

Fix it 1 Common factor first

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Before you start, look for a number that goes into all three terms. Take the biggest one out in front of a bracket, then factorise the bracket. No number goes into all three? Carry on.

EXAMPLE

Take out the biggest common factor of $6x^2 + 27x + 27$

1. 3 goes into 6, 27 and 27.
2. $6 = 3 \times 2$ and $27 = 3 \times 9$
3. $6x^2 + 27x + 27 = 3(2x^2 + 9x + 9)$
4. Now factorise $2x^2 + 9x + 9$.

YOUR TURN

- 1 Take out the biggest common factor, if there is one:
 $12x^2 + 30x + 12$

$$6(2x^2 + 5x + 2)$$

- 2 Take out the biggest common factor, if there is one:
 $6x^2 - 4x - 10$

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

- 3 Take out the biggest common factor, if there is one:
 $4x^2 + 8x + 3$

None: 2 does not go into 3

Check: Multiply the bracket by the number in front: you get the quadratic. Nothing else goes into all three terms in the bracket.

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Fix it 2 First number times the last

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Multiply the number in front of x^2 by the number at the end. Keep the sign of the number at the end: a minus there makes the answer negative.

EXAMPLE

Factorise $3x^2 + 10x - 8$

Work out the first number times the last.

1. The first number: 3 (in front of x^2)
2. The last number: -8 , sign and all
3. $3 \times -8 = -24$

YOUR TURN

- 1 Factorise $2x^2 + 13x + 15$
Work out the first number times the last.

$$30$$

- 2 Factorise $5x^2 - 3x - 2$
Work out the first number times the last.

$$-10$$

- 3 Factorise $6x^2 - 17x + 12$
Work out the first number times the last.

$$72$$

Check: Divide your answer by the number in front of x^2 . You get the number at the end, sign and all.

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Fix it 3 Find the two numbers

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Find two numbers that multiply to make the first number times the last, and add to make the number in front of x . List the factor pairs, signs and all.

EXAMPLE

Find two numbers that multiply to make -24 and add to make 10 .

1. One is negative: the product is negative.
2. -3 and 8 add to 5 ; -4 and 6 add to 2
3. -2 and 12 add to 10 ✓
4. 12 and -2

YOUR TURN

- 1 Find two numbers that multiply to make 60 and add to make 16 .

6 and 10

- 2 Find two numbers that multiply to make -18 and add to make -7 .

-9 and 2

- 3 Find two numbers that multiply to make 24 and add to make -14 .

-12 and -2

Check: Multiply your two numbers: you get the first number times the last. Add them: you get the number in front of x . *The Maths Habit*

Fix it 4 Split the middle term

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Put the x^2 term top left and the number bottom right. The two numbers become x terms in the other two boxes, signs kept. Either way round works.

EXAMPLE

Split the middle term of $3x^2 + 10x - 8$ in the grid. The numbers are 12 and -2 .

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$3x^2$	$+12x$
$-2x$	-8

1. $3x^2$ top left, -8 bottom right
2. 12 and -2 become $+12x$ and $-2x$

YOUR TURN

- 1 Split the middle term of $2x^2 + 11x + 14$ in the grid. The numbers are 7 and 4 . What goes in the empty boxes?

$+7x$ and $+4x$

×

$2x^2$	
	$+14$

- 2 Split the middle term of $5x^2 + 9x - 2$ in the grid. The numbers are 10 and -1 . What goes in the empty boxes?

$+10x$ and $-x$

×

$5x^2$	
	-2

- 3 Split the middle term of $6x^2 - 19x + 10$ in the grid. The numbers are -15 and -4 . What goes in the empty boxes?

$-15x$ and $-4x$

×

$6x^2$	
	$+10$

Check: Add the two x terms in the boxes. You get the middle term back.

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Fix it 5 Find the headings

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The top row's heading is what goes into both its boxes: the biggest common factor, with x . Divide each top box by it for the headings across. Divide the bottom left box by the heading above it for the last one.

EXAMPLE

Find the headings of the grid for $3x^2 + 10x - 8$.

	x	$+4$
$3x$	$3x^2$	$+12x$
-2	$-2x$	-8

- Top row $3x^2$ and $12x$: both have $3x$
- $\frac{3x^2}{3x} = x$ and $\frac{12x}{3x} = 4$
- $\frac{-2x}{x} = -2$

YOUR TURN

- Find the headings of the grid for $2x^2 + 11x + 15$.

	x	
	$2x^2$	$+6x$
	$+5x$	$+15$

$2x + 5$ down; $x + 3$ across

- Find the headings of the grid for $4x^2 + 4x - 3$.

	x	
	$4x^2$	$+6x$
	$-2x$	-3

$2x - 1$ down; $2x + 3$ across

- Find the headings of the grid for $6x^2 - 13x + 6$.

	x	
	$6x^2$	$-9x$
	$-4x$	$+6$

$3x - 2$ down; $2x - 3$ across

Check: Multiply the two headings of the bottom right box. You get the number in it, sign and all.

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Fix it 6 Write the answer

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The headings down the side make one bracket and the headings across the top make the other, signs kept. A common factor you took out first goes in front.

EXAMPLE

The headings for $3x^2 + 10x - 8$ are $3x, -2$ down and $x, +4$ across. Write the answer.

- Down the side: $(3x - 2)$
- Across the top: $(x + 4)$
- $3x^2 + 10x - 8 = (3x - 2)(x + 4)$

YOUR TURN

- The headings for $3x^2 + 14x + 8$ are $3x, +2$ down and $x, +4$ across. Factorise it.

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

- The headings for $10x^2 - x - 3$ are $5x, -3$ down and $2x, +1$ across. Factorise it.

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

- $6x^2 + 3x - 18 = 3(2x^2 + x - 6)$. The grid's headings are $2x, -3$ down and $x, +2$ across. Factorise $6x^2 + 3x - 18$ fully.

$3(2x - 3)(x + 2)$

Check: The first terms of your brackets multiply to the x^2 term, and the last terms to the number.

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Expand your brackets in a grid: four terms. Collect the two x terms, and multiply by any number in front. You must get the quadratic you started with, signs and all.

EXAMPLE

Check $3x^2 + 10x - 8 = (3x - 2)(x + 4)$

1. Expand: $3x^2 + 12x - 2x - 8$
2. Collect: $12x - 2x = 10x$
3. $3x^2 + 10x - 8$ ✓

YOUR TURN

- 1 Expand $(4x + 3)(x + 2)$ to check it gives $4x^2 + 11x + 6$.

$$4x^2 + 11x + 6 \checkmark$$

- 2 Ali writes $6x^2 - 17x + 12 = (3x + 4)(2x + 3)$. Expand to check. Is Ali right?

$$\text{No: it gives } 6x^2 + 17x + 12$$

- 3 Expand $5(2x - 1)(x + 3)$ to check it gives $10x^2 + 25x - 15$.

$$10x^2 + 25x - 15 \checkmark$$

Check: Substitute $x = 1$ into the quadratic and into your answer. Both give the same number.

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