

Objectives

- To know what GeoGebra is and how to get it.
- To understand the basic capabilities of Geogebra.
- To be able to use the tools in order to build a dynamic GeoGebra file that aids with your teaching of mathematics.



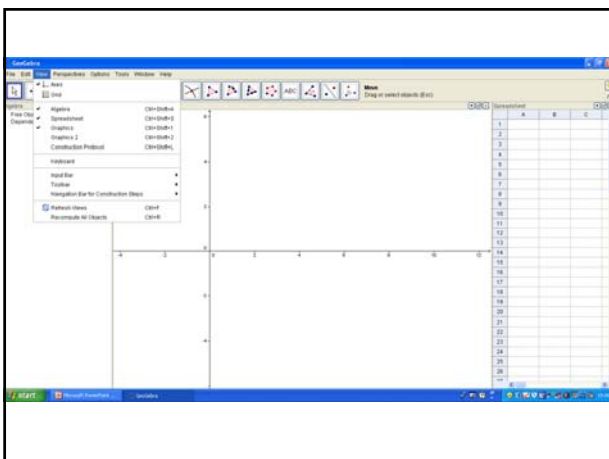
What is GeoGebra?

- GeoGebra is free dynamic geometry software which can be used to support teaching and learning in the primary or secondary school class room.
- www.geogebra.org



View

- Algebra: Lists all the items you have added to your graphics board.
- Spreadsheet: Will do all the things a spreadsheet program will do and all inputs can be linked to the graphics board.
- Graphics: Your main workspace where all items on the toolbar can be placed.
- Graphics 2: A second workspace that can be linked to the first.
- Construction Protocol: More detail on items you have added.



Graphics: Toolbar

The toolbar consists of various inputs to place on our graphics board. Play with each tool to discover what it does. The bar is split into general lists of:

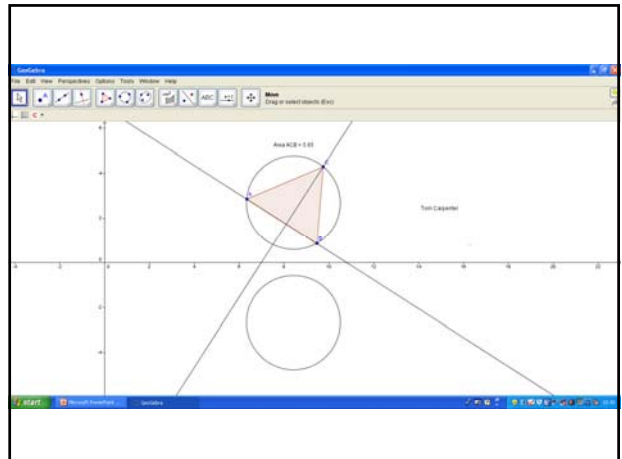
Movement	Conics
Point	Measurement
Line	Transformations
Special line	Special object
Polygon	Action object
Circle & arc	General

When a tool is selected, the toolbar will give you an instruction in order to use it.



Task 1

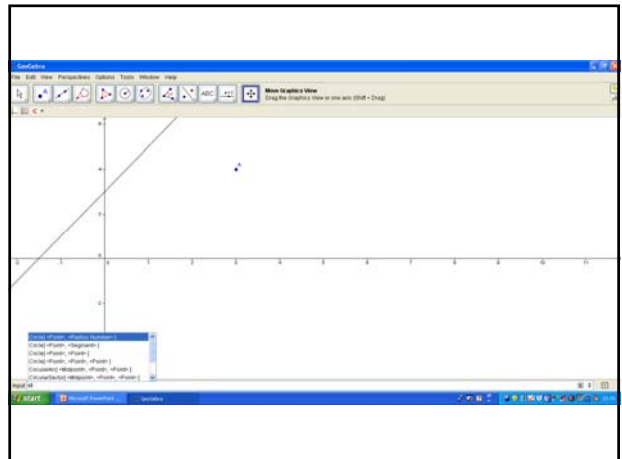
- Plot 3 points.
- Draw a line through 2 of the points.
- Draw a perpendicular line that goes through the 3rd point.
- Draw a triangle through the 3 points.
- Draw a circle through the 3 points.
- Display the area of the circle.
- Reflect your circle in the x-axis.
- Put your name on your work



Graphics: Input bar

The input bar is an alternative way of entering items on the graphics board and is more useful for entering more specific inputs. For example:

- Typing “(3,4)” will plot the point (3,4).
 - Typing “ $y=2x+3$ ” will draw the line $y=2x+3$.
- All items on the tool bar can be input via the input bar if you know the right command (e.g. “circle[{point}, {radius}]”)



Graphics: Presentation

Right click → Object Properties:

- Basic – choose whether to show/hide the object, whether to have a label, or whether you want to fix it so it can't be accidentally altered.
- Colour – choose a colour.
- Style – choose a thickness or style of your line or how opaque a shape is.



