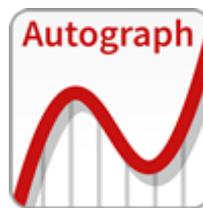




# NEW FEATURES in AUTOGRAPH 5



Draft: 25 Feb 2020

## GENERAL

### ◆ No activation required

La Salle's Autograph is free of charge to all users, so no activation is required on installation.

### ◆ Autograph 5 Manual

The 'New Features' listed in this document will be merged with the version 3 Manual and the version 4 Manual Extension to form a new Autograph 5 Manual in due course.

### ◆ Autograph for Mac-OS

Please be aware that the latest incarnation of Mac-OS **10.15 Catalina** is a significant upgrade and its changes are affecting a number of major software titles. It is likely to be a few months before Autograph 5 is fully tested and working on Catalina OS.

Please also note that a version for **IOS (iPad), Chromebook OS and Android tablets** is under development, and details will be made available in due course, on the home page:

<https://www.completemaths/autograph>

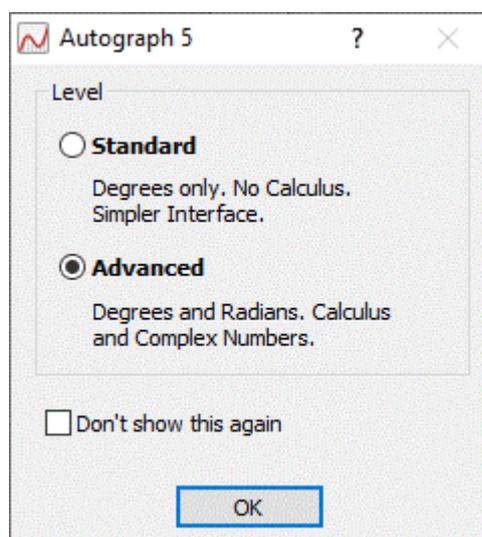
There is a growing catalogue of videos, images and resources here:

<https://www.tsm-resources.com/>

### ◆ Revised level selector on start-up:

There is an automatic "Check for updates" on start-up.

If you check "Don't show this again" you can revert to showing this on start-up in VIEW -> PREFERENCES "Show Level Selector on Startup"



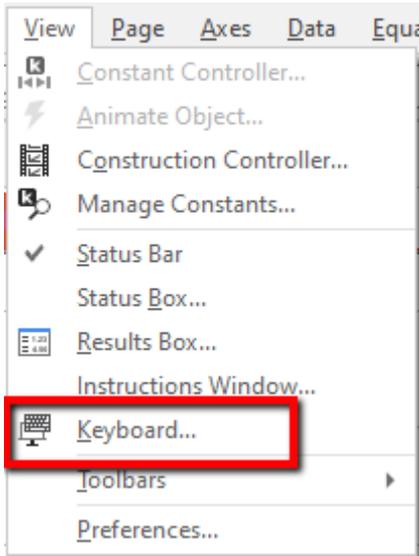
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## Autograph 5: REVISED KEYBOARD

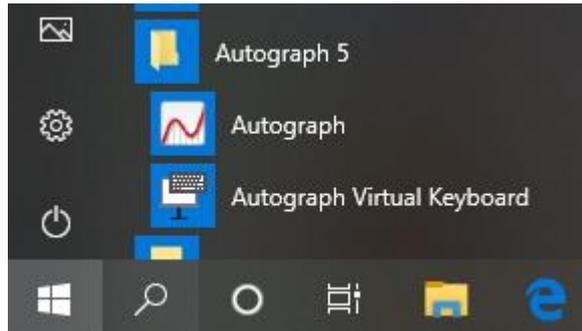
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Autograph's celebrated on-screen keyboard allows a wide range of mathematical characters to be entered, both in Autograph itself and any other Windows application, including emails.

The keyboard can be viewed either  
In the Autograph VIEW menu:



or, independently of Autograph, in the  
Windows START menu:



The central panel includes a link, in red, to the home page:

[www.completemaths/autograph](http://www.completemaths/autograph)



**EXTRA panel:**  $\infty \circ \neq \approx \ell \bullet \perp \int \dot{x} \ddot{x}$       Greek:  $\alpha \beta \varepsilon \lambda \delta \mu \sigma \phi \omega$     CAPS:  $\Delta \Gamma \Sigma X \Phi$

**MAIN panel:**      Superscript:  $^2 ^3 ^4 ^n$       Subscript:  $_0 _1 _2 _3 _4$   
 $( ) ^ \times \div \frac{1}{2} \pm \sqrt{\pi} | \leq \geq < > * + \theta \sin \cos \tan$

**CENTRAL panel:** Esc, Undo, Redo, PgUp, PgDn, Shift Ctrl Arrows

**DATA panel:**  $\pi \div \times - +$  Tab Delete left Delete right

List separator: COMMA      Decimal: POINT

*In Europe:*      List separator: SEMI-COLON      Decimal: COMMA

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## Decimal point and List Separator settings

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### Autograph: Point (1.2, 3.4) or Point (1,2; 3,4) ?

Many countries, eg England, use Decimal Symbol = '.' and List Separator = ',' ie (1.2, 3.4)  
Others, eg France, use Decimal Symbol = ',' and List Separator = ';' ie (1,2; 3,4)

The computer must use the same for all applications so that, for example, both Excel and Autograph are expecting the same convention.

Additionally Autograph uses the List Separator to enter Parametric Equations,  
eg  $x = 1.2\sin t$ ,  $y = 3.4\cos t$  OR  $x = 1,2\sin t$ ;  $y = 3,4\cos t$

Apple and Windows computers treat this topic a little differently.

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### WINDOWS 10 (PC): go to Start => Settings => Time and Language

=> 'Region': choose Country or region that you want, eg France  
To check Decimal symbol and List Separator go to 'Additional Settings' => 'Numbers'

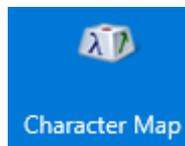
=> 'Additional date, time and regional settings' => 'Region' (Change date, time or number formats)

=> 'Format', eg French (France) => 'Additional Settings'

This is where the DECIMAL SYMBOL and LIST SEPARATOR are set



Autograph onscreen keyboard



Character Map' (all Unicode symbols)

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### APPLE (Mac): go to System Preferences => Personal => Language and Text

=> **Language**: drag your preferred language to the top of the list. 'English' is USA English. If the one you want is not there, (eg British English) you will need to find it in "Edit List" and make sure it is checked.

=> **Formats => Region**: choose a region that does decimals the way you want it - you check this by clicking on **Numbers => Customize**. Note: Apple does not seem to have a setting for List Separator (though there is one for 'thousands' which is different, and often just a space). Autograph will assume it is ';' when the Decimal Symbol is ','.

=> **Input Sources (Keyboards)**: Choose which national keyboards are to display in the list under the flag in the top toolbar. This will also determine the language format of the Autograph keyboard.

#### Also useful in the Flag drop-down:

'Show Character Viewer' (access to a large range of Unicode symbols)

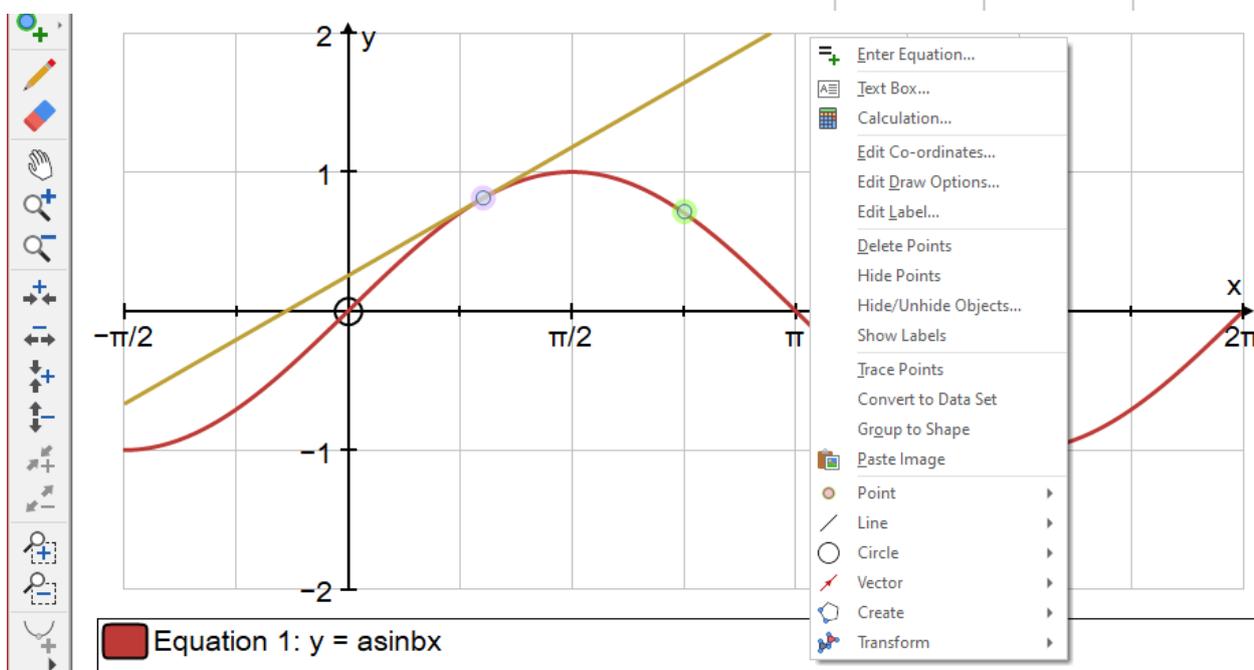
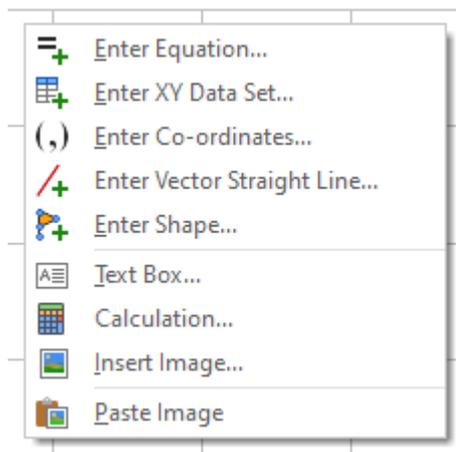
'Show Keyboard Viewer' (appropriate language Apple keyboard - the SHIFT key does not stay down)

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## Autograph 5: 2D PAGE – THE OBJECT MENU (Right-Click)

The right-click menu is central to Autograph’s user-interface, giving immediate access to new objects that relate to the current object selection. It is a duplicated of the “OBJECT” menu.

