

# Solving Simultaneous Equations Algebraically with 2 Linear Equations **Answers**

## ✓ Check In

1. Solve  $3x + 4 = -11$ .

**$x = -5$**

2. Solve  $2x - 7 = -3$ .

**$x = 2$**

3. Substitute  $x = -2$  into  $3x + 2$ .

**$-4$**

4. Find the value of  $4x - 5$  when  $x = -2$ .

**$-13$**

5. Multiply every term in this equation by three:  $2y = 3x + 4$ .

**$6y = 9x + 12$**



## Exam Style Questions

1. Solve the following simultaneous equations:

a.  $2x + 2y = 10$

(3)

$2x - 5y = -4$

**$x = 3, y = 2$**

b.  $x + 3y = 13$

(3)

$-x + 5y = 19$

**$x = 1, y = 4$**

c.  $x + 2y = 11$

(3)

$2x + 2y = 16$

**$x = 5, y = 3$**

d.  $-2x + 3y = 1$

(3)

$-2x + 7y = 21$

**$x = 7, y = 5$**

2. Solve the following simultaneous equations:

a.  $2a + 2b = 18$

(3)

$3a + b = 19$

**$a = 5, b = 4$**

b.  $4f + 2g = 8$

(3)

$3f + g = 7$

**$f = 3, g = -2$**

c.  $5s - 2t = 9$

(3)

$3s - 5t = 32$

**$s = -1, t = -7$**

d.  $4p - 3q = 11$

(3)

$6p + 5q = -12$

**$p = \frac{1}{2}, q = -3$**

3. Solve the following simultaneous equations:

a.  $4x - 5y = -6$  (4)                      c.  $3x + 4y = -6$  (4)

$$10x + 10y = 39$$

$$4x - 3y = -18$$

$$x = \frac{3}{2}, y = \frac{12}{5}$$

$$x = -\frac{18}{5}, y = \frac{6}{5}$$

b.  $4x + 3y = 3$  (4)                      d.  $6x - 4y = 7$  (4)

$$6x + 7y = 5$$

$$8x + 3y = -9$$

$$x = \frac{3}{5}, y = \frac{1}{5}$$

$$x = -\frac{3}{10}, y = -\frac{11}{5}$$

4. Two families visit the cinema. The Simpsons take 2 adults and 3 children and pay £33.20.

The Frys take 3 adults and 1 child and pay £30.20.

How much do individual adult and child tickets cost at this cinema? (4)

**Adult = £8.20, Child = £5.60**

5. a. Eva is working on a solution for a pair of simultaneous equations but is stuck. Her workings are shown below. What has she done wrong?

$$5y = 2x + 7 \quad \mathbf{1}$$

$$3y = 4x - 7 \quad \mathbf{2}$$

$$\mathbf{1 + 2: 8y = 6x} \quad \text{I don't know!} \quad (2)$$

**She hasn't multiplied to get the same coefficient in either variable before combining equations.**

b. Solve the problem correctly. (3)

$$x = 4, y = 3$$

# Solving Linear Simultaneous Equations Algebraically

## Check In

1. Solve  $3x + 4 = -11$ .
2. Solve  $2x - 7 = -3$ .
3. Substitute  $x = -2$  into  $3x + 2$ .
4. Find the value of  $4x - 5$  when  $x = -2$ .
5. Multiply every term in this equation by three:  $2y = 3x + 4$ .

This guide has everything you need on solving linear simultaneous equations algebraically. It involves **solving linear equations** and **substitution** so if you don't feel confident with these topics, you may find it helpful to review the revision sheets on those first. Once you've mastered this, you may want to move on to **solving linear simultaneous equations graphically**.

The key principle of simultaneous equations is that both equations have the **same solutions**. This means when you solve one, you immediately solve the other as well, simultaneously.

## Example 1

Solve  $y = -x + 7$  and  $y = x + 1$  simultaneously.

The method works by making sure one variable has the same coefficient (it can have different signs) so that it can be eliminated. Once one variable is eliminated, we will have an equation we can solve.

In this example, both the  $y$  and  $x$  terms already have the same coefficient, although the  $x$  terms have different signs. This means you can choose which variable to eliminate first.

You only need to choose one of these routes, but we have shown both in this case. Once you have found your first variable, you must substitute back into either of the original equations to find the second variable. It is a good idea to check that the solution works in the other equation too.

Eliminate $x$ first	Step-by-step:	Eliminate $y$ first
$y = -x + 7$ <b>1</b> $y = x + 1$ <b>2</b>	Label the equations 1 and 2 for reference and to keep the working clear.	$y = -x + 7$ <b>1</b> $y = x + 1$ <b>2</b>
$y = -x + 7$ <b>1</b> $y = x + 1$ <b>2</b>	Make sure one variable has the same coefficient, ignoring the sign. This time, this is already done.	$y = -x + 7$ <b>1</b> $y = x + 1$ <b>2</b>
$x$ signs <b>different</b> – <b>ADD</b> $y = -x + 7$ <b>1</b> $y = x + 1$ <b>2</b> $2y = 8$ <b>1 + 2</b>	Eliminate the selected variable in one of these ways: If signs are <b>different</b> – <b>ADD</b> the two equations together. If signs are <b>the same</b> – <b>SUBTRACT</b> one equation from the other.	$y$ signs <b>the same</b> – <b>SUBTRACT</b> $y = -x + 7$ <b>1</b> $y = x + 1$ <b>2</b> $0 = 2x - 6$ <b>2 - 1</b>

