

Solving Simultaneous Equations Algebraically

Starter

We will use these skills when solving simultaneous equations algebraically.

- (Review of previous material) Collecting like terms**
Simplify: (a) $4x + 3y + 5x - 3y$ (b) $7x - 5y - (7x + 2y)$
- (Review of previous material) Substituting**
Find the value of x when $y = 2$ and $3x - 5y = 14$
- (Review of previous material) Solving linear equations**
Solve: (a) $3x = 12$ (b) $8 + 7y = 29$

Notes

So far we have solved simultaneous equations graphically by drawing lines on the same set of axes and seeing where the lines intersect. It can be quicker and more accurate answer if we solve them algebraically.

Keyword The **coefficient** is the number in front of a term with letters.
The **coefficient** of x in $3x$ is 3.
The **coefficient** of y^2 in $7y^2$ is 7.
The **coefficient** of xy in $-9xy$ is -9 .

Elimination method for solving simultaneous equations

We are going to learn the elimination method for solving simultaneous equations. The substitution method can also be used but often leads to dealing with difficult fractions.

Please stop copying – read the notes carefully to follow the worked examples. You will be told when to start copying again.

Step 1: choose which unknown to eliminate

Our aim is to eliminate one of the unknowns (either the x or y). We look for the unknown whose **coefficients are the same (at this stage we ignore the signs)**.

Take a moment to consider these Further examples and decide which unknown to eliminate by recognising which unknown has the same coefficient.

N.B. When writing the simultaneous equations make sure the = signs are above each other.

E.g. 1

$$\begin{array}{l} 4x + 7y = 26 \\ 4x - 3y = 6 \end{array}$$

The coefficients of x are both 4
The coefficients of y are 7 and -3
Since the **coefficients** of x **are the same**
we will eliminate this unknown.

E.g. 2

$$\begin{array}{l} 2x - y = 3 \\ x + y = 9 \end{array}$$

The coefficients of x are 2 and 1
The coefficients of y are -1 and 1
By ignoring the signs, the **coefficients**
of y **are the same**, so eliminate y .

Step 2: add or subtract the equations

After choosing which unknown to eliminate, we then decide whether to **add or subtract the equations**. Here's the way to remember...and again we are back to the coefficients.

Looking at the coefficient of the unknown we are going to eliminate:

Same sign \Rightarrow Subtract (notice the **S**)

Different sign \Rightarrow Add (notice the **D**)

Don't worry too much at this stage because if you add the equations and an unknown is not eliminated then you just need to go back and subtract the equations.

Take a moment to look at our examples and decide whether to add or subtract the equations.

E.g. 1

$$\begin{array}{r} 4x + 7y = 26 \\ 4x - 3y = 6 \\ \hline \end{array}$$

We plan to eliminate x
Both coefficients are 4
Same sign – both +ve
Subtract the equations

E.g. 2

$$\begin{array}{r} 2x - y = 3 \\ x + y = 9 \\ \hline \end{array}$$

We plan to eliminate y
Coefficients are -1 and $+1$
Different sign: $-ve$ and $+ve$
Add the equations

Step 3: add or subtract the equations

E.g. 1

$$\begin{array}{r} 4x + 7y = 26 \\ 4x - 3y = 6 \\ \hline \text{Sub.} \quad 10y = 20 \end{array}$$

Sub. is short for Subtract – write it as part of your working

Draw a line between different stages of the process

$$\begin{array}{r} 4x - 4x = 0 \text{ (} x \text{ is eliminated)} \\ 7y - -3y = 10y \\ 26 - 6 = 20 \end{array}$$

E.g. 2

$$\begin{array}{r} 2x - y = 3 \\ x + y = 9 \\ \hline \text{Add} \quad 3x = 12 \end{array}$$

Draw a line between different stages of the process

$$\begin{array}{r} 2x + x = 3x \\ -y + y = 0 \text{ (} y \text{ is eliminated)} \\ 3 + 9 = 12 \end{array}$$

We have now done the difficult parts and the rest is just solving linear equations and substitution.

Step 3: solve the linear equation to find the value of the 1st unknown

E.g. 1

$$\begin{array}{r} 4x + 7y = 26 \\ 4x - 3y = 6 \\ \hline \text{Sub.} \quad 10y = 20 \\ \hline y = 2 \end{array}$$

E.g. 2

$$\begin{array}{r} 2x - y = 3 \\ x + y = 9 \\ \hline \text{Add} \quad 3x = 12 \\ \hline x = 4 \end{array}$$

Draw a line underneath as we have finished another stage of the process.

