

Y11 Extra Transition – Using Desmos

The connection between algebra and coordinate geometry runs through almost all of A-level Maths. This activity will explore GCSE Algebra skills in a more visual way, as you will have to do to succeed at A-level Maths in 6th form.

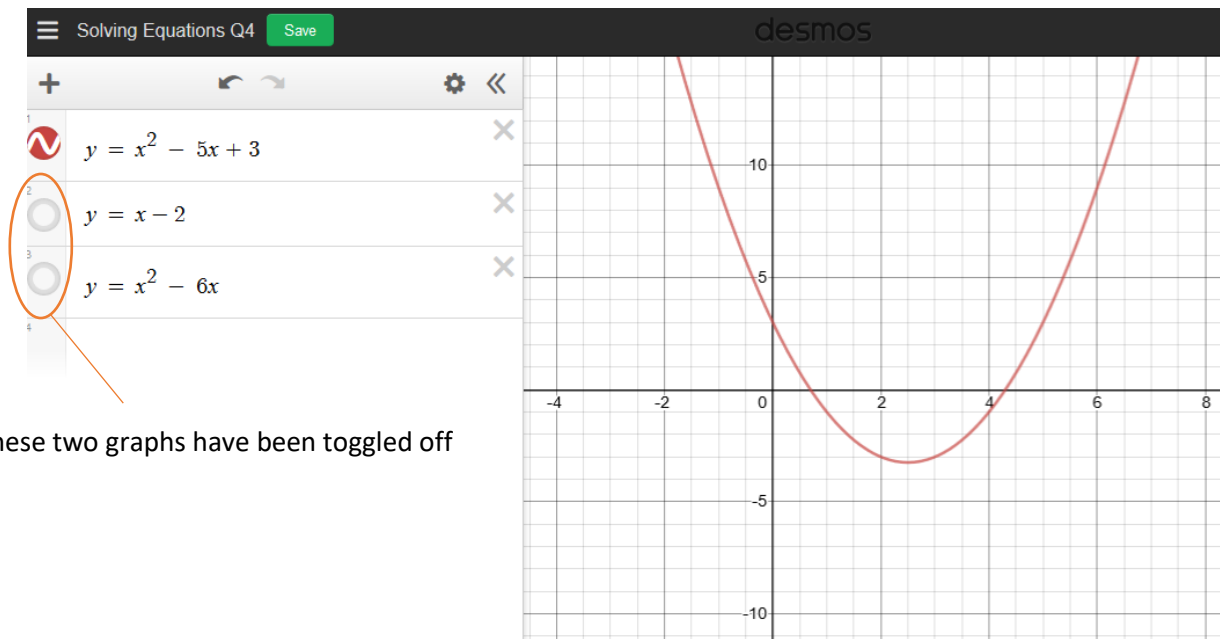
You will need to go to www.desmos.com or download the free Desmos app on your phone.

Graphing software is incredibly useful at A-level, especially when working on tasks at home. You don't need to spend a fortune on a graphical calculator (although we recommend them for Further Maths students), free apps like Desmos and Geogebra are powerful enough for our requirements.

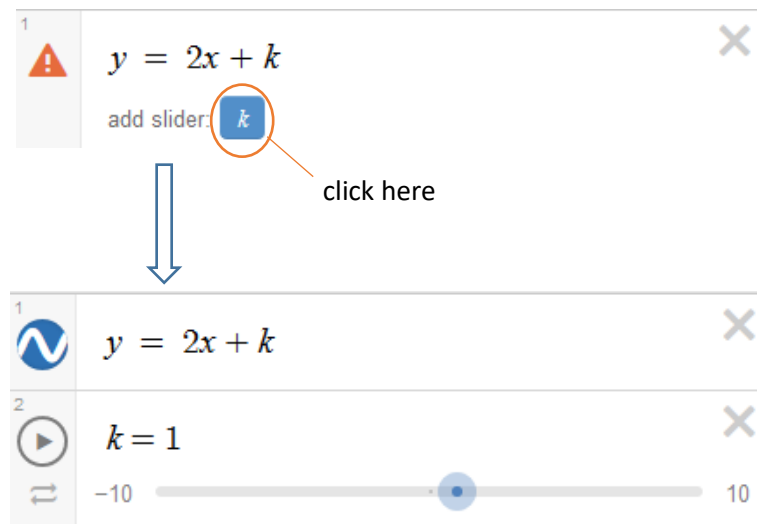
A few tips on using Desmos: you can use the ^ symbol to write a power: x^2 will give x^2

The settings icon in the top right allows you to choose the scale of the axes if the graphs don't fit nicely.

