



# NumberGym Geometry version 2.0

## User Guide

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These activities are ideal on Interactive Whiteboards for whole-class or group participation.

### What is NumberGym Geometry?

**NumberGym Geometry** comprises a stimulating set of interactive teaching tools and student challenges to assist in the teaching of mathematics at Key Stages 3 & 4. It's a natural follow on from **The Number Gym** which offers similar activities for Key Stages 1 & 2.

Topics include:

- The Four Transformations
- Circle Geometry
- Understanding basic Trigonometry
- Graphs - we provide a powerful set of easy-to-use graphing tools enabling the user to quickly create and compare graphs involving straight lines, quadratics, cubics,  $n/x$  and the basic trigonometric functions.
- An intriguing visual proof of Pythagoras' famous theorem

The guiding principles behind every **NumberGym Geometry** activity are

- to use to the full the interactivity that only computers can offer
- to present the student with clear, memorable graphics and animations to demonstrate each mathematical topic
- to motivate and extend the student by offering both challenges and open-ended explorations to test out 'what if' scenarios
- to provide the maths teacher with a powerful set of easy to use teaching tools



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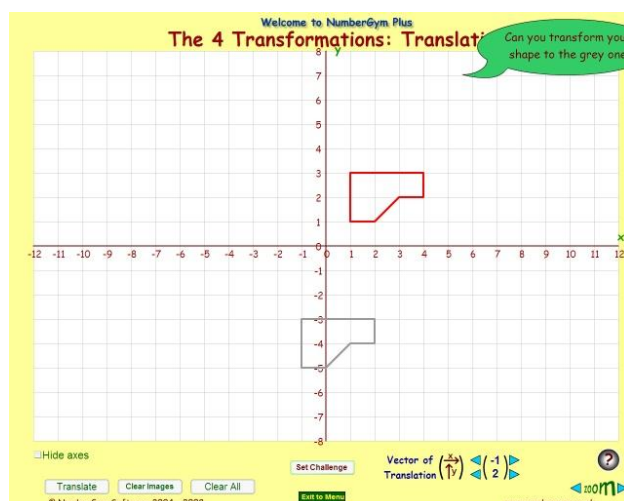
## The Four Transformations: Translation

Start by drawing a shape for translation. Simply hold down the left mouse button and drag a line out before releasing the button. All lines automatically click to the grid.

If required, you may then click the 'Set Challenge' button to generate a target image.

Set the required Vector of Translation using the blue triangular controls.

Then click the 'Translate' button to view the animated translation.



The 'Clear Images' button deletes the transformed images but keeps the original drawing and any target image. The 'Clear All' button clears the screen.

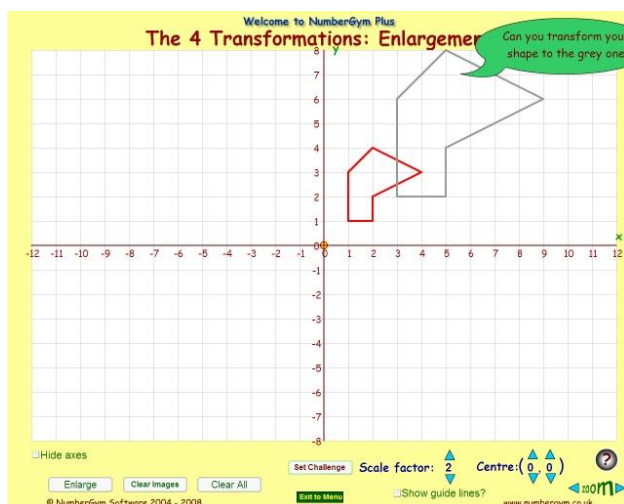
If a transformation moves off the grid, use the 'Zoom' controls to adjust the visible grid.

## The Four Transformations: Enlargement

Start by drawing a shape for enlargement. Simply hold down the left mouse button and drag a line out before releasing the button. All lines automatically click to the grid.

If required, you may then click the 'Set Challenge' button to generate a target image.

If necessary, move the centre of enlargement, using the blue triangular controls, so that the guide lines intersect the vertices of the target image.



Set the required Scale of Enlargement. (To create a challenge with a negative enlargement, set the Scale Factor to a negative value before pressing the 'Set Challenge' button.)

Click the 'Enlarge' button to view the animated enlargement.

The guide lines may be switched off by clicking on the 'Show Guide Lines?' check box.

The 'Clear Images' button deletes the transformed images but keeps the original drawing and any target image. The 'Clear All' button clears the screen.

If a transformation moves off the grid, use the 'Zoom' controls to adjust the visible grid.