Step 4: replace the unknown we have found by its value

Replace the unknown we have found by its value in one of the original equations — choose the equation with the easiest numbers.

N.B. It does not matter which equation you substitute into.

E.g. 1

$$\begin{array}{r} 4x + 7y = 26 \\ 4x - 3y = 6 \\ \text{Sub.} \quad \underline{10y = 20} \\ \quad \quad y = 2 \\ \underline{4x + 14 = 26} \end{array}$$

Substituted into
2nd equation

E.g. 2

$$\begin{array}{r} 2x - y = 3 \\ \quad \quad x + y = 9 \\ \text{Add} \quad \underline{3x = 12} \\ \quad \quad x = 4 \\ \underline{4 + y = 9} \end{array}$$

Substituted into
1st equation

Step 5: solve the linear equation

E.g. 1

$$\begin{array}{r} 4x + 7y = 26 \\ 4x - 3y = 6 \\ \text{Sub.} \quad \underline{10y = 20} \\ \quad \quad y = 2 \\ \underline{4x + 14 = 26} \\ \quad \quad 4x = 12 \\ \quad \quad x = 3 \end{array}$$

E.g. 2

$$\begin{array}{r} 2x - y = 3 \\ \quad \quad x + y = 9 \\ \text{Add} \quad \underline{3x = 12} \\ \quad \quad x = 4 \\ \underline{4 + y = 9} \\ \quad \quad y = 5 \end{array}$$

Step 6: communicate your final answer

Start copying again.

E.g. 1

$$\begin{array}{r} 4x + 7y = 26 \\ 4x - 3y = 6 \\ \text{Sub.} \quad \underline{10y = 20} \\ \quad \quad y = 2 \\ \underline{4x + 14 = 26} \\ \quad \quad 4x = 12 \\ \quad \quad x = 3 \\ \underline{x = 3, y = 2} \end{array}$$

E.g. 2

$$\begin{array}{r} 2x - y = 3 \\ \quad \quad x + y = 9 \\ \text{Add} \quad \underline{3x = 12} \\ \quad \quad x = 4 \\ \underline{4 + y = 9} \\ \quad \quad y = 5 \\ \underline{x = 4, y = 5} \end{array}$$

Success Criteria – solving simultaneous equations

1. Choose which unknown to eliminate — **same coefficient** (ignore the signs)
2. Add or subtract the equations — look at the coefficient of the unknown we are going to eliminate:

Same sign \Rightarrow **S**ubtract (notice the **S**)

Different sign \Rightarrow **A**dd (notice the **D**)

3. Solve the linear equation to find the value of the 1st unknown
4. Replace the unknown we have found by its value in either of the original equations
5. Solve the linear equation
6. Communicate your final answer

Have a go at these examples.

E.g. 3

$$\begin{array}{r} 3x + y = -1 \\ -3x + 5y = 31 \end{array}$$

E.g. 4

$$\begin{array}{r} 5x + 2y = 24 \\ -4x + 2y = -30 \end{array}$$

E.g. 5

$$\begin{array}{r} x - 5y = -21 \\ 2x + 5y = 18 \end{array}$$

E.g. 6

$$\begin{array}{r} -x + 7y = 19 \\ -x + 2y = 4 \end{array}$$

Video A: [Solving simultaneous equations algebraically](#)
Video B: [Solving simultaneous equations algebraically](#)

[Solutions to Starter and E.g.s](#)

Exercise

9-1 class textbook: p381 M12.3 Qu 1-12
A*-G class textbook: p344 M12.3 Qu 1-12
9-1 homework book: p127 M12.3 Qu 1-10
A*-G homework book: p96 M12.3 Qu 1-10

Summary

Solving simultaneous equations

1. Choose which unknown to eliminate — *same coefficient* (ignore the signs)
2. Add or subtract the equations — look at the coefficient of the unknown we are going to eliminate:
 Same sign \Rightarrow **S**ubtract (notice the **S**)
 Different sign \Rightarrow **A**dd (notice the **D**)
3. Solve the linear equation to find the value of the 1st unknown
4. Replace the unknown we have found by its value in either of the original equations
5. Solve the linear equation
6. Communicate your final answer

[Homework book answers \(only available during a lockdown\)](#)