5y$ and y

4. $2m$ and $2m^2$

B. Simplify

5. $4a + 3a$

6. $9t - 5t$

7. $6n + 2n - 3n$

8. $7p - p + 2p$

C. Simplify by collecting like terms

9. $3x + 5 + 4x + 2$

10. $5a + 2b + 3a + 6b$

11. $6m + 7n - 2m - 3n$

12. $4y^2 + 3y + 2y^2 - y$

Name: Date:

Lesson 3: Multiplying and dividing terms

Learning question: Why is a × a not the same as 2a?

A. Simplify: number × term

1. $3 \times 4m$

2. $5t \times 2$

3. $6 \times 3y$

4. $-2 \times 4k$

B. Simplify: term × term

5. $2a \times 5b$

6. $3p \times 4q$

7. $d \times 6c$

8. $4a \times 2a$

C. Simplify: dividing

9. $\frac{8x}{2}$

10. $\frac{15n}{5}$

11. $\frac{12b}{4}$

12. $\frac{4m}{8}$

Name: Date:

Lesson 4: Index laws

Learning question: Why do we add the powers when we multiply, instead of multiplying them?

A. Write using index notation

1. $a \times a \times a$

2. $y \times y \times y \times y \times y$

3. $4 \times 4 \times 4$

4. $m \times m \times n \times n \times n$

B. Simplify: multiplying powers

5. $x^2 \times x^3$

6. $a^4 \times a^2$

7. $y^5 \times y$

8. $2n^3 \times 4n^2$

C. Simplify: dividing powers

9. $t^6 \div t^2$

10. $b^8 \div b^3$

11. $\dfrac{x^7}{x^4}$

12. $\dfrac{10p^5}{2p^2}$

Name: Date:

Lesson 4: Index laws · Extension (page 2)

Learning question: Why do we add the powers when we multiply, instead of multiplying them?

D. Powers in brackets

13. Simplify.

$(x^2)^3$

14. Simplify.

$(y^4)^2$

15. Simplify.

$(a^5)^3$

16. Simplify.

$(2m^3)^2$

E. Use more than one law

17. Simplify.

$(x^2)^3 \times x^4$

18. Simplify.

$(p^3)^4 \div p^5$

19. Simplify.

$$\frac{x^4 \times x^5}{x^3}$$

20. Simplify.

$$\frac{12y^8}{4y^3}$$

F. Think deeper

21. Find the missing power.

$x^{\square} \times x^3 = x^9$

22. Find the missing power.

$(n^{\square})^4 = n^{12}$

23. Sam says $(x^3)^2 = x^5$. Explain his mistake.

24. Work out the value.

$7^0 + (2^2)^2$

Name: Date:

Lesson 5: Writing expressions

Learning question: Why is 5 less than x written as x – 5, not 5 – x?

A. Write as an expression

1. 5 more than x

2. 4 less than y

3. 6 lots of m

4. p divided by 3

B. I think of a number. Use n for the number.

5. I add 7.

6. I multiply it by 3.

7. I multiply it by 2, then add 5.

8. I divide it by 4, then subtract 1.

C. Write an expression for each situation

9. A pen costs c pence. What is the cost of 5 pens?

10. Mia is y years old. Her brother is 3 years older. How old is he?

11. A bag holds n sweets. 2 are eaten. How many are left?

12. A rectangle has sides b cm and h cm. What is its perimeter?

Name: Date:

Lesson 6: Substitution

Learning question: When x = 4, why is 3x equal to 12 and not 34?

A. Work out the value when $x = 4$

1. $3x$

2. $x + 9$

3. $5x - 2$

4. $\frac{x}{2}$

B. Work out the value when $a = 5$ and $b = 2$

5. $a + b$

6. ab

7. $4a - 2b$

8. $\frac{8a}{b}$

C. Work out the value when $p = 3$ and $q = -2$

9. p^2

10. $2p^2$

11. $3q$

12. q^2

Name: Date:

Lesson 7: Formulae

Learning question: What makes a formula more useful than an expression?

A. pay = hourly rate × hours worked. Work out the pay.

1. £6 an hour for 3 hours

2. £8 an hour for 5 hours

3. £10 an hour for 7 hours

4. £9 an hour for 4 hours

B. Use the formula

5. $A = bh$

$b = 6$, $h = 4$. Work out A.

6. $F = ma$

$m = 5$, $a = 3$. Work out F.

7. $v = u + at$

$u = 2$, $a = 3$, $t = 4$. Work out v.

8. $s = \frac{d}{t}$

$d = 40$, $t = 5$. Work out s.

C. Write a formula

9. A ticket costs £t. Write a formula for the cost, C, of 4 tickets.

10. A pen costs p pence. A pencil costs 5 pence less. Write a formula for its cost, C.

11. A taxi charges £2 plus £3 per mile. Write a formula for the cost, C, of m miles.

12. Zara works h hours at £r per hour. Write a formula for her pay, P.

Name: Date:

Lesson 8: Expanding brackets

Learning question: Why must everything inside the bracket be multiplied?

A. Expand

1. $3(x + 2)$

2. $5(a + 4)$

3. $2(y - 7)$

4. $4(2m + 3)$

B. Expand: negative outside

5. $-2(x + 5)$

6. $-3(a + 1)$

7. $-4(t - 2)$

8. $-(n + 6)$

C. Expand: letter outside

9. $x(x + 3)$

10. $a(a - 5)$

11. $p(2p + 1)$

12. $3y(y + 2)$

Name: Date:

Lesson 9: Expand and simplify

Learning question: Why do we expand before we collect like terms?

A. Expand and simplify

1. $3(t + 4) + 2$

2. $5(m - 2) + 6$

3. $2(x + 3) + 4x$

4. $a(a - 8) + 2a$

B. Expand and simplify: adding two brackets

5. $2(x + 1) + 3(x + 2)$

6. $4(a + 2) + 2(a + 5)$

7. $3(y + 4) + 2(y - 1)$

8. $5(n - 1) + 2(n + 3)$

C. Expand and simplify: subtracting a bracket

9. $5(x + 3) - 2(x + 1)$

10. $4(a + 3) - 3(a + 2)$

11. $6(p + 2) - 2(p - 1)$

12. $4(2a + 3) - 3(a + 2)$

Name: Date:

Lesson 10: Factorising

Learning question: How can you check that a factorised answer is correct and complete?

A. Find the highest common factor (HCF)

1. 12 and 18

2. 15 and 25

3. $8x$ and 12

4. a^2 and a

B. Factorise

5. $3x + 12$

6. $5a - 20$

7. $8y + 12$

8. $15 - 10t$

C. Factorise: letters

9. $x^2 + 5x$

10. $n^2 + n$

11. $4a^2 + 3a$

12. $3a^2 - 9a$