At the start of a new 2D page, with no objects drawn, the choice is the full range of ‘top-level’ objects (in this case also “Paste Image” when there is something on the clipboard).



With objects in place, and selected (here, two point attached to a graph), the following SUB-MENUS can be available, all dependent on the selection:

**Sub-menu**      **Examples:**

<b>Point</b>	Midpoint, Midpoint on curve, Ratio, XY Attribute point, Closest Point
<b>Line</b>	Straight Line, Segment, Ray, Tangent, Normal, Parallel line, Perpendicular line
<b>Circle</b>	Circle (radius), Circle (2 pts), Circle (diameter), Semicircle, Sector, Segment
<b>Vector</b>	Vector (1 pt), Vector (2 pts), Copy vector, Perpendicular vector, Add vector
<b>Create</b>	Area, Locus, Arc length, Rectangle, Regular Polygon, Newton-Raphson iteration
<b>Transform</b>	Rotation, Enlargement, Shear, Translation, Stretch, Matrix Transformation

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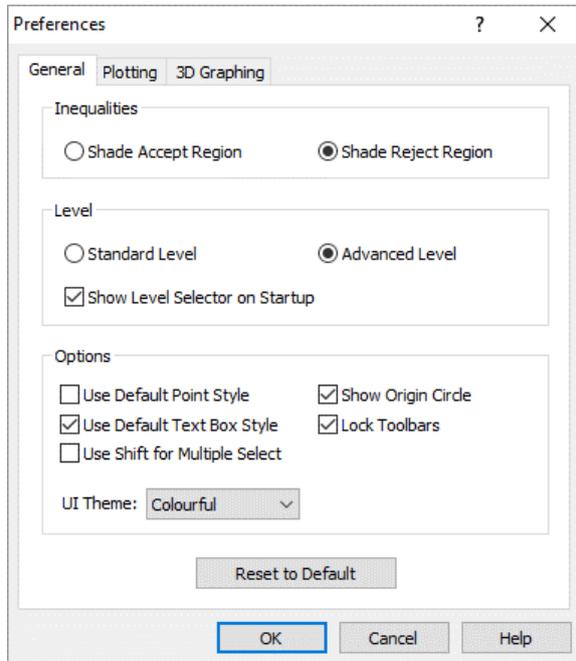
## Autograph 5: 2D PAGE – minor improvements

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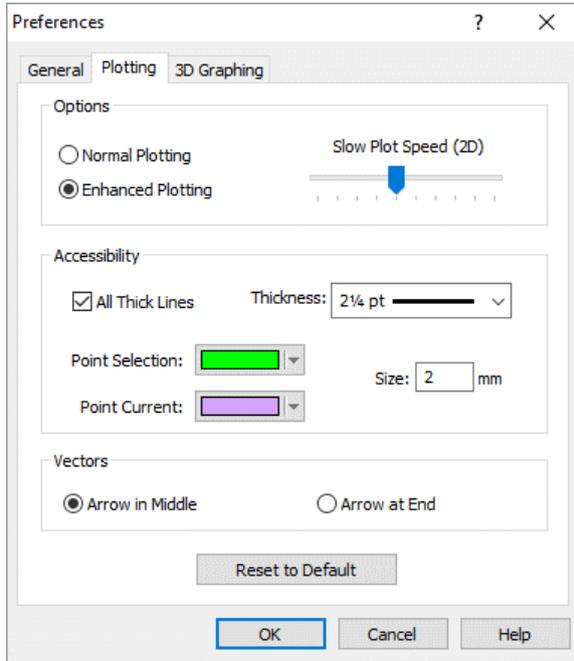
- ◇ **Attributes of polynomials** >3 renumbered:  
eg quartic is  $a_1x^4 + a_2x^3 + a_3x^2 + a_4x + a_5c \Rightarrow$  should be  $a_4x^4, a_3x^3, a_2x^2, a_1x, a_0c$
- ◇ **Text Box and Calculator:** MathML converts to single-line notation when copying
- ◇ **Origin circle** no longer gets too small if window size reduced
- ◇ **“Create data set from graph”** does not have “Join Points” ticked
- ◇ **Image attached to a point:** takes its gradient at the point, not the middle  
Attribute: gradient
- ◇ 2 points selected: **“Ratio”** the other way around
- ◇ **Double-click on “4 s.f.”** opens up “Page” -> “Settings”  
Advanced: Double-Click on “Radians” opens up “Page” -> “Settings”  
Standard: Double-click on “Standard” opens up “Preferences” -> “General”
- ◇ **Font colours:** Extend the pallet
- ◇ Equation entry **Start-up Options:** Manual limits can take constants
- ◇ **Polygons** – allow (integer) constants for number of sides
- ◇ **2-point Vector:** text box says AB ( ) instead of “Join Vector”
- ◇ **Images:** can nudge with arrow keys (and Ctrl)
- ◇ **XY Data:** Column Headers ticked by default
- ◇ **Import and export data** (2D and Stats): CSV or TAB options + saves heading(s)
- ◇ 2D page: **CTRL-MOUSE-WHEEL zoom** speeded up
- ◇ All: **Animation parameters:** change 0 ... 10 ... step 1 to **-3 ... 3 ... Step 0.1**
- ◇ In Edit Axes, if the **VARIABLES have been changed** to 't' and 'v' in RANGES the options now say 't' and 'v' not 'x' and 'y'
- ◇ **Accept two ‘ for “** to enter 2<sup>nd</sup> order D.E.

## Autograph 5: 2D PAGE MAJOR NEW FEATURES

### ◆ Preferences - General

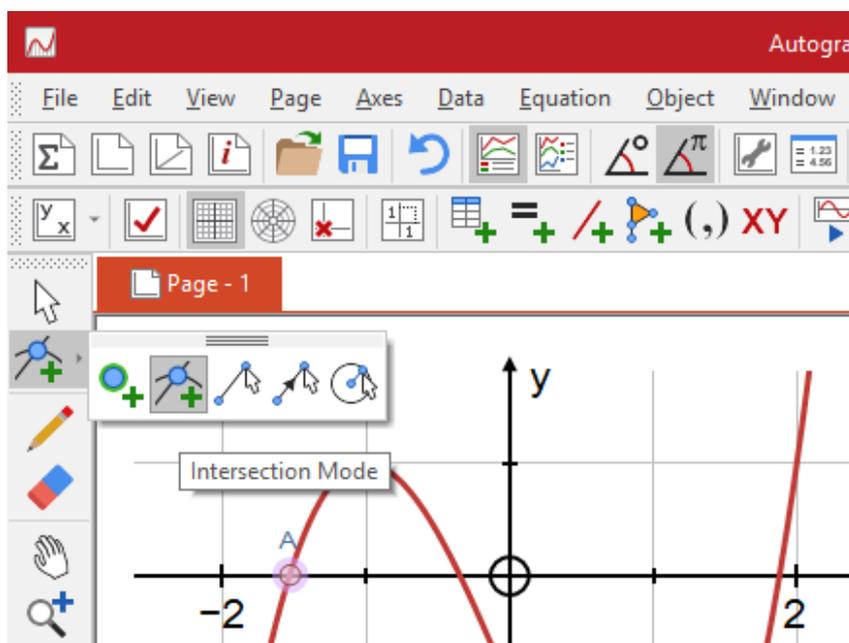


New option: "User Interface theme"



New option "Accessibility" to adjust colours. Used for selection by those hard of sight, or selection not showing well on whiteboards.

### ◆ New intersection icon, equivalent to pressing CTRL to find intersections, max, min



◇ **AXES MENU: label objects settings**

Label objects: objects will be labelled from now on.  
Label Points only – this will not label other objects (lines, etc)  
Any new 2D page opens with “Label Objects” OFF

Labels are allocated sequential letters whether shown or hidden

◇ **RIGHT-CLICK OPTIONS** on selected points, lines etc

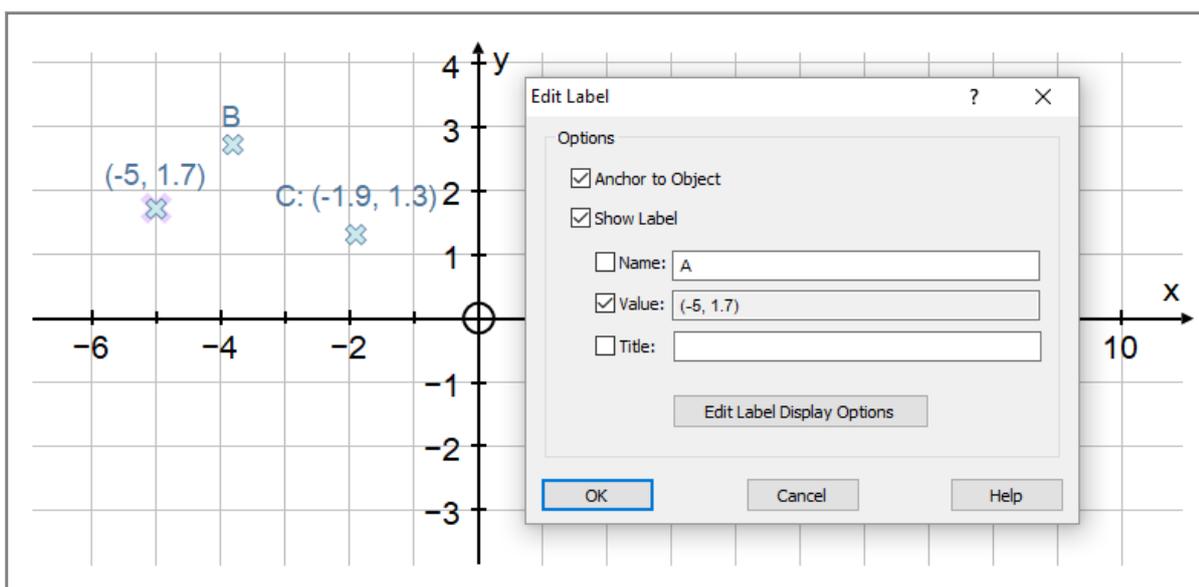
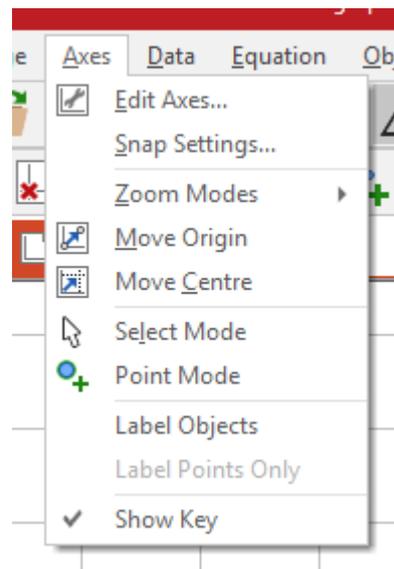
“Show Labels”

“Hide Labels”

“Edit draw options” (eg in the case of points, change their shape)

◇ **RIGHT-CLICK OPTIONS** on single point

“Edit label” (or double-click on label)



Note: Labels are important when using the CALCULATOR or XY ATTRIBUTE POINT as both refer to host objects by label.