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## The Four Transformations: Rotation

Start by drawing a shape for rotation. Simply hold down the left mouse button and drag a line out before releasing the button. All lines automatically click to the grid.

If required, you may then click the 'Set Challenge' button to generate a target image.

If necessary, move the centre of rotation, using the blue triangular controls.

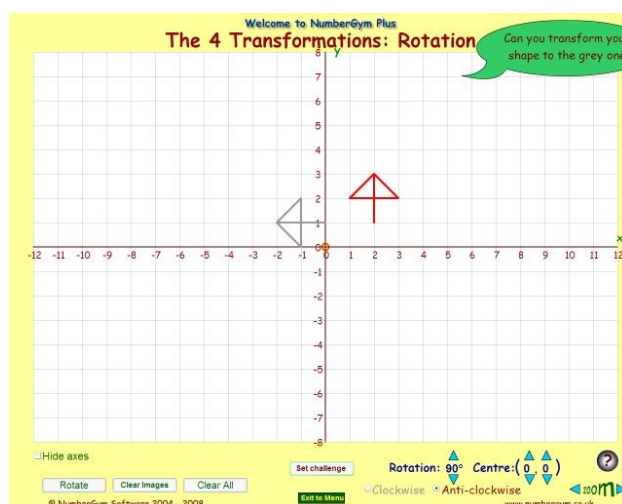
Set the required degrees and direction of rotation.

Click the 'Rotate' button to view the animated rotation.

The 'Clear Images' button deletes the transformed images but keeps the original drawing and any target image.

The 'Clear All' button clears the screen.

If a transformation moves off the grid, use the 'Zoom' controls to adjust the visible grid.



## The Four Transformations: Reflection

Start by drawing a shape for reflection. Simply hold down the left mouse button and drag a line out before releasing the button. All lines automatically click to the grid.

If required, you may then click the 'Set Challenge' button to generate a target image.

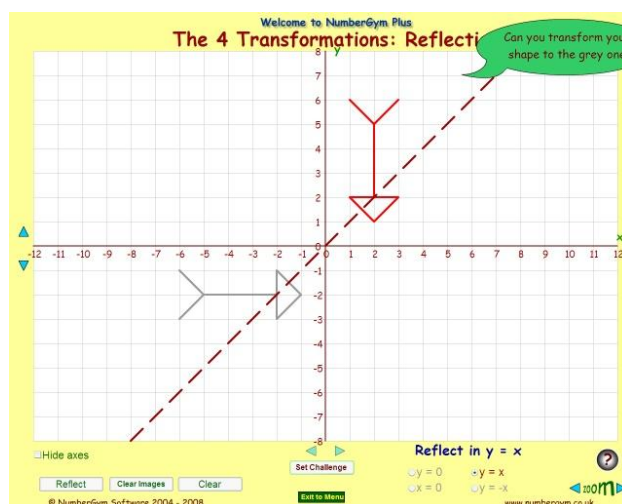
Select the required line of reflection using the radio buttons and, optionally, adjust further using the blue triangular controls to the left of the x axis or below the y axis.

Click the 'Reflect' button to view the animated reflection.

The 'Clear Images' button deletes the transformed images but keeps the original drawing and any target image.

The 'Clear All' button clears the screen.

If a transformation moves off the grid, use the 'Zoom' controls to adjust the visible grid.

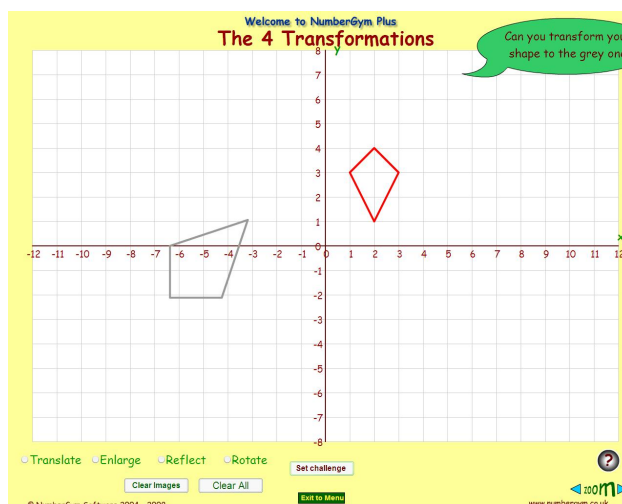


### Combining Transformations

This activity follows on from the four separate explorations on Translation, Enlargement, Reflection and Rotation.

Start by drawing the shape you wish to transform. To do this, use the mouse, holding the left button down and dragging the line out - release to end the line, which will automatically click to the grid.

Now select the required transformation (bottom left) and set the parameters (bottom right). Then click the transformation button eg 'Translate'.