If you are drawing multiple graphs on the same axis, click the coloured icons to toggle each graph on and off:



If you type an equation with a letter other than x and y , for example $y = 2x + k$, it will give you any option to add a "slider" for that letter. This allows you to quickly see how the graph changes for different values of the letter:



Introductory Questions

1. Draw the graph of $2y = 3x + 4$ and circle the two equations which are equivalent:

A $2x = 3y + 4$

B $y - \frac{3}{2}x = 2$

C $y = \frac{3}{2}x + 4$

D $3x - 2y + 4 = 0$

(Hint: plot all five graphs on Desmos: which ones overlap?)

2. Plot the quadratic graph $y = x^2 + 3x - 10$ (Use the ^ symbol to write a power: x^2 will give x^2)

a) Where does the graph cross the x -axis?

b) Where does the graph cross the y -axis?

c) The graph $y = x^2 + 3x - k$ crosses the x -axis at the points $(-4, 0)$ and $(1, 0)$.

Use a **slider** on Desmos to find the value of k

(Typing k into the equation should give an option to add a slider. See [learn.desmos.com/sliders](https://www.desmos.com/sliders) for more)

3. Plot the graph $x^2 + y^2 = 100$

Describe the graph.

4. Plot the graph $x^2 + 4y^2 = 200$

Describe the graph.

5. The equation of a circle is $(x - 3)^2 + (y - 5)^2 = 16$

a) What is the radius of the circle?

b) Where is the centre of the circle?

c) How do these results relate to the equation of the circle?

d) Use your previous answers to **predict** the centre and radius of the circle $(x - 4)^2 + (y - 7)^2 = 49$

Centre: _____

Radius: _____

Now plot the graph. Were your predictions correct?

Solving Equations

1. a) Solve the equation $6x - 5 = 2x + 13$ using an algebraic method.
- b) Plot the graphs of $y = 6x - 5$ and $y = 2x + 13$ and write down where they cross.
- c) What connects your answers to parts *a* and *b*?

To solve an equation graphically, we plot graphs of the left- and right-hand sides and see where they cross!

2. Solve $5x - 9 = 3x + 11$ using a graphical method, and write down your solution.

(Hint: plot $y = 5x - 9$ and $y = 3x + 11$ and see where they cross)

3. a) Plot the graph $y = 6x^2 + 2x - 5$
- b) Use the graph to solve the equation $6x^2 + 2x - 5 = 0$ (give your answers to 1 decimal place)

$x = \underline{\hspace{2cm}}$ and $x = \underline{\hspace{2cm}}$

(Hint: where does the graph $y = 6x^2 + 2x - 5$ meet $y = 0$?)

- c) Add another graph to the diagram and use it to solve the equation $6x^2 + 2x - 5 = 2x + 1$

$x = \underline{\hspace{2cm}}$ and $x = \underline{\hspace{2cm}}$

4. a) Draw two graphs and use them to solve $x^2 - 5x + 3 = x - 2$

$x = \underline{\hspace{2cm}}$ and $x = \underline{\hspace{2cm}}$

- b) Draw a graph of $y = x^2 - 6x + 5$ and write down the solutions to the equation $x^2 - 6x + 5 = 0$

$x = \underline{\hspace{2cm}}$ and $x = \underline{\hspace{2cm}}$

- c) Why are your answers to parts (a) and (b) the same?

5. The solution to the equation $3x - 5 = ax + 5$ is $x = 4$

Draw graphs of $y = 3x - 5$ and $y = ax + 5$ and use the slider to find the value of a

Simultaneous Equations

To solve simultaneous equations graphically, draw graphs for each equation and find the coordinate where they meet. This is a GCSE topic, but it's much easier with graphing software like Desmos!