◇ 2 points selected:

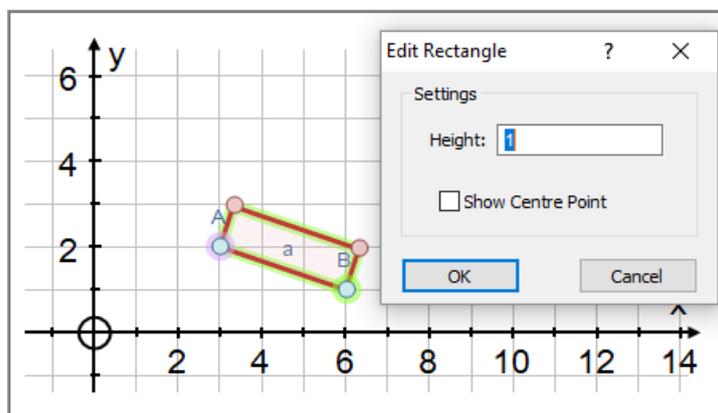
### RECTANGLE

Attributes:

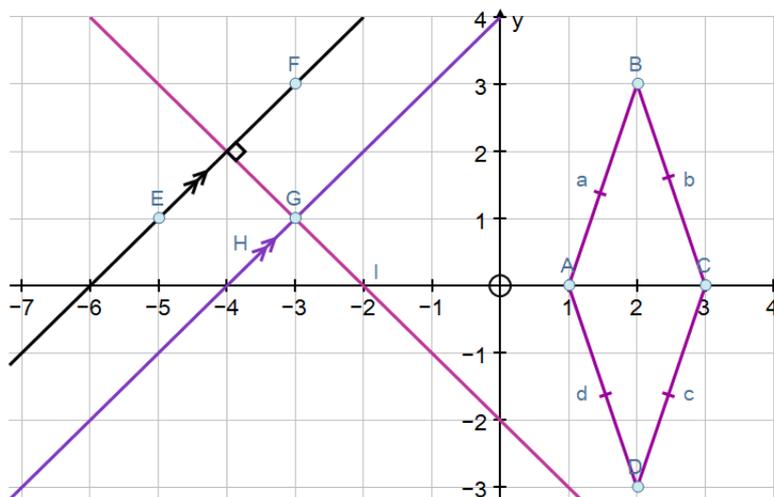
Enter height; plotted clockwise from the 2<sup>nd</sup> point  
side, height, Perimeter =  $2 * (\text{side} + \text{height})$   
Area = side x height

Status bar:

Rectangle 2 x 3, Area = 6



### LINE TESTS:



◇ Select two lines/rays/segments:

LINE TESTS – parallel or perpendicular

If the lines or line segments are parallel,  
place single arrows at the mid-point (+ a bit)

If lines are  $\perp$ , place a right-angle sign at the intersection

◇ Select two or more segments:

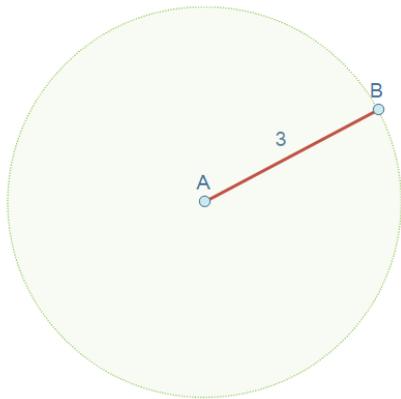
LINE TESTS – as above together with test for EQUALITY

- single marks at mid-point, single, then double

◇ Select any line with ticks/'Delete':

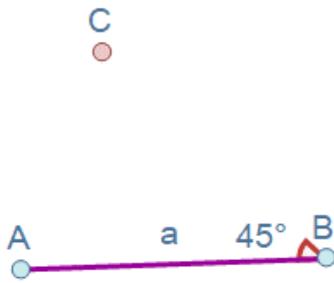
Deletes all test marks in this and associated lines

◆ Select a single point

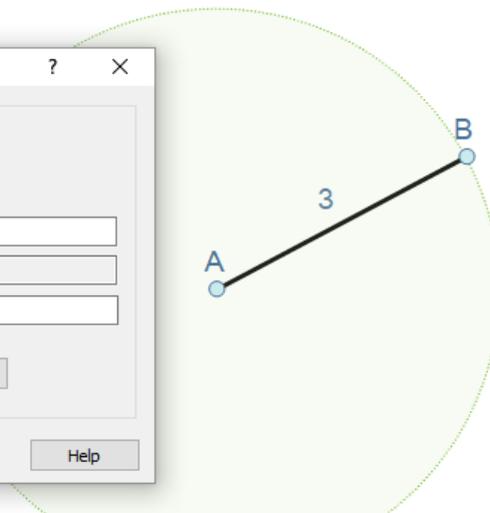
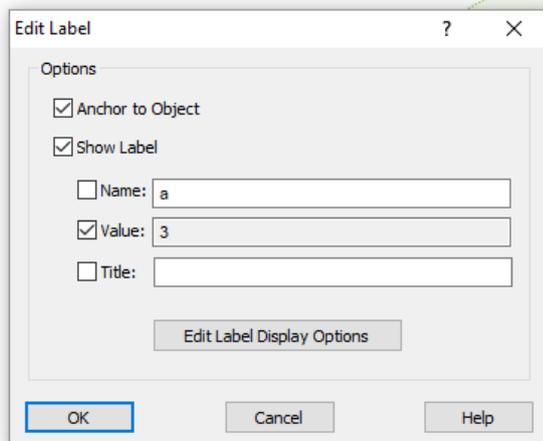
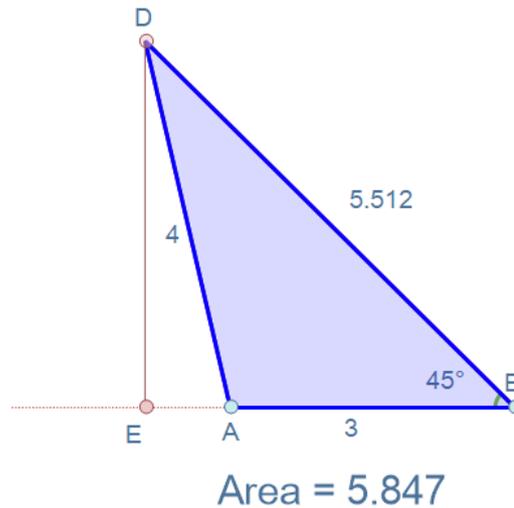


LINE -> Create a **FIXED LENGTH LINE**: enter length ('d')  
Draws and labels a line horizontally to the right,  
which can then swing round a circle of radius 'd'

◆ Select two points AB



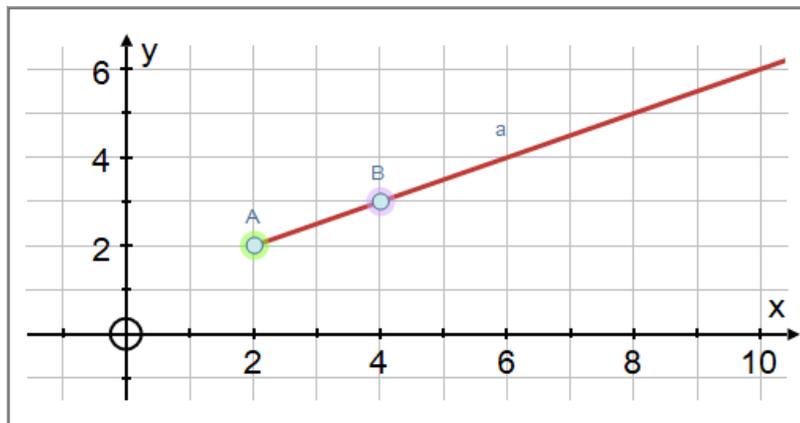
CREATE -> an **ANGLE**: enter angle ('θ')  
Draws and labels an angle at 'B' (tick for Clockwise)



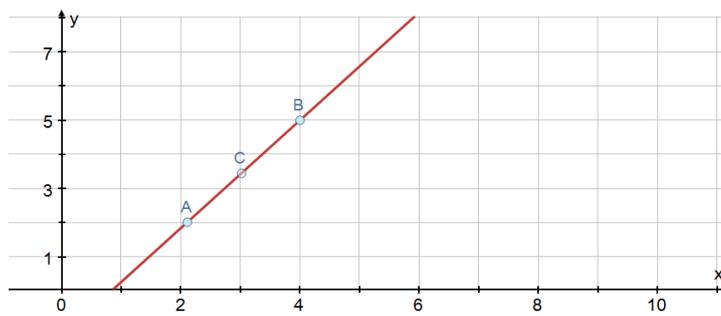
Any object: you can double-click on its label to open this dialogue,  
or with an object selected use the right-click option "Edit label"

◇ 2 points selected (in order):

**Ray** - a one-sided straight line  
Attributes: gradient and intercept



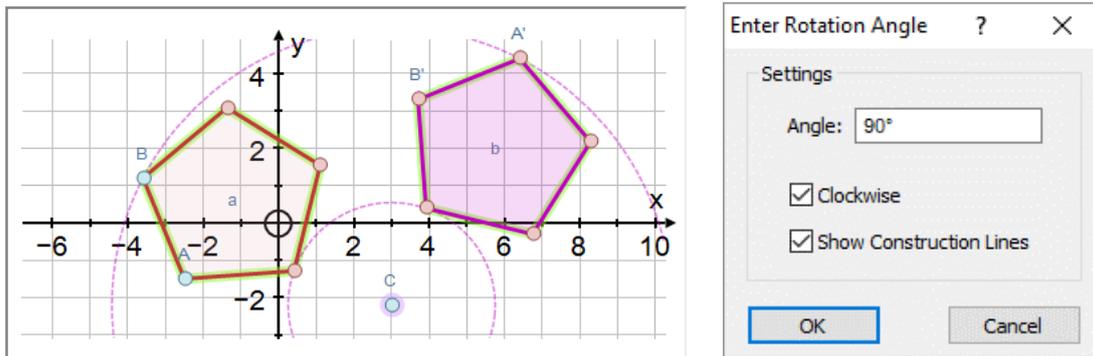
◇ Point 'C' added to line 'A'-'B' maintains its relative position if 'A' or 'B' moved



