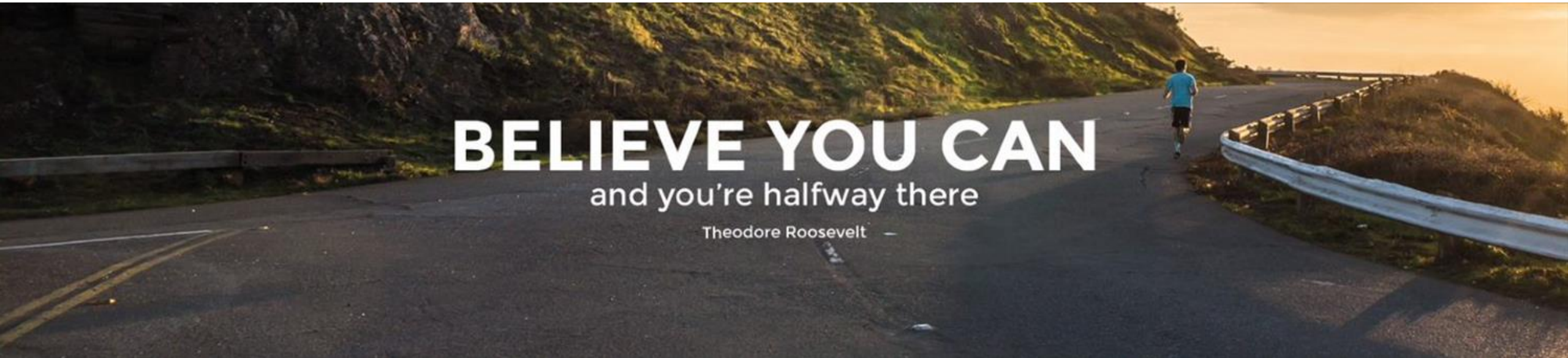


# EB Education Revision Guide



## How to work with Simultaneous Equations

# Simultaneous equations

## What is a simultaneous equation?

Equations that have more than one unknown can have an infinite number of solutions.

For example,  $3x + y = 15$  could be solved by:

$$x = 1 \text{ and } y = 12$$

$$x = 2 \text{ and } y = 9$$

$$x = 3 \text{ and } y = 6$$

To be able to solve an equation like this, another equation needs to be used alongside it. That way it is possible to find the only pair of values that solve both equations at the same time. These are known as simultaneous equations.

## Example

$$2x - 3y = 16$$

$$2x + 4y = -12$$

# Elimination Method

## Steps

1. Rearrange both equations into the form  $aX + by = c$  (a, b and c are numbers)
2. Match up the **coefficients** (numbers in front) of either the x's or the y's in both equations. Sometimes you will need to multiply one or both equations by a suitable number to get them to match.
3. Add or subtract the two equations to **ELIMINATE** the terms with the same coefficient.
4. Solve the equation you are left with.
5. Substitute the value you have found back into the first equation and solve it.

## Example 1:

$$\begin{array}{r} 3x + y = 11 \\ - \quad 2x + y = 8 \\ \hline x = 3 \end{array}$$

As the coefficient of the y in both equations is 1 – the y's can be eliminated by subtracting.

$$\begin{array}{r} (3 \times 3) + y = 11 \\ 9 + y = 11 \\ y = 11 - 9 \\ y = 2 \end{array}$$



# Elimination Method

**TOP TIP:**

If the coefficients you are going to eliminate have the same sign (both +ve or both -ve) then subtract. If the coefficients have opposite signs (one +ve and one -ve), then add.

**Example 2:**

$$\begin{array}{l} 2x + 4y = 6 \\ 4x + 3y = -3 \end{array} \quad \times 2$$

$$\begin{array}{r} 4x + 8y = 12 \\ - 4x + 3y = -3 \\ \hline 5y = 15 \\ y = 3 \end{array}$$

$$2x + (4 \times 3) = 6$$

$$2x + 12 = 6$$

$$2x = 6 - 12$$

$$2x = -6$$

$$x = -3$$

To get the coefficient of x to match – you can multiply the 1<sup>st</sup> equation by 2.  
Make sure you multiply everything in the equation by 2.

To eliminate the x's then you need to subtract. Remember to subtract the whole equation.  
Be careful with -ve numbers.  
12 - - 3 is the same as 12 + 3

Substitute the value of y into the 1<sup>st</sup> equation and solve.  
To check your answer you can substitute the values of x and y back into the 2<sup>nd</sup> equation and make sure it works.

# Elimination Method

## Example 3:

$$2x + 3y = 8 \quad \times 3$$

$$3x + 2y = 7 \quad \times 2$$

$$\begin{array}{r} 6x + 9y = 24 \\ - \underline{6x + 4y = 14} \\ 5y = 10 \\ y = 2 \end{array}$$

$$2x + (3 \times 2) = 8$$

$$2x + 6 = 8$$

$$2x = 8 - 6$$

$$2x = 2$$

$$x = 1$$

To get the coefficient of x to match – you can multiply the 1<sup>st</sup> equation by 3, and the 2<sup>nd</sup> equation by 2.

Make sure you multiply everything in both equations.

To eliminate the x's then you need to subtract.

Remember to subtract the whole equation.

Substitute the value of y into the 1<sup>st</sup> equation and solve.

To check your answer you can substitute the values of x and y back into the 2<sup>nd</sup> equation and make sure it works.

# Using simultaneous equations

## Problems

Simultaneous equations can also be used to solve problems. You will need to form the equations before you can solve them.