1. Solve the simultaneous equations using a graphical method:

$$2x + 4y = 1$$

$$3x - 5y = 7$$

$$x = \underline{\hspace{2cm}}, \quad y = \underline{\hspace{2cm}}$$

2. Solve the simultaneous equations using a graphical method:

$$y = 10 - x$$

$$y = 2x^2 + 4$$

$$x = \underline{\hspace{2cm}}, \quad y = \underline{\hspace{2cm}}$$

and $x = \underline{\hspace{2cm}}, \quad y = \underline{\hspace{2cm}}$

3. Solve the simultaneous equations using a graphical method:

$$x^2 + y^2 = 36$$

$$y = 2x + 1$$

$$x = \underline{\hspace{2cm}}, \quad y = \underline{\hspace{2cm}}$$

and $x = \underline{\hspace{2cm}}, \quad y = \underline{\hspace{2cm}}$

4. a) Solve the simultaneous equations $x^2 + y^2 = 25$ and $4y = 3x + 25$

$$x = \underline{\hspace{2cm}}, \quad y = \underline{\hspace{2cm}}$$

- b) Use the graphs to explain why these simultaneous equations only have one pair of solutions.

Optional Challenge Questions: Solving Problems

HINT: You can use letters (a, b, c, k , etc.) in your equations and use **sliders** to try out different values for them.

1. The equation $x^2 - 6x + k = 0$ has solutions at $x = 1$ and $x = 5$

Use the slider to find the value of k

2. The equation $x^2 + 3x + 2 = x + k$ has two possible values for x , one of which is $x = -3$

Use the slider to find the value of k and the other possible value of x

3. Draw the graphs of the simultaneous equations below:

$$(x - 2)^2 + y^2 = 100$$

$$y = \frac{3}{4}x + k$$

Set a slider for k , with values from -20 to 20 and a step of 1 .

Use this to find the **two** possible values of k for which the equations only have **one** solution.

4. Draw the following graphs:

$$x^2 + y^2 = 100$$

$$x^4 + y^4 = 10000$$

What do you expect the graph $x^{100} + y^{100} = 10^{100}$ to look like?

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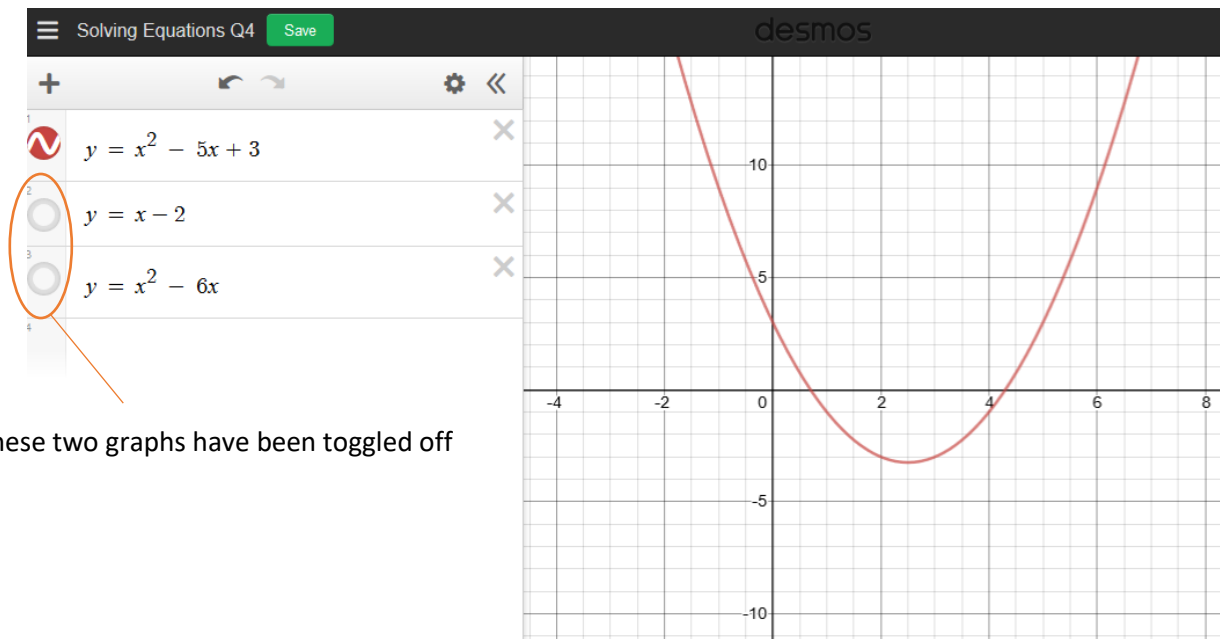
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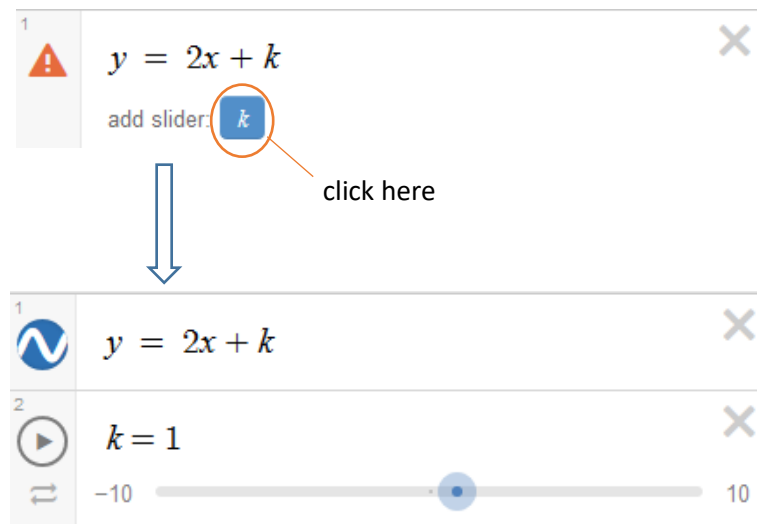
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(Hint: plot all five graphs on Desmos: which ones overlap?)