◇ **NEW TRANSFORMATIONS** Rectangle and regular polygons  
Rotation, Enlargement, translation, etc

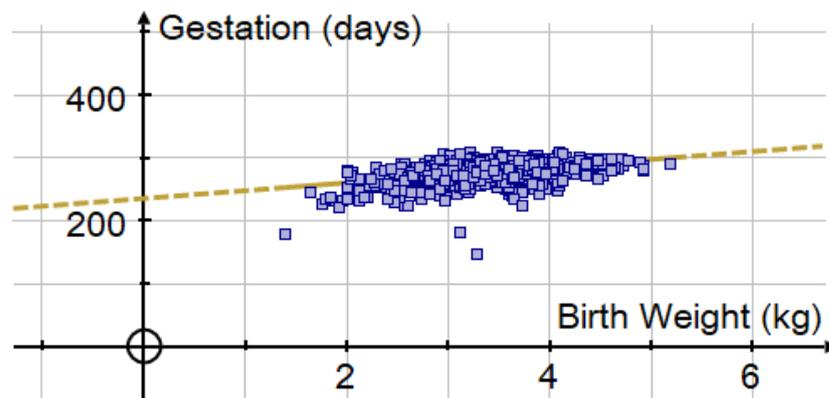


◇ Clockwise option for rotation

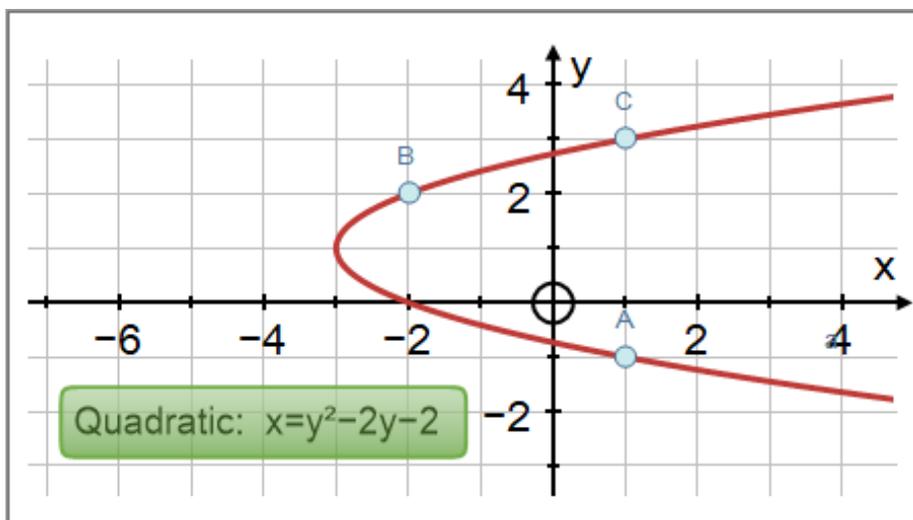


◇ y-on-x Regression line: show dotted <xmin and > xmax

x-on-y Regression line: show dotted <ymin and > ymax



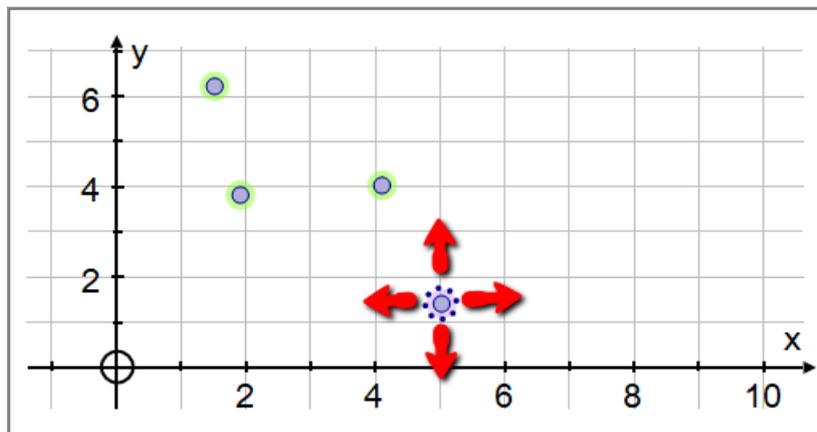
◇ Quadratic fit to 3 points:  $x=f(y)$  option



◇ **NEW CLICK and HOLD options**

1. DATABASE DRAWN

**Click-hold-drag** as alternative to CTRL-drag to select/move points in a database  
For use on white-boards and touch interfaces



- 2. SELECT Mode      **Click** (marquee select) and **HOLD** (drag scene)
- 3. ZOOM Mode        **Click-release**: Zoom in/out **Click-drag**:

◇ **POINTS RECORDED AS DATA in the Results Box**

Create an “XY” attribute point from two objects (Here the two attributes are x-coordinate of the point on curve and the value of the slope of the gradient). Tick “Record to Results Box”

⚡ With ‘A’ selected click Animation and set the step to 0.25  
Step along the curve, and note the values recorded in the Results Box.

**Edit XY Attribute Point**

Attributes

x-Attribute: A: x

y-Attribute: a: Gradient

Origin and Scaling

x-Origin: 0      x-Scale: 1

y-Origin: 0      y-Scale: 1

Show Origin       Record to Results Box

**Adjust Position**

Animate      Position: 2      Step: 0.25

Equation 1:  $y = x^3 - 3x - 1$

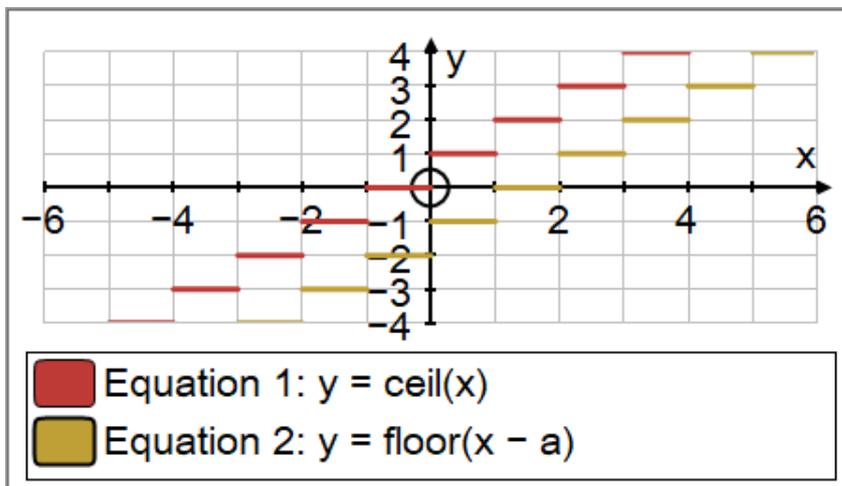
**Results Box**

Tangent:  $y = 3.75x + 5.75$

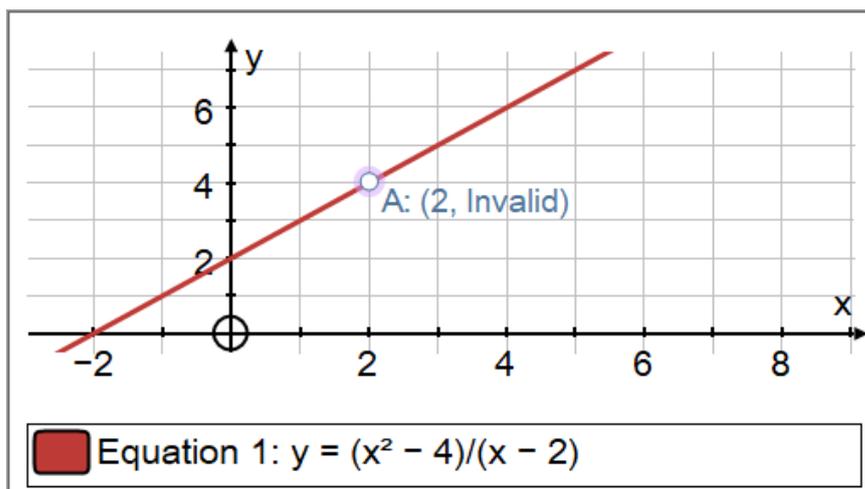
Recording XY Attribute Point...	
x	Gradient
-2	9
-1.75	6.1875
-1.5	3.75
-1.25	1.6875
-1	0
-0.75	-1.3125
-0.5	-2.25
-0.25	-2.8125
0	-3
0.25	-2.8125
0.5	-2.25
0.75	-1.3125
1	0
1.25	1.6875
1.5	3.75
1.75	6.1875
2	9

◇ MAJOR REVISION OF PLOTTING PROCEDURES

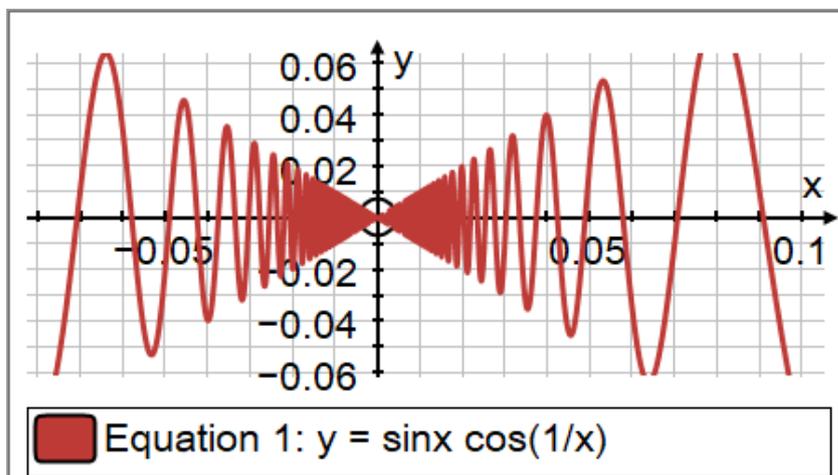
1. Floor(x) and ceil(x) and int(x) now plot with no verticals