### Example:

Mr and Mrs Smith take their two children to the cinema. The total cost is £33. Mr Jones takes his three children to the cinema and the total cost is £27.50. Calculate the price of a child's ticket and an adult's ticket.

**Step 1:** Form the equations.

a = adult tickets    c = child's tickets

Mr and Mrs Smith:

$2a + 2c = 33$     2 adults and 2 children

Mr Jones

$a + 3c = 27.50$     1 adult and 3 children

Step 2: Solve the equations following the usual method.

$$2a + 2c = 33$$

$$a + 3c = 27.50 \quad \times 2$$

$$\begin{array}{r} 2a + 2c = 33 \\ - 2a + 6c = 55 \\ \hline -4c = -22 \\ c = 5.5 \end{array}$$

$$2a + (2 \times 5.5) = 33$$

$$2a + 11 = 33$$

$$2a = 33 - 11$$

$$2a = 22$$

$$a = 11$$

Adult ticket = £11

Child's ticket = £5.50

# Your turn:

1.  $3x + 2y = 4$   
 $4x + 5y = 17$

2.  $3x + 5y = 19$   
 $4x - 2y = -18$

3.  $5x + 2y = 11$   
 $4x - 3y = 18$

4.  $4x - 3y = 11$   
 $10x + 2y = -1$

5.  $6x - 2y = 33$   
 $4x + 3y = 9$

6.  $3x + 4y = 200$   
 $2x + 3y = 144$

# Your turn:

7. In a toy box there are blue and green bricks only. Find the weight of each type of brick if 9 blue bricks and 6 green bricks weigh 324g and 5 blue bricks and 4 green bricks weigh 200g.

8. Four knives and five forks cost £4. 90 in total. Seven knives and three forks cost £5.70 in total. Find the cost of a knife and a fork.





**TOP TIP:**

If the coefficients you are going to eliminate have the same sign (both +ve or both -ve) then subtract. If the coefficients have opposite signs (one +ve and one -ve), then add.

# Answers:

1.  $3x + 2y = 4$   
 $4x + 5y = 17$

$x \ 4$	$12x + 8y = 16$	$3x + (2 \times 5) = 4$
$x \ 3$	$-12x + 15y = 51$	$3x + 10 = 4$
	<hr/>	
	$-7y = -35$	$3x = -6$
	$y = 5$	$x = -2$

4.  $4x - 3y = 11$   
 $10x + 2y = -1$

$x \ 2$	$8x - 6y = 22$	$(4 \times 0.5) - 3y = 11$
$x \ 3$	$+30x + 6y = -3$	$2 - 3y = 11$
	<hr/>	
	$38x = 19$	$-3y = 9$
	$x = 0.5$	$y = -3$

2.  $3x + 5y = 19$   
 $4x - 2y = -18$

$x \ 4$	$12x + 20y = 76$	$3x + (5 \times 5) = 19$
$x \ 3$	$-12x - 6y = -54$	$3x + 25 = 19$
	<hr/>	
	$26y = 130$	$3x = -6$
	$y = 5$	$x = -2$

5.  $6x - 2y = 33$   
 $4x + 3y = 9$

$x \ 3$	$18x - 6y = 99$	$(6 \times 4.5) - 2y = 33$
$x \ 2$	$+8x + 6y = 18$	$27 - 2y = 33$
	<hr/>	
	$26x = 117$	$-2y = 6$
	$x = 4.5$	$y = -3$

3.  $5x + 2y = 11$   
 $4x - 3y = 18$

$x \ 3$	$15x + 6y = 33$	$(5 \times 3) + 2y = 11$
$x \ 2$	$+8x - 6y = 36$	$15 + 2y = 11$
	<hr/>	
	$23x = 69$	$2y = -4$
	$x = 3$	$y = -2$

6.  $3x + 4y = 200$   
 $2x + 3y = 144$

$x \ 2$	$6x + 8y = 400$	$3x + (4 \times 32) = 200$
$x \ 3$	$-6x + 9y = 432$	$3x + 128 = 200$
	<hr/>	
	$-y = -32$	$3x = 72$
	$y = 32$	$x = 24$

# Answers:

7. In a toy box there are blue and green bricks only. Find the weight of each type of brick if 9 blue bricks and 6 green bricks weigh 324g and 5 blue bricks and 4 green bricks weigh 200g.

$$\begin{array}{rcl}
 9b + 6g = 324 & \times 4 & 36b + 24g = 1296 \\
 5b + 4g = 200 & \times 6 & - \underline{30b + 24g = 1200} \\
 & & 6b = 96 \\
 & & b = 16 \text{ grams}
 \end{array}
 \qquad
 \begin{array}{rcl}
 (9 \times 16) + 6g = 324 \\
 144 + 6g = 324 \\
 6g = 180 \\
 g = 30 \text{ grams}
 \end{array}$$

8. Four knives and five forks cost £4.90 in total. Seven knives and three forks cost £5.70 in total. Find the cost of a knife and a fork.

$$\begin{array}{rcl}
 4k + 5f = 4.90 & \times 3 & 12k + 15f = 14.70 \\
 7k + 3f = 5.70 & \times 5 & - \underline{35k + 15f = 28.50} \\
 & & -23k = -13.80 \\
 & & k = 0.60 \text{ (60p)}
 \end{array}
 \qquad
 \begin{array}{rcl}
 (4 \times 0.6) + 5f = 4.90 \\
 2.40 + 5f = 4.90 \\
 5f = 2.50 \\
 f = 0.50 \text{ (50p)}
 \end{array}$$

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