

# Solving linear simultaneous equations by substitution

## A LEVEL LINKS

Scheme of work: Scheme of work: 1c. Equations – quadratic/linear simultaneous

## Key points

- Two equations are simultaneous when they are both true at the same time.
- Solving simultaneous linear equations in two unknowns involves finding the value of each unknown which works for both equations.
- Make sure that the coefficient of one of the unknowns is the same in both equations.
- Eliminate this equal unknown by either subtracting or adding the two equations.
- The substitution method is the method most commonly used for A level. This is because it is the method used to solve linear and quadratic simultaneous equations.

**Example 1** Solve the simultaneous equations  $y = 2x + 1$  and  $5x + 3y = 14$

$5x + 3(2x + 1) = 14$ $5x + 6x + 3 = 14$ $11x + 3 = 14$ $11x = 11$ $\text{So } x = 1$ $\text{Using } y = 2x + 1$ $y = 2 \times 1 + 1$ $\text{So } y = 3$ Check: equation 1: $3 = 2 \times 1 + 1$ YES equation 2: $5 \times 1 + 3 \times 3 = 14$ YES	<ol style="list-style-type: none"><li>1 Substitute <math>2x + 1</math> for <math>y</math> into the second equation.</li><li>2 Expand the brackets and simplify.</li><li>3 Work out the value of <math>x</math>.</li><li>4 To find the value of <math>y</math>, substitute <math>x = 1</math> into one of the original equations.</li><li>5 Substitute the values of <math>x</math> and <math>y</math> into both equations to check your answers.</li></ol>
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**Example 2** Solve  $2x - y = 16$  and  $4x + 3y = -3$  simultaneously.

$y = 2x - 16$ $4x + 3(2x - 16) = -3$ $4x + 6x - 48 = -3$ $10x - 48 = -3$ $10x = 45$ $\text{So } x = 4\frac{1}{2}$ <p>Using <math>y = 2x - 16</math></p> $y = 2 \times 4\frac{1}{2} - 16$ $\text{So } y = -7$ <p>Check:</p> <p>equation 1: <math>2 \times 4\frac{1}{2} - (-7) = 16</math> YES</p> <p>equation 2: <math>4 \times 4\frac{1}{2} + 3 \times (-7) = -3</math> YES</p>	<ol style="list-style-type: none"> <li><b>1</b> Rearrange the first equation.</li> <li><b>2</b> Substitute <math>2x - 16</math> for <math>y</math> into the second equation.</li> <li><b>3</b> Expand the brackets and simplify.</li> <li><b>4</b> Work out the value of <math>x</math>.</li> <li><b>5</b> To find the value of <math>y</math>, substitute <math>x = 4\frac{1}{2}</math> into one of the original equations.</li> <li><b>6</b> Substitute the values of <math>x</math> and <math>y</math> into both equations to check your answers.</li> </ol>
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## Practice questions

Solve these simultaneous equations.

**1**  $y = x - 4$   
 $2x + 5y = 43$

**2**  $y = 2x - 3$   
 $5x - 3y = 11$

**3**  $2y = 4x + 5$   
 $9x + 5y = 22$

**4**  $2x = y - 2$   
 $8x - 5y = -11$

**5**  $3x + 4y = 8$   
 $2x - y = -13$

**6**  $3y = 4x - 7$   
 $2y = 3x - 4$

**7**  $3x = y - 1$   
 $2y - 2x = 3$

**8**  $3x + 2y + 1 = 0$   
 $4y = 8 - x$

**9** Solve the simultaneous equations  $3x + 5y - 20 = 0$  and  $2(x + y) = \frac{3(y - x)}{4}$ .

## Answers

1  $x = 9, y = 5$

2  $x = -2, y = -7$

3  $x = \frac{1}{2}, y = 3\frac{1}{2}$

4  $x = \frac{1}{2}, y = 3$

5  $x = -4, y = 5$

6  $x = -2, y = -5$

7  $x = \frac{1}{4}, y = 1\frac{3}{4}$

8  $x = -2, y = 2\frac{1}{2}$

9  $x = -2\frac{1}{2}, y = 5\frac{1}{2}$