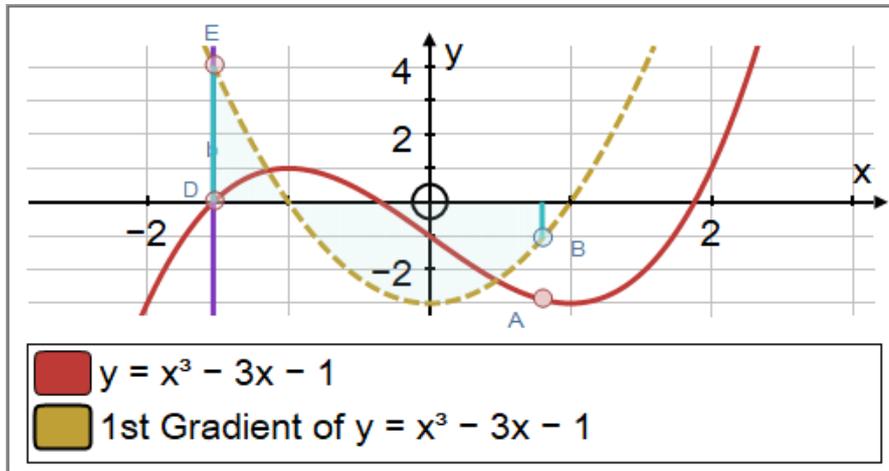
2. Plotting a discontinuity eg  $y = (x^2 - 4)/(x - 2)$



3. 2D plotting revised and improved, eg  $y = \sin x \cos(1/x)$

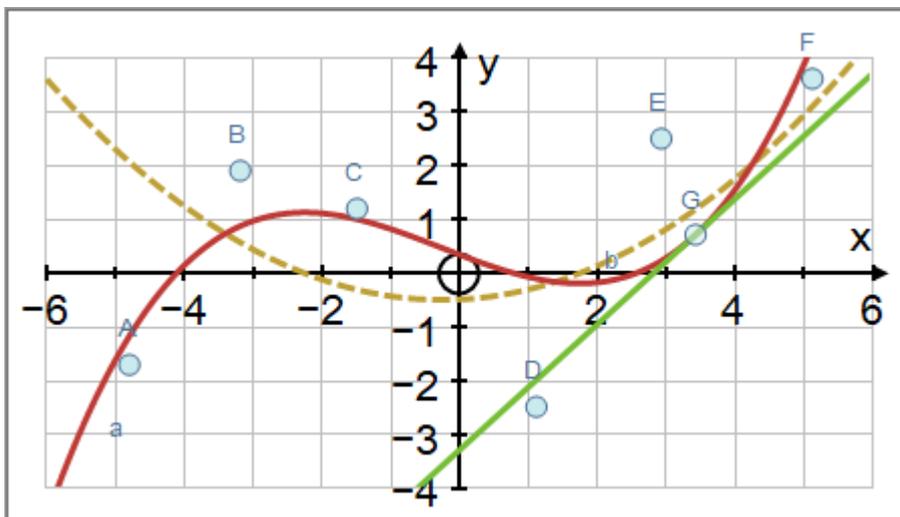


- ◇ **Gradient function:** now behaves like an entered function:  
Enter point on curve, draw tangent, create area (2 pts); draw gradient function

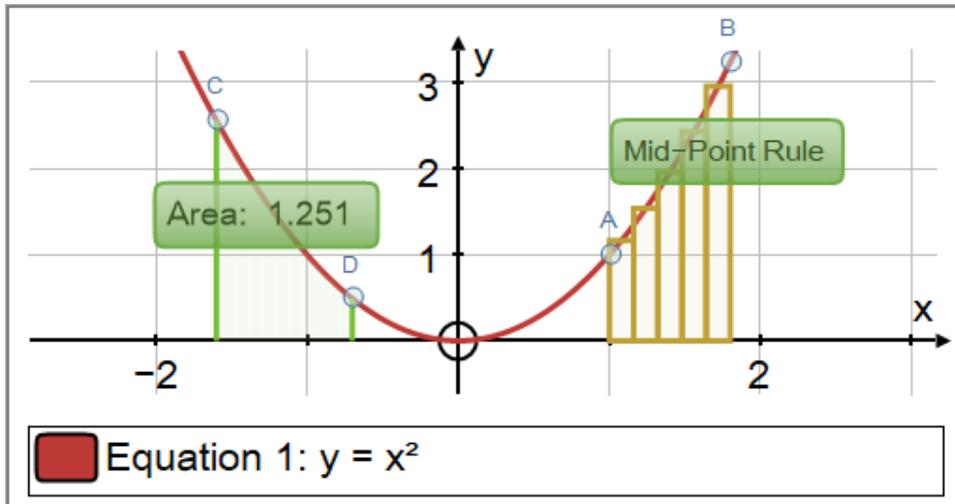


- ◇ **Polynomial best fit from n points:** now behaves like an entered function:  
Enter point on curve, draw tangent, create area (2 pts); draw gradient function

Also Animation Controller available to animate order of polynomial



◇ AREA OPTIONS:

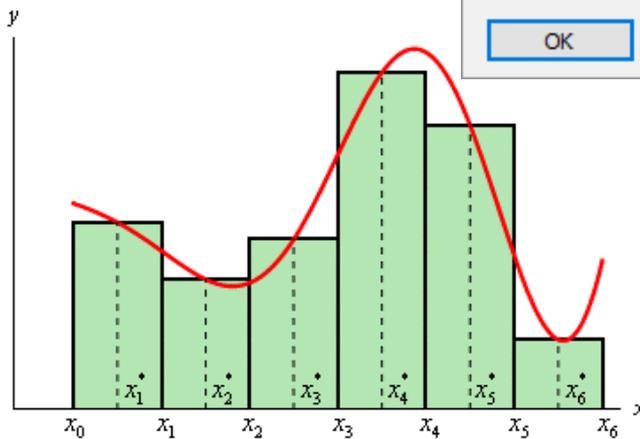
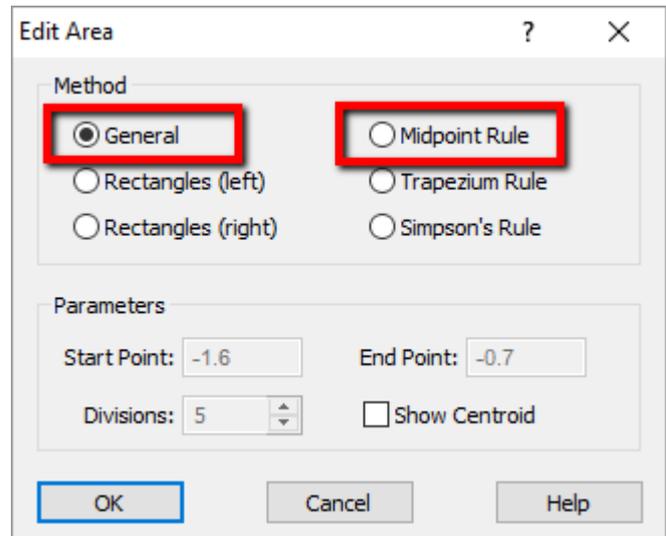


2 points selected on a graph  
Right-click "CREATE" -> "AREA"

'General' and 'Mid-interval Rule' added

'General' => Simpsons with 150 divisions  
+ standard object fill

Rectangles (left) was (-) and (right) was (+)  
"left" means the height used is  
the left of the interval



Rectangles and so for a general  $n$  we get that,

$$\int_a^b f(x) dx \approx \Delta x [f(x_1^*) + f(x_2^*) + \dots + f(x_n^*)]$$

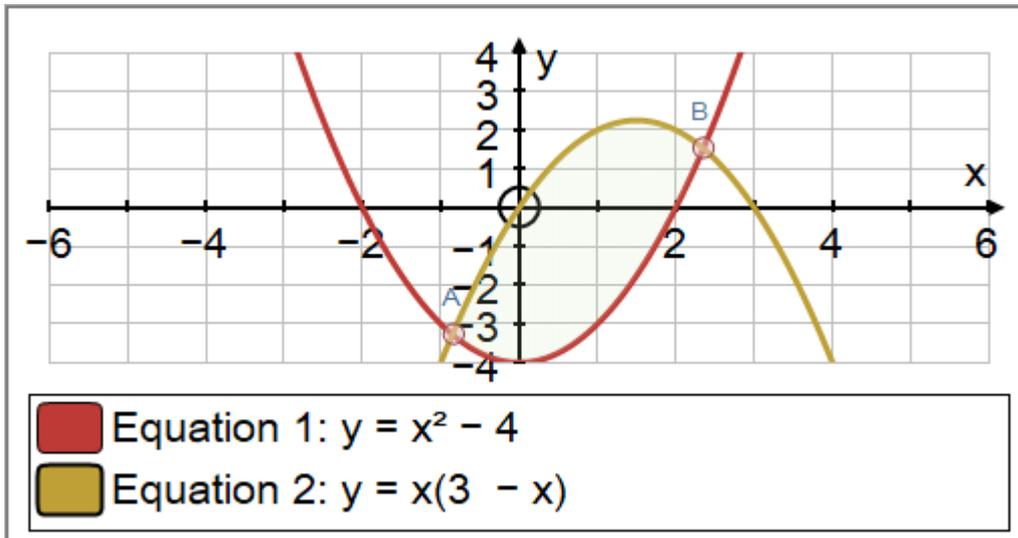
Midpoint Rule.

$$\int_a^b f(x) dx \approx \Delta x [f(x_1^*) + f(x_2^*) + \dots + f(x_n^*)]$$

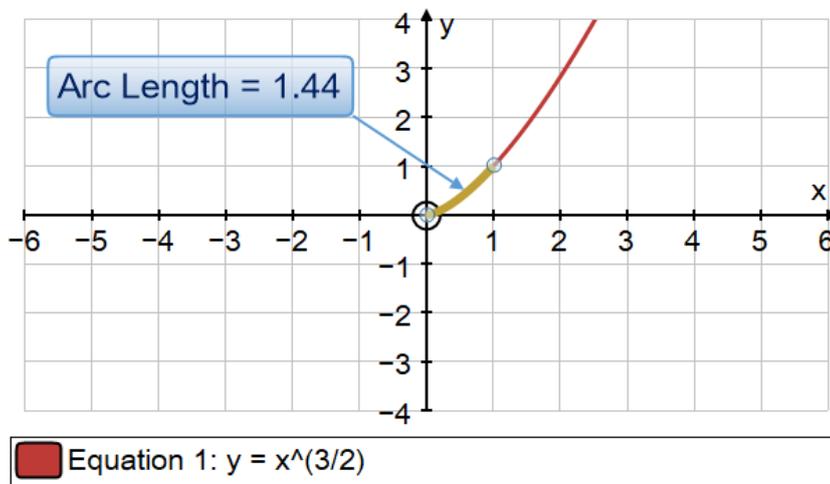
 to animate the number of divisions, select (just) the AREA and use the ANIMATION CONTROLLER.