[Click here to see the graphs](#)

2. Plot the quadratic graph $y = x^2 + 3x - 10$ (Use the ^ symbol to write a power: x^2 will give x^2)

- a) Where does the graph cross the x -axis?

$(-5, 0)$ and $(2, 0)$

- b) Where does the graph cross the y -axis?

$(0, -10)$

- c) The graph $y = x^2 + 3x - k$ crosses the x -axis at the points $(-4, 0)$ and $(1, 0)$.

Use a **slider** on Desmos to find the value of k

$k = 4$

[Click here to see the graphs](#)

3. Plot the graph $x^2 + y^2 = 100$

Describe the graph - **the graph is a circle, radius 10, centre $(0, 0)$.** [Click here to see it](#)

4. Plot the graph $x^2 + 4y^2 = 200$

Describe the graph - **the graph is an ellipse, centre $(0, 0)$.** [Click here to see it](#)

5. The equation of a circle is $(x - 3)^2 + (y - 5)^2 = 16$ [Click here to see it](#)

- a) What is the radius of the circle?

4

- b) Where is the centre of the circle?

$(3, 5)$

- c) How do these results relate to the equation of the circle?

The coordinates of the centre are the values subtracted in the brackets. The radius is $\sqrt{16}$

- d) Use your previous answers to **predict** the centre and radius of the circle $(x - 4)^2 + (y - 7)^2 = 49$

Centre: $(4, 7)$ Radius: $\sqrt{49} = 7$

Solving Equations

1. a) Solve the equation $6x - 5 = 2x + 13$ using an algebraic method

$$4x = 18 \rightarrow x = 4.5$$

- b) Plot the graphs of $y = 6x - 5$ and $y = 2x + 13$ and write down where they cross.

$$(4.5, 22) \quad \text{Click here to see the graphs}$$

- c) What connects your answers to parts a and b?

The x -coordinate is the solution to the equation.

To solve an equation graphically, we plot graphs of the left- and right-hand sides and see where they cross!