You may perform another transformation which will be applied to the first and so on.

The Set Challenge button will generate a target that can be reached in not more than two transformations.

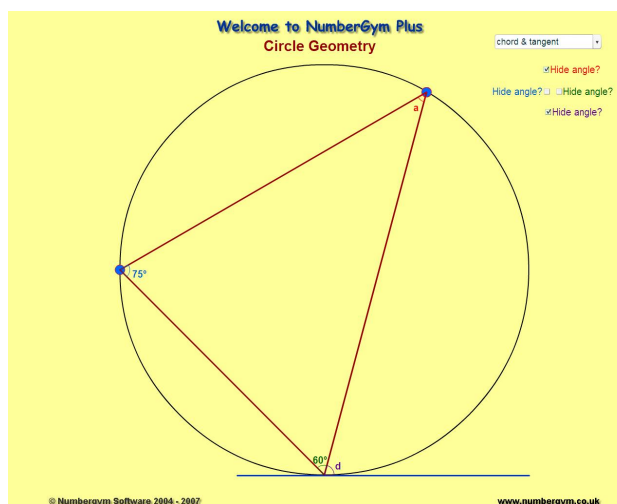
The 'Clear Images' button deletes the transformed images but keeps the original drawing and any target image. The 'Clear All' button clears the screen.

If a transformation moves off the grid, use the 'Zoom' controls to adjust the visible grid.

## Circle Geometry

Select the required feature you wish to demonstrate using the drop-down box (top right). Features available are:

- angles in a semi-circle...are always equal to  $90^\circ$
- angles in a segment... are always equal in the same segment and sum to  $180^\circ$  in opposite segments
- angle at centre... is twice the angle at the circumference
- chord and tangent... the angle that a chord makes with its tangent is equal to the angle in the opposite segment



For each feature you may then drag the blue handles around the circle to change the angles and observe the results.

You may also hide each of the angles as required to introduce some challenges and to check whether the rules have been learnt.

Note: With a rounding to one degree and the accuracy of calculation being limited with any pixel-based graphics, you may occasionally find a position where a discrepancy of one degree may arise between angles which 'should' be equal. Students should understand that this is not a case that breaks the rule but rather a limitation of a simplified graphical representation of the mathematical ideal.

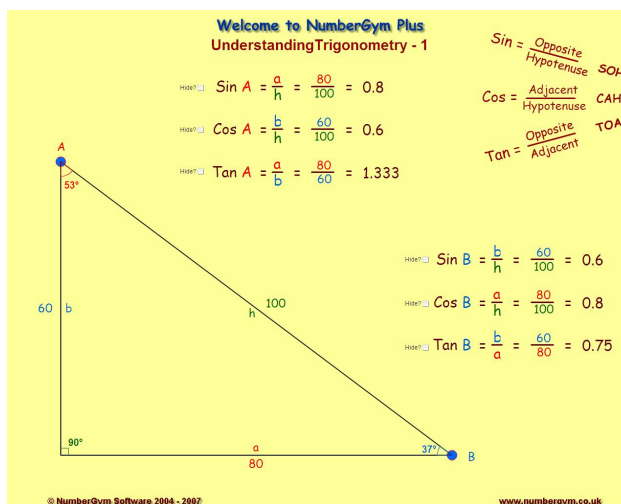
## Interactive Trigonometry

This activity aims to illustrate the complex relationships between the angles and the sides of any right-angled triangle.

It may also serve as a revision guide for the basic trigonometric functions.

Top right defines the functions and gives the standard mnemonics.

Bottom left shows our interactive right-angled triangle ABH with angles and sides suitable labelled. The value of each angle and the length of each side are also given.



Top centre, we show the trig functions for angle A. Right centre we show the same for angle B.

Now we are ready to explore what happens as our triangle changes. Angle A may be dragged vertically up or down using the blue handle at its tip. Similarly angle B can be dragged horizontally.

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Encourage your students to notice what happens to our trig functions as one side shrinks to near zero.

Why is it that Sine A always equals Cosine B and vice versa?

What about the trig functions of *similar* triangles (same angles, different size)?

Hopefully, exploring these and other questions will bring about some 'light-bulb' moments for your students.

Note: With a rounding to one degree and the accuracy of calculation being limited with any pixel-based graphics, you may occasionally find a position where a discrepancy of one degree may arise between angles which 'should' be equal. Students should understand that this is not a case that breaks the rule but rather a limitation of a simplified graphical representation of the mathematical ideal.

### *Interactive proof of Pythagoras' famous theorem*

This is an interesting visual demonstration with optional accompanying algebra of the theorem that the square on the hypotenuse is equal to the sum of the squares on the other two sides.