Note: Simpson's Rule is exact for quadratics and cubics.

◇ Select 2 points (on or off graph) + TWO functions (in order): **Create** -> **Area**



◇ 2 points selected on a graph: **Create** -> **Arc Length**, option to show centroid



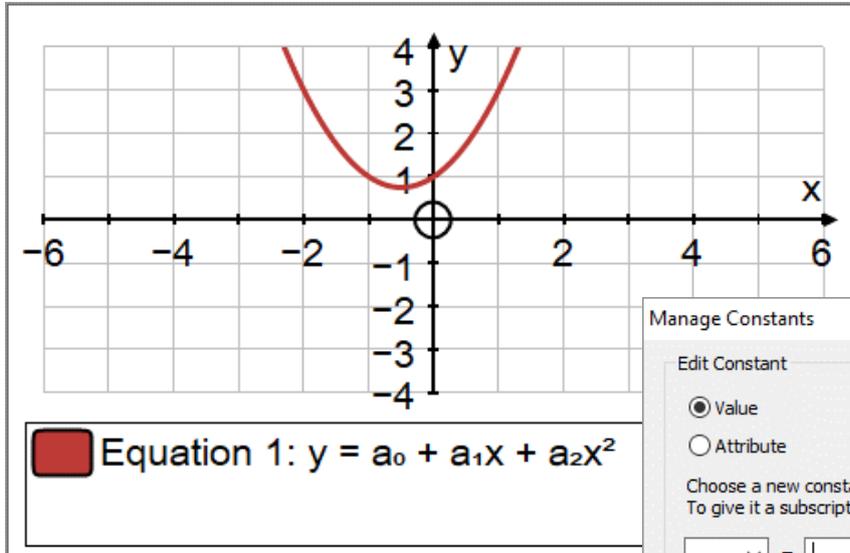
Arc length =  $\int \sqrt{1 + (f'(x))^2}$

We can compute the arc length of the graph of  $f(x) = x^{3/2}$  over  $[0, 1]$  as follows:

$$\begin{aligned}
 L &= \int_0^1 \sqrt{1 + [f'(x)]^2} dx = \int_0^1 \sqrt{1 + [3x^{1/2}/2]^2} dx \\
 &= \int_0^1 \sqrt{1 + 9x/4} dx \\
 &= \frac{8}{27} (1 + 9x/4)^{3/2} \Big|_0^1 \\
 &= (1 + 9/4)^{3/2} - (1)^{3/2} \\
 &= (13/4)^{3/2} - 1 \\
 &\approx 1.44.
 \end{aligned}$$

◇ **SUBSCRIPTS!**

Enter using eg a<sub>2</sub> for a<sub>2</sub> in the range 0 ... 9  
Manage constants redesigned:  
subscripts for lower-case and uppercase constants  
(single upper-case constants not permitted)



Manage Constants

Edit Constant

Value  
 Attribute

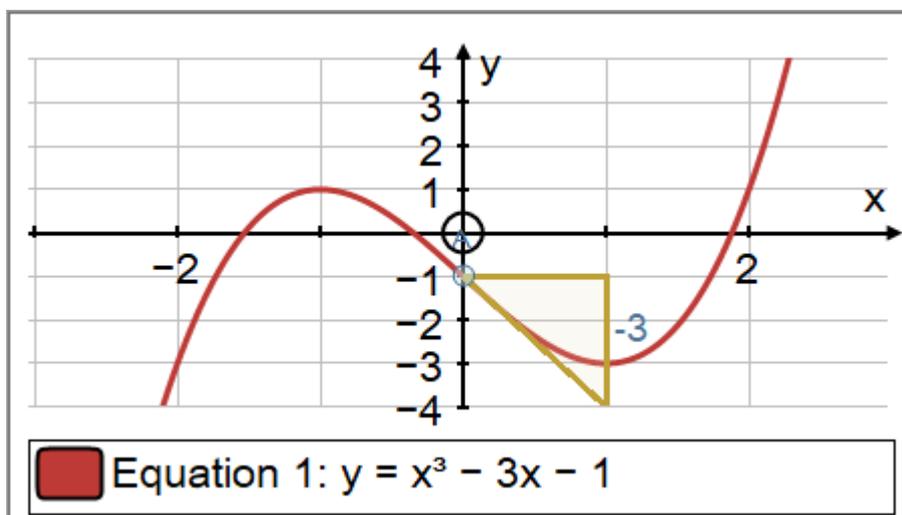
Choose a new constant from the drop-down  
To give it a subscript enter a<sub>1</sub> => a<sub>1</sub> [0 . . . 9] + -

▾ = |

a<sub>0</sub>: 1  
a<sub>1</sub>: 1  
a<sub>2</sub>: 1

Close Help

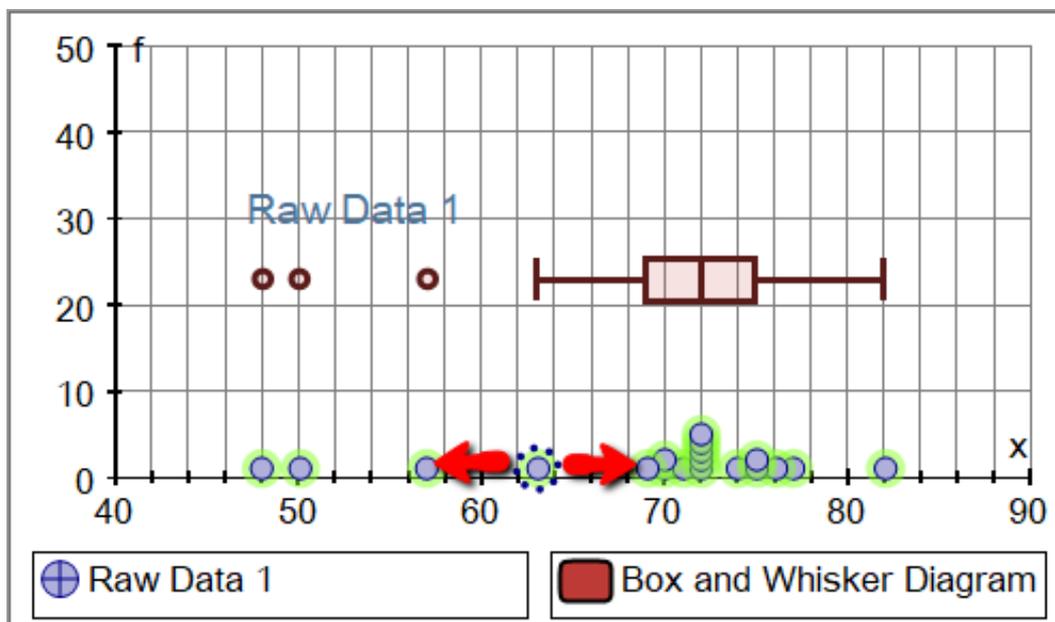
◇ Point on graph: **Unit Gradient triangle**



## Autograph 5: STATISTICS PAGE NEW FEATURES

### ◇ Dynamic Raw Data

Enter Raw Data: Option to show the data as a **Dynamic Dot Plot**



Dynamic points in a dataset can be moved around holding CTRL and drag or HOLD and drag

**Points can also be added in Point Mode** (max 1000 points). Such points when selected (using marquee select) can add to an existing dataset or can create a new dataset

Subsequent dependent objects will adjust accordingly

A listed Raw Data set can be deselected to allow a new set of data points to be added.

Individually selected dynamic data point: coordinates given in status bar.

◆ **BOX AND WHISKER PLOTS**

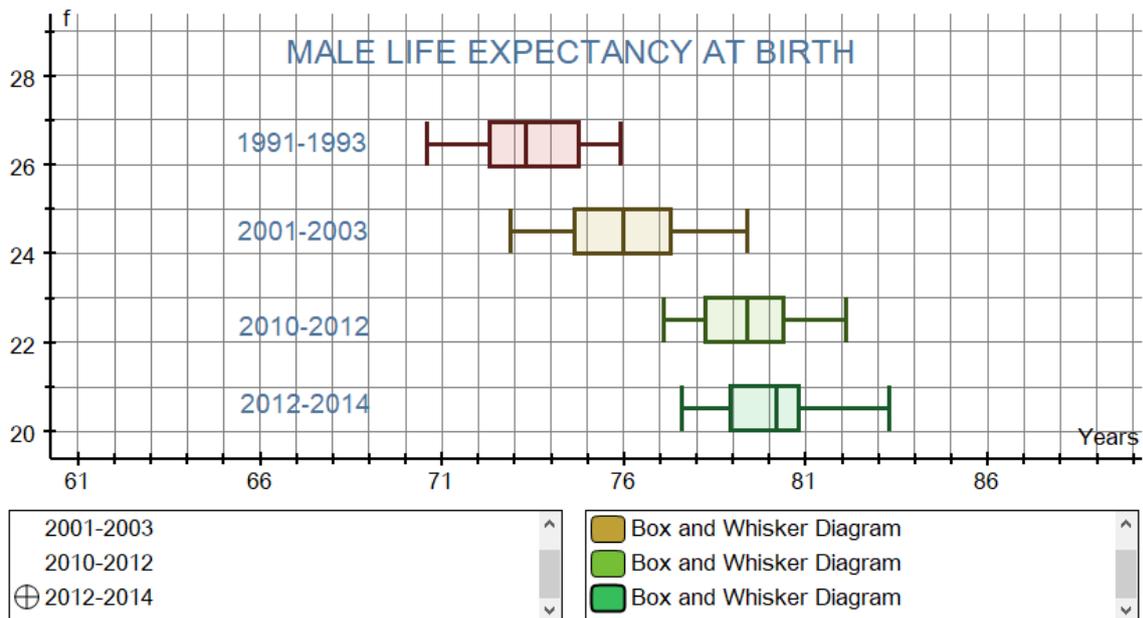
**Outliers: Data points further out than 1.5 x IQR are shown as potential outliers**

The Box Plot extreme verticals are the lowest and highest data that can be considered not to be outliers.

◆ **MULTIPLE BOX PLOTS:** Must be entered one at a time, but individually labelled.