2. Solve $5x - 9 = 3x + 11$ using a graphical method, and write down your solution.

(Hint: plot $y = 5x - 9$ and $y = 3x + 11$ and see where they cross)

$$x = 10 \text{ (they cross at } (10, 41) \text{ but the original equation was only in terms of } x) \text{ Click here to see the graphs}$$

3. a) Plot the graph $y = 6x^2 + 2x - 5$

- b) Use the graph to solve the equation $6x^2 + 2x - 5 = 0$ (give your answers to 1 decimal place)

$$x = -1.1 \text{ and } x = 0.8$$

- c) Add another graph to the diagram and use it to solve the equation $6x^2 + 2x - 5 = 2x + 1$

$$x = -1 \text{ and } x = 1 \quad \text{Click here to see the graphs}$$

4. a) Draw two graphs and use them to solve $x^2 - 5x + 3 = x - 2$

$$x = 1 \text{ and } x = 5$$

- b) Draw a graph of $y = x^2 - 6x + 5$ and write down the solutions to the equation $x^2 - 6x + 5 = 0$

$$x = 1 \text{ and } x = 5 \quad \text{Click here to see the graphs}$$

- c) Why are your answers to parts (a) and (b) the same?

The two equations are equivalent: if you rearrange $x^2 - 5x + 3 = x - 2$ by subtracting x and adding 2 to both sides, you get $x^2 - 6x + 5 = 0$

5. The solution to the equation $3x - 5 = ax + 5$ is $x = 4$

Draw graphs of $y = 3x - 5$ and $y = ax + 5$ and use the slider to find the value of a

$$a = 0.5 \text{ so that the graphs cross at } x = 4 \quad \text{Click here to see the graphs}$$

Simultaneous Equations

To solve simultaneous equations graphically, draw graphs for each equation and find the coordinate where they meet. This is a GCSE topic, but it's much easier with graphing software like Desmos!

1. Solve the simultaneous equations using a graphical method:

$$2x + 4y = 1$$

[Click here to see the graphs](#)

$$3x - 5y = 7$$

$$x = 1.5, y = -0.5$$

Notice that we give the x and y values here, as the original equations have both variables.

2. Solve the simultaneous equations using a graphical method:

$$y = 10 - x$$

$$y = 2x^2 + 4$$

$$x = -2, y = 12$$

[Click here to see the graphs](#)

and $x = 1.5, y = 8.5$

3. Solve the simultaneous equations using a graphical method:

$$x^2 + y^2 = 36$$

$$y = 2x + 1$$

$$x = 2.276, y = 5.552$$

[Click here to see the graphs](#)

and $x = -3.076, y = -5.152$

4. a) Solve the simultaneous equations $x^2 + y^2 = 25$ and $4y = 3x + 25$

$$x = -3, y = 4$$

[Click here to see the graphs](#)

- b) Use the graphs to explain why these simultaneous equations only have one pair of solutions.

The line is a *tangent* to the circle: it just touches the circle at a single point, rather than passing through it.

Optional Challenge Questions: Solving Problems

HINT: You can use letters (a , b , c , k , etc.) in your equations and use **sliders** to try out different values for them.

1. The equation $x^2 - 6x + k = 0$ has solutions at $x = 1$ and $x = 5$

Use the slider to find the value of k

$$k = 5$$

[Click here to see the graph](#)

2. The equation $x^2 + 3x + 2 = x + k$ has two possible values for x , one of which is $x = -3$

Use the slider to find the value of k and the other possible value of x

$$x = 1 \text{ (} k = 5 \text{ so that the graphs meet when } x = -3\text{)}$$

[Click here to see the graphs](#)

3. Draw the graphs of the simultaneous equations below:

$$(x - 2)^2 + y^2 = 100$$

$$y = \frac{3}{4}x + k$$

Set a slider for k , with values from -20 to 20 and a step of 1 .

Use this to find the **two** possible values of k for which the equations only have **one** solution.

There is only one solution when the straight line touches the circle at a single point.

This only occurs when $k = -14$ and $k = 11$

[Click here to see the graphs](#)

4. Draw the following graphs:

$$x^2 + y^2 = 100$$

$$x^4 + y^4 = 10000$$

[Click here to see the graphs](#)

What do you expect the graph $x^{100} + y^{100} = 10^{100}$ to look like?

As you increase the powers, the graph gets closer and closer to being a square!

Desmos can just about draw $x^{100} + y^{100} = 10^{100}$, with a warning that it can't manage all the detail.

A bit of trivia: 10^{100} is a 1 with a hundred zeroes, and is called a Googol. The name Google comes from this!