Use the *Next* button to step through the proof. Show it first without the algebra. Then, once the students are familiar with the proof, repeat with the algebra. Don't forget there are a few extra steps at the end to simplify the algebra.

Proving Pythagoras Theorem **Welcome to NumberGym Plus**  
To Prove: area C = area A + area B

So, can we fit our tiles exactly into area A and area B?

To Prove:  $c^2 = a^2 + b^2$   
 $c^2 = \frac{1}{2}ab + \frac{1}{2}ab + \frac{1}{2}ab + \frac{1}{2}ab + (a-b)^2$   
 $c^2 = ab...$

Show algebra?

Back Next Restart

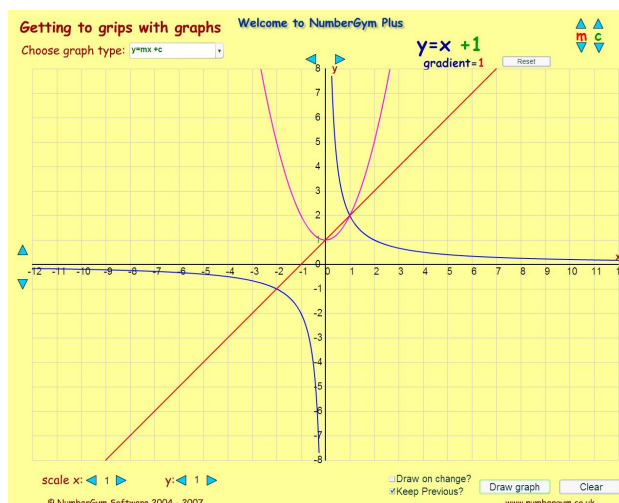
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## Drawing Graphs 1. Straight Lines and Curves

Use the drop-down box (top left) to select the required graph type from the following:

- $y = c$
- $x = c$
- $y = mx + c$
- $y = ax^2 + bx + c$
- $y = ax^3 + bx^2 + cx + d$
- $y = a/x$

The general equation will be presented top right. Use the blue up/down buttons to set your required equation or just experiment and observe the effects of adjusting each component.

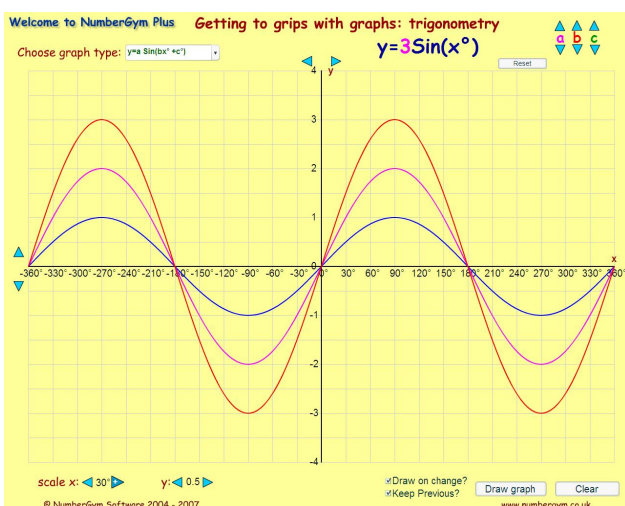


By default, each change to the equation replaces the old graph with the latest. To overlay graphs just click on the *Keep Previous* check-box (bottom right). The *Draw on Change* check-box (bottom right) causes a new graph to be drawn each time the equation is modified. Click on this check-box to turn off this feature and just use the *Draw Graph* button when required.

Notice that, for the straight line graphs, the gradient  $m$  is always given below the equation and the point at which the line graph crosses the Y axis,  $c$ , is coloured green when visible.

You may change the position of the X and Y axes using the controls left of the X axis and above the Y axis. You may also change the scale of the X and Y axes independently using the *Scale* controls bottom left.

## Drawing Graphs 2. The Trigonometric Functions



This activity uses similar buttons and check-boxes to Graphs 1. The available functions are:

- $y = a\sin(bx + c)$
  - $y = a\cos(bx + c)$
  - $y = a\tan(bx + c)$
- where  $c$  will increment/decrement in multiples of 15 degrees.

This activity is ideal for demonstrating the effects of each component of the trig functions eg the difference between  $y = 2\sin(x)$  and  $y = \sin(2x)$

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Finally, we hope that these activities offer some assistance in the challenging task of teaching mathematics. Do please let us know if you've found these resources useful or have some suggestions for their improvement.

Please send your comments to [feedback@numbergym.co.uk](mailto:feedback@numbergym.co.uk)



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