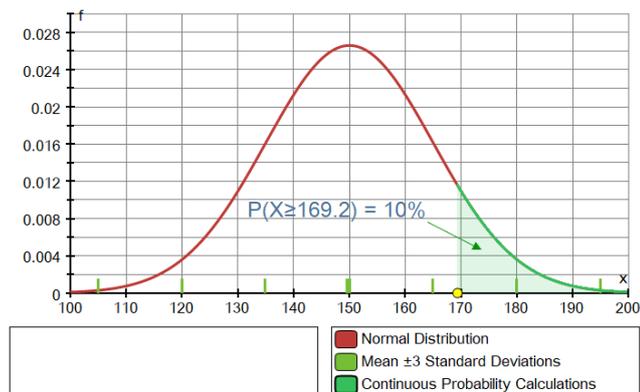
Autoscaling optimised, and each on has a LABEL based on the individual data column header.

Label can be edited using the right-click option with the parent box plot selected.



◆ **Minor fixes to the Statistics page:**

Normal areas plotted nicely



◆ Objects can be arranged in ORDER

◆ **Add image**

◆ **Variance** now uses  $/(n-1)$  form throughout

◆ **Vertical scaling and its label** are determined by the first object plotted.

=====

◇ **NEW STATISTICS OBJECT: Q-Q Normal Plot**

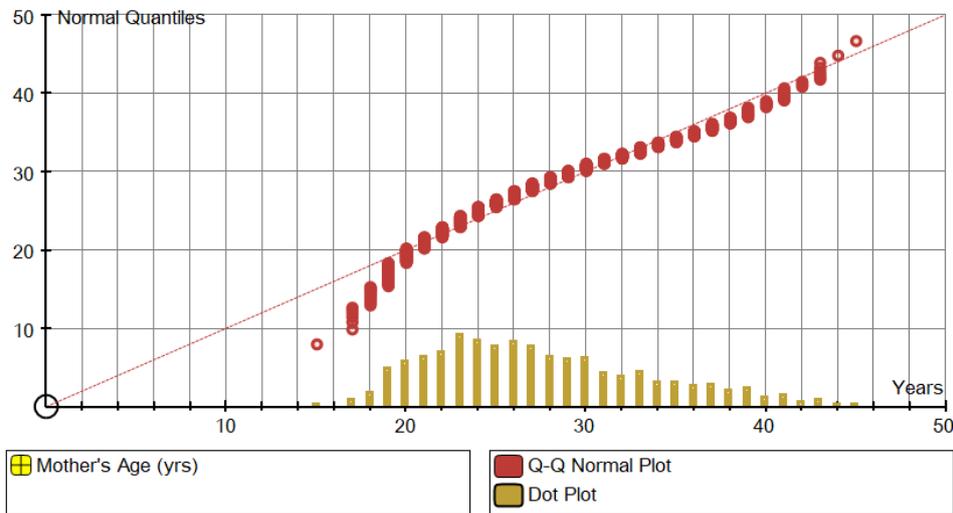
A test for normality used in Core Maths on a raw data set  
 So with a raw data set entered, RC option “Q-Q Normal Plot”

1. Data is first sorted in ascending order and numbered 1 to n
2. The mean and SD of the dataset are calculated
3. The dataset is formed of three columns:  
 Data number i (1...n) Quantile Normal

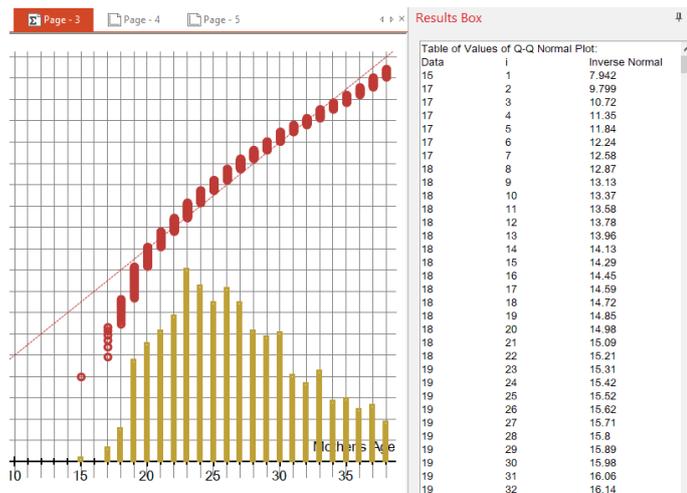
-----

123      1                      Inverse Normal((i-0.5)/n, mean, SD)

Normal Quantiles are plotted against the data on equal scales.  
 The line  $y = x$  is drawn dotted



Select the Q-Q plot and “Table of Statistics” to show 3 columns in the Results Box.



## Autograph 5: 3D PAGE NEW FEATURES

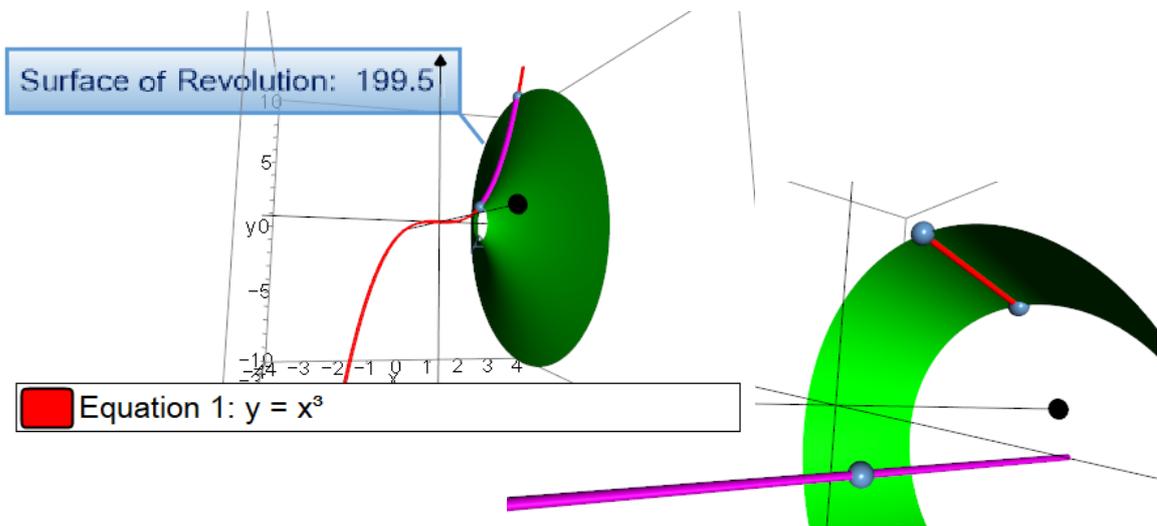
### ◇ ARC LENGTH and SURFACE OF REVOLUTION

2 points selected on a 2D graph - right-click: **Create -> Arc Length**

Option to draw axis of revolution in the form  $y = k$  (plot as 2D)

Arc length selected:

**Create -> Surface of revolution:** enter axis of revolution (If not drawn and selected)



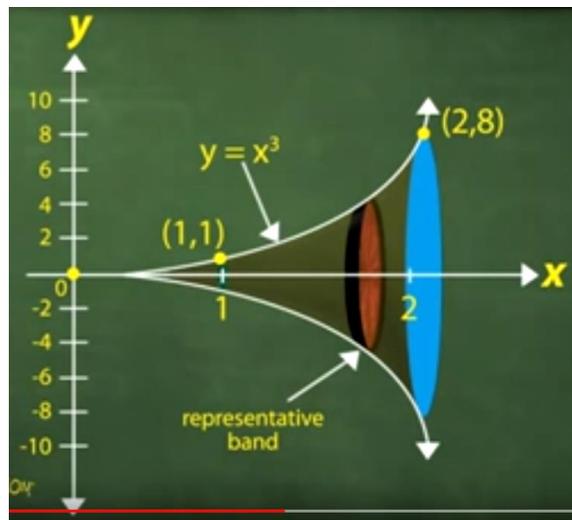
Arc length can be a line segment (must be in x-y plane, so  $z = 0$ )

Surface of Revolution and optional axis selected:

Arc length =  $\Sigma \sqrt{1 + (f'(x))^2}$

Surface area of Revolution =  $\Sigma 2\pi f(x) \sqrt{1 + (f'(x))^2}$

$$\begin{aligned}
 & \int_0^2 2\pi x^3 \sqrt{1+(3x^2)^2} dx \\
 &= 2\pi \int_0^2 x^3 \sqrt{1+9x^4} dx \\
 &= \frac{2\pi}{36} \int_0^2 36x^3 \sqrt{1+9x^4} dx \\
 &= \frac{\pi}{18} \int_0^{45} u^{1/2} du \\
 &= \frac{\pi}{18} \left[ \frac{2}{3} u^{3/2} \right]_0^{45} \\
 &= \frac{\pi}{18} \left( \frac{2}{3} \cdot 145^{3/2} - \frac{2}{3} \cdot 10^{3/2} \right) \\
 &\approx 199.5 \text{ square units}
 \end{aligned}$$



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## THE 3D "CREATE" SUB-MENU

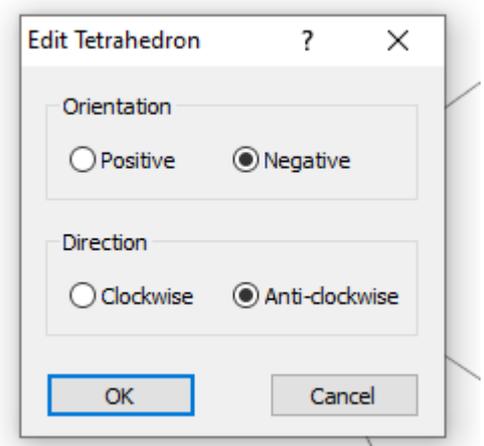
- ◇ **1 point and 3 vectors** Create -> **Parallelepiped**  
Attributes: Volume =  $(\mathbf{a} \times \mathbf{b}) \cdot \mathbf{c}$
- ◇ **1 point selected** Create -> **Sphere** (enter radius)  
Attributes: radius, surface area, volume
- ◇ **2 points selected** Create -> **Cylinder** (enter radius)  
Attributes: radius, height, surface area, top/bottom area  
Create -> **Sphere** (centre at first point)  
Attributes: radius, surface area, volume
  - On a plane Create -> **Cube\***  
Attributes: Side length, Surface area, Volume, Inside/Outside radius
  - On a plane Create -> **Tetrahedron\***  
Attributes: Side length, Height, Surface A, Volume, Inside/Outside radius
  - On a plane Create -> **Regular polygon** (enter number of sides)  
Attributes: Sides, perimeter, area, centre, side length, inside/outside radius, int angle
  - On a plane Create -> **Right pyramid\*** (enter no. of sides and height)  
Attributes: Sides, side length, height, slant height, Surface area, volume, inside/outside radius, slant height, base area
- ◇ **3 points selected** Create -> **Polygon** (free or on a plane)  
Attributes: sides, perimeter, area, centre
- ◇ **4 points selected** Create -> **Sphere**  
(except when on a plane)
- ◇ **≥ 4 points on a plane** Create -> **Polygon**

- 
- ◇ **1 random polygon or 1 regular polygon** selected (on a plane), or **1 plane side of a cube, tetrahedron, pyramid or prism**

Create -> **Right Prism\*** (enter height)  
Attributes (regular pol): sides, height, Surface area, volume. base area, centre, side length, inside/outside radius

Create -> **Right Pyramid\*** (enter height)

NOTE:For a right pyramid, the vertex is drawn vertically above the MEAN of the points that make up the base polygon.