## Solving Linear Simultaneous Equations Algebraically

$\begin{array}{r} 2y = 8 \\ \div 2 \qquad \div 2 \\ y = 4 \end{array}$	Solve the linear equation now it has a single variable.	$\begin{array}{r} 0 = 2x - 6 \\ + 6 \qquad \qquad + 6 \\ 6 = 2x \\ \div 2 \qquad \qquad \div 2 \\ 3 = x \end{array}$
$\begin{array}{r} y = x + 1 \\ (4) = x + 1 \\ - 1 \qquad \qquad - 1 \\ 3 = x \end{array}$	Substitute this value into either of the original equations to find the solution to the other variable.	$\begin{array}{l} y = x + 1 \\ y = (3) + 1 \\ y = 4 \end{array}$
<b><math>x = 3</math> and <math>y = 4</math></b>	Write your solutions to <b>both</b> variables clearly.	<b><math>x = 3</math> and <math>y = 4</math></b>

### ? Example 2

Solve  $2y - 3x = 4$  and  $5y + 2x = -9$  simultaneously.

This time we will focus on one route – we will eliminate the  $x$  terms first.

Eliminate $x$ first	Step-by-step:
$\begin{array}{r} 2y - 3x = 4 \quad \mathbf{1} \\ 5y + 2x = -9 \quad \mathbf{2} \end{array}$	Label the equations 1 and 2 for reference and to keep the working clear.
$\begin{array}{r} 2y - 3x = 4 \quad \mathbf{1} \times 2 \rightarrow 4y - 6x = 8 \quad \mathbf{1} \\ 5y + 2x = -9 \quad \mathbf{2} \times 3 \rightarrow 15y + 6x = -27 \quad \mathbf{2} \end{array}$	Make sure one variable has the same coefficient, ignoring the sign. If we double equation <b>1</b> and triple equation <b>2</b> , the coefficients of $x$ will be 6 and -6.
$\begin{array}{l} x \text{ signs } \mathbf{different} - \mathbf{ADD} \\ 4y - 6x = 8 \quad \mathbf{1} \\ 15y + 6x = -27 \quad \mathbf{2} \\ 19y = 9 = 9 \quad \mathbf{1} + \mathbf{2} \end{array}$	Eliminate the selected variable by either adding or subtracting. If signs are <b>different</b> – <b>ADD</b> the two equations together. If signs are <b>the same</b> – <b>SUBTRACT</b> one equation from the other.
$\begin{array}{r} 19y = -19 \\ \div 19 \qquad \qquad \div 19 \\ y = -1 \end{array}$	Solve the linear equation now it has a single variable.
$\begin{array}{r} 2y - 3x = 4 \\ 2(-1) - 3x = 4 \\ -2 - 3x = 4 \\ + 2 \qquad \qquad + 2 \\ -3x = 6 \\ \div -3 \qquad \qquad \div -3 \\ x = -2 \end{array}$	Substitute this value into either of the original equations to find the solution to the other variable.
<b><math>x = -2</math> and <math>y = -1</math></b>	Write your solutions to <b>both</b> variables clearly.

# Solving Linear Simultaneous Equations Algebraically

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## Exam Style Questions

1. Solve the following simultaneous equations:

a.  $2x + 2y = 10$  (3)                      c.  $x + 2y = 11$  (3)  
 $2x - 5y = -4$                                        $2x + 2y = 16$

b.  $x + 3y = 13$  (3)                      d.  $-2x + 3y = 1$  (3)  
 $-x + 5y = 19$                                        $-2x + 7y = 21$

2. Solve the following simultaneous equations:

a.  $2a + 2b = 18$  (3)                      c.  $5s - 2t = 9$  (3)  
 $3a + b = 19$                                        $3s - 5t = 32$

b.  $4f + 2g = 8$  (3)                      d.  $4p - 3q = 11$  (3)  
 $3f + g = 7$                                        $6p + 5q = -12$

3. Solve the following simultaneous equations:

a.  $4x - 5y = -6$  (4)                      c.  $3x + 4y = -6$  (4)  
 $10x + 10y = 39$                                        $4x - 3y = -18$

b.  $4x + 3y = 3$  (4)                      d.  $6x - 4y = 7$  (4)  
 $6x + 7y = 5$                                        $8x + 3y = -9$

4. Two families visit the cinema. The Simpsons take 2 adults and 3 children and pay £33.20. The Frys take 3 adults and 1 child and pay £30.20.

How much do individual adult and child tickets cost at this cinema? (4)

5. a. Eva is working on a solution for a pair of simultaneous equations but is stuck. Her workings are shown below. What has she done wrong?

$$\begin{array}{l} 5y = 2x + 7 \quad \mathbf{1} \\ 3y = 4x - 7 \quad \mathbf{2} \\ \mathbf{1 + 2:} \quad 8y = 6x \quad \text{I don't know!} \end{array} \quad (2)$$

b. Solve the problem correctly. (3)