Graphics: Presentation

View:

- Axes – show/hide the axes.
- Grid - Axes – show/hide the grid.

Options:

- Font Size – choose the size of you writing.
- Rounding – choose the number of decimal places your displayed numbers are to.

Special tools:

- Insert image – browse for a picture to display.

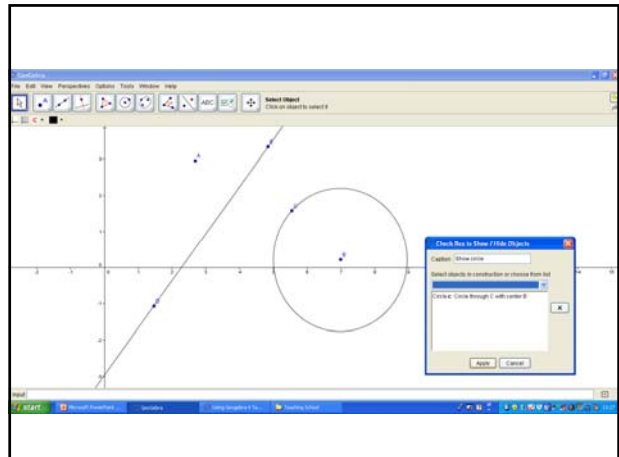


Graphics: Presentation

Action tools:

Checkbox – shows/hides an object(s) each time it is selected.

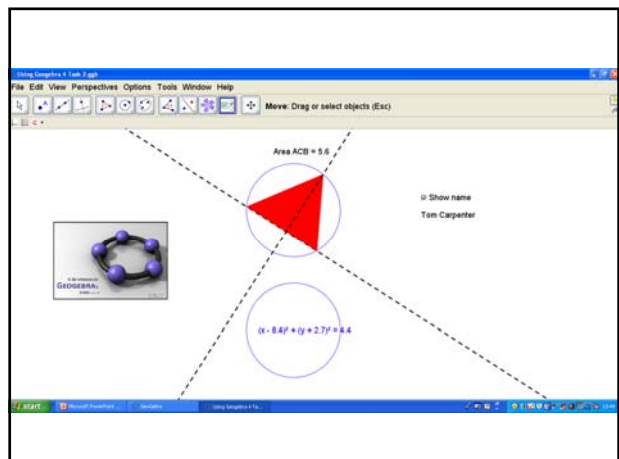
Select the checkbox, click where you want to place it, give it a name and select what you want to show/hide (either via the drop-down list or by clicking on them individually)



Task 2

Starting with your final product from task 1:

- Hide all your points and the axes.
- Label one of your circles with its equation (value) and colour both of them blue.
- Make your lines thicker and dashed.
- Make your triangle red and opaque (100%), and display its area.
- Insert a picture of your choice.
- Insert a checkbox that hides/shows your name.



Graphics: Dynamic changes

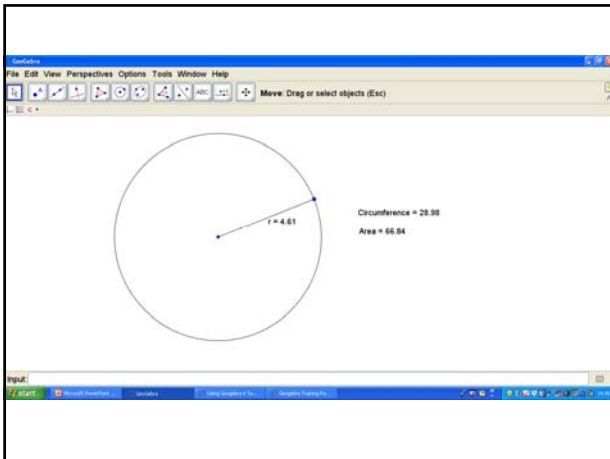
- Once an object is placed on the graphics work space, it doesn't have to be fixed to this location.
- If we double-click on the object, we have the option to type in the change we want to make.
- However we can click and drag to move objects, which is frequently a more ideal situation.



Graphics: Dynamic changes

- Create a circle, and join the 2 construction points with a line to make the radius. The point on the circumference can be dragged around to show, by sight, that the area and the circumference of the circle increases as the radius increases.
- We can also display measures of the radius, circumference and area to show that this is also true as the values change as we move the point around.

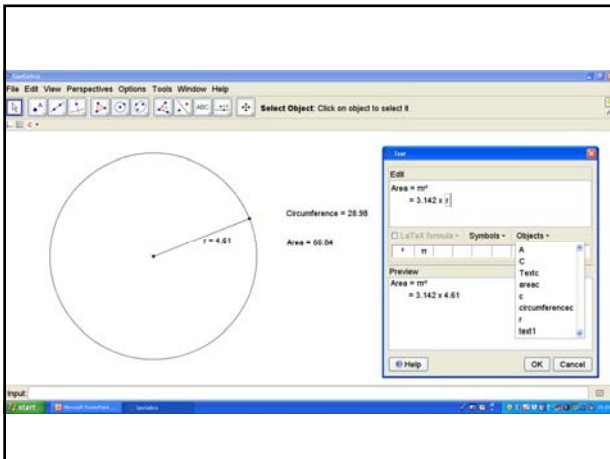




Graphics: Dynamic changes

Dynamic text:

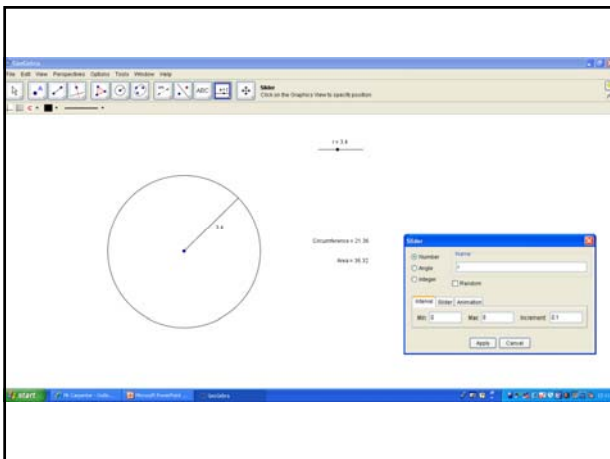
- Text in text boxes can also change as we alter an object.
- Dynamic text can be displayed in the box as well as static text.
- Once text box tool has been selected and placed, any static text can be typed, whilst any dynamic text can be selected from the objects' drop-down list. Any object with some value attached to it will be seen in that list.



Graphics: Dynamic changes

Action tools → Slider:

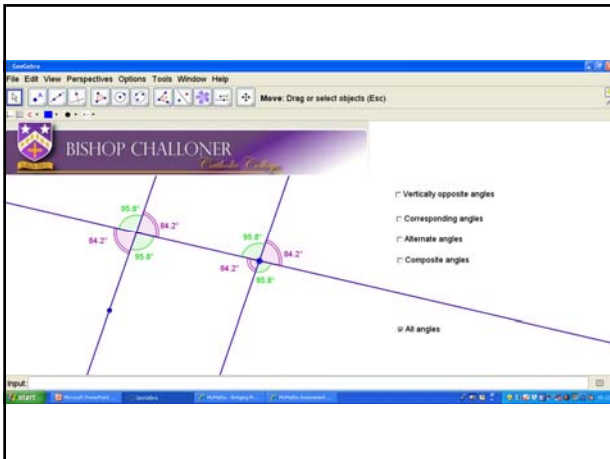
- The slider allows us to change a value associated with an object to a specific one, quickly and easily.
- In the slider menu we can choose the range of the slider and its increments, making note of its name (usually a letter).
- The number on the slider is now associated with that name and can be used when creating an object.
- For example, when creating a circle with a given radius, we can enter the name of the slider as our value of the radius.



Task 3

- Create a dynamic worksheet that demonstrates the relationships of different angles created by one set of parallel lines and an intersecting line.
- Think about the presentation and dynamic capabilities as well as the mathematical concepts that it is demonstrating.





Spreadsheet

- The spreadsheet view can be selected from the view menu and positioned where you wish.
- The spreadsheet can be used similar to any other spreadsheet software, where entries and calculations can be done separately from your graphics view.
- A statistics toolbar becomes available to help perform any statistical processes.
- Commands can be entered into the cells to perform numerous mathematical operations.

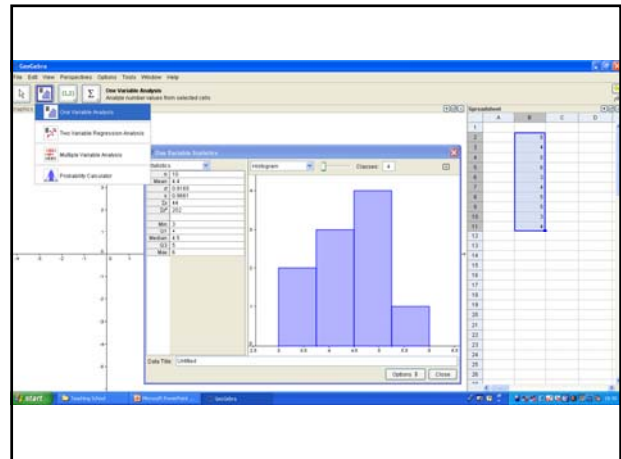


Spreadsheet Toolbar

The toolbar consists of various outputs that analyse a set of data that has been entered into the spreadsheet. Play with each tool to discover what it does. The bar is split into general lists of:

Movement	Create
Data analysis	Simple stats

When a tool is selected, the toolbar will give you an instruction in order to use it.



Spreadsheet Commands

- There are a large number of commands that can be performed with data that has been entered into the spreadsheet.
- These commands can be similar to those of Excel but it is a case of trying different commands and seeing what they do.
- Unlike Excel, no “=” is required and suggested commands pop up as you begin to type.



Spreadsheet Commands

Some helpful beginner commands are as follows:

- `randombetween[a,b]` – returns a random number between the 2 given values a & b inclusive. Good for creating randomly generated data/questions.
- `if[a,b,c]` – returns b or c, depending on condition a.



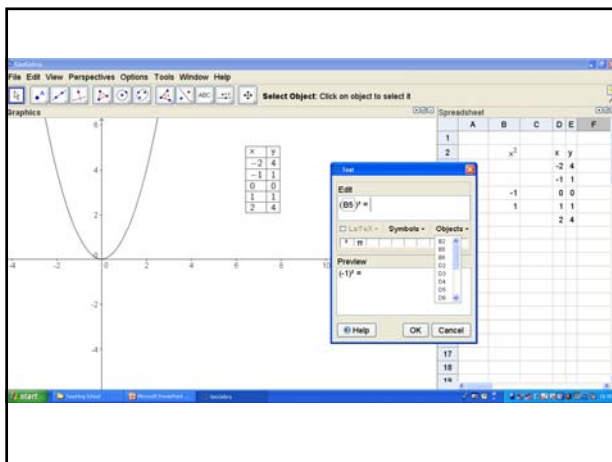
Spreadsheet Commands

- `ceil/floor[a]` – rounds the given value up/down.
- `mean/mode/median/etc[list]` – returns specific data analysis value of the given list.
- `Simplify/expand/factorise[function]` – applies algebraic manipulation on the given function.
- `Root/roots[function]` – returns the roots/specific root of the given function.
- A full list of commands can be found on the website: www.geogebra.org/help



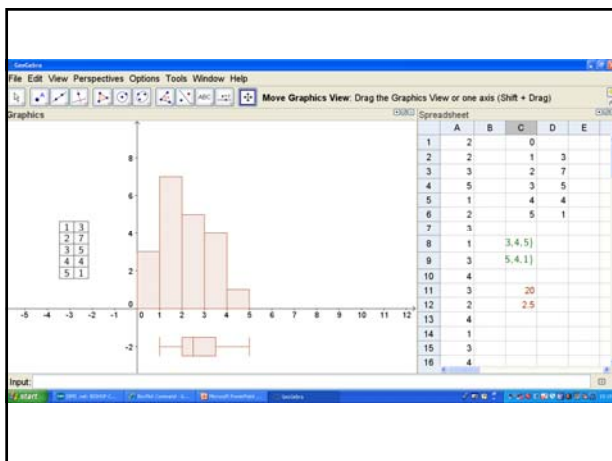
The Graphics-Spreadsheet Connection

- Anything inputted on the spreadsheet can be demonstrated on the graphics board, and vice-versa.
- Typing a function into a cell will automatically draw it on the axes.
- Highlighting spreadsheet data and creating a table, displays it on the graphics board.
- Most importantly, filled cells now appear in the object drop-down list in the textbox entry.



Task 4

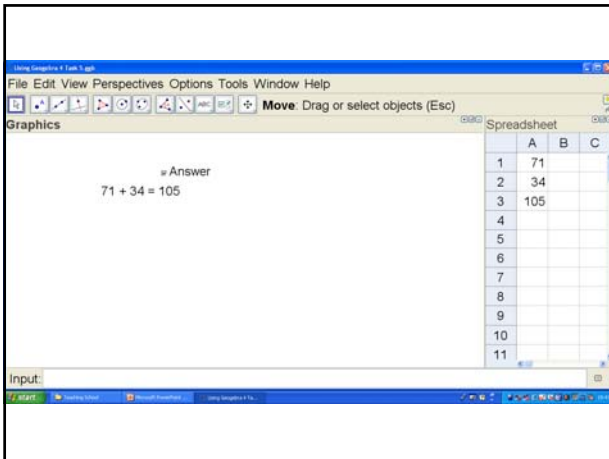
- Create a list of 