- \* These objects all have the choice of **positive** or **negative** orientation and **clockwise/anti** rotation
- \* If the wrong one has plotted, double-click on the object and change orientation/rotation

- ◇ **To create a cuboid:**  
Enter and select 4 points on a plane in a **rectangle**: create -> **Polygon**  
Select the polygon -> **Right prism** (enter height)
-

---

## THE 3D “CREATE” SUB-MENU

Cube

Tetrahedron

Regular polygon

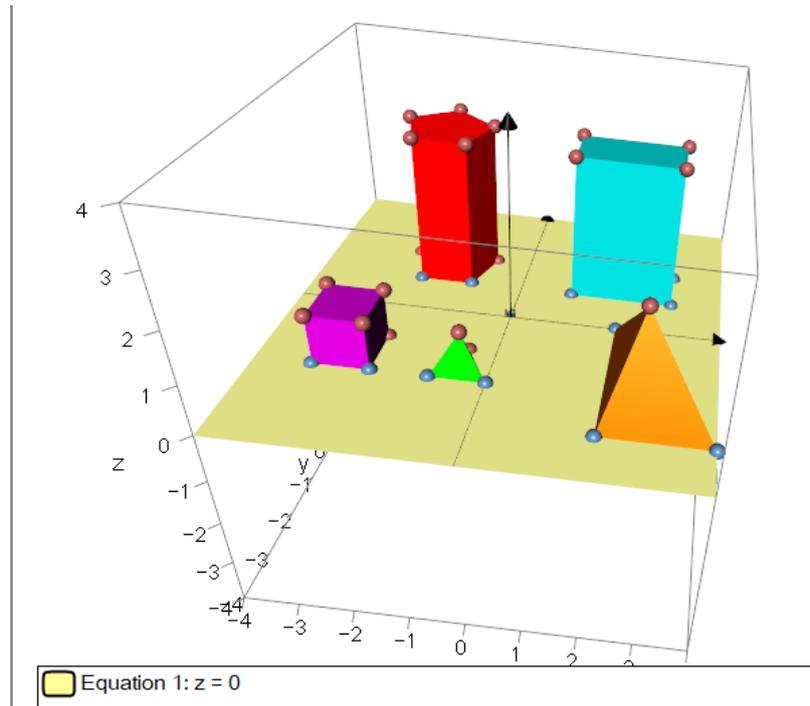
Right pyramid

Polygon (*free or on a plane*)

Right Prism

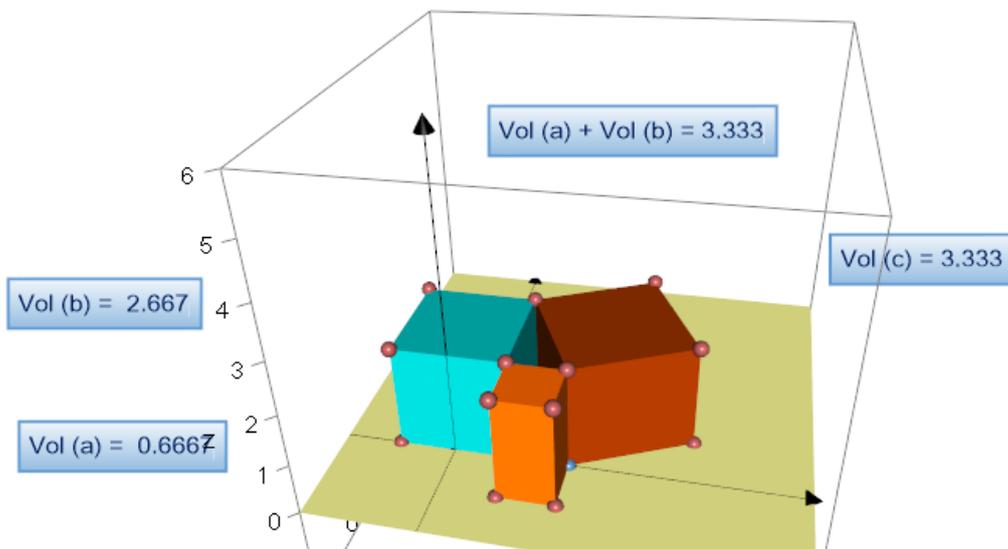
Right Pyramid

Cuboid




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## Pythagoras in 3D



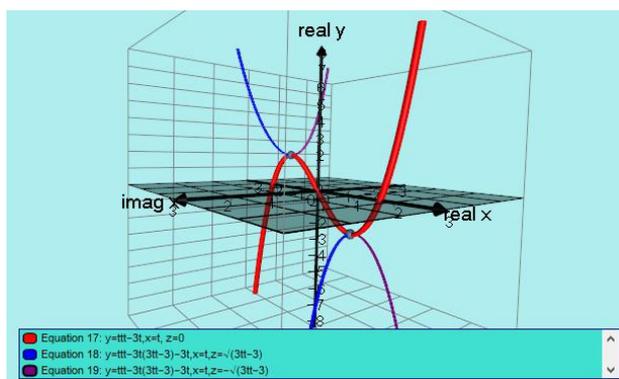
On the plane  $z = 0$ , create a right angle triangle

For each side create a square (regular polygon 4 sides)

For each square create a prism

Use the Calculator to create the text by selecting the “Volume” attribute of each prism.

- 
- ◇ **3D parametric plotting improved.**



- ◇ **3D line segment: Value (in label) is its LENGTH**

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## The HELP menu

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### Autograph Help (F1)

This is the comprehensive help system for v.3 which is still largely relevant to v.5  
It is definitely worth spending time reading the Two extension manuals for v.4 and v.5

### Autograph Manual (F2)

This is the comprehensive [v.3 Manual](#)

Please also refer to

[v.4 Manual: new features](#)

[v.5 Manual: new features](#)

A new manual for v.5 is in progress

### Autograph Resources (F4)

<https://www.tsm-resources.com/>

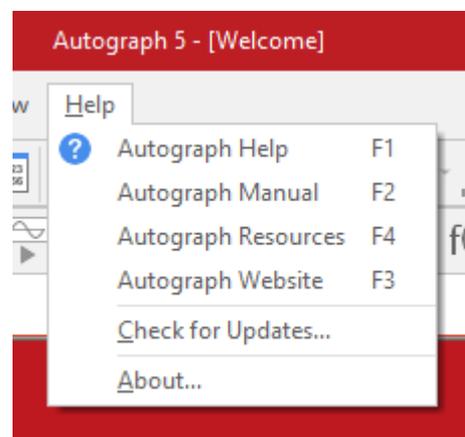
Downloads, Videos, Worksheets and Resources

### Autograph Website (F3)

<https://autograph.completemaths.com/>

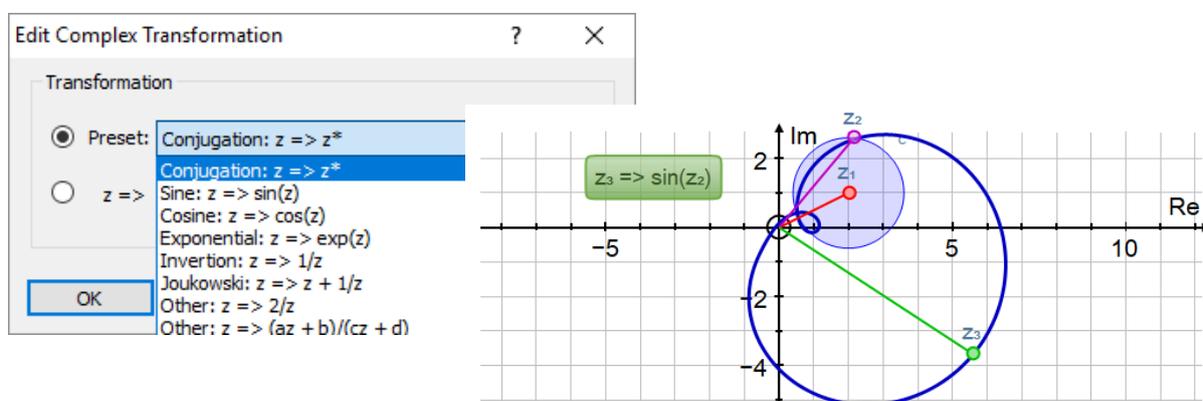
Check for Updates...

About...



## Autograph 5: COMPLEX NUMBER PAGE NEW FEATURES

- ◇ New object: **Circle (centre 0,0)**
- ◇ Single CN selected: **vertical line, horizontal line, circle**
- ◇ 2 CNs selected: **straight line, line segment, perp. bisector  
ellipse (enter sum of radii)**
- ◇ 3CNs selected: **Circle, Ellipse (1<sup>st</sup> 2 CNs are the foci, then point on the ellipse)**
- ◇ **Complex transformations:** for lines, circles and ellipse, and a single point
- ◇ Single point and its complex transformation: **locus**



- ◇ Selected complex numbers      New right-click option to show/hide vector to origin
- ◇ Right-click sub-menu            "Calculations" on selected complex number(s)
- ◇ Auto-scale                        always includes the origin
- ◇ Nth roots labels                 n roots of the nth root labelled  $\omega_1, \omega_2, \omega_3, \dots$
- ◇ Calculation results labels       $z_1+z_2, z_1-z_2, z_1z_2, z_1/z_2, z_1^*, az_1, z_1^n, \sqrt[n]{z_1}, |z|, \arg(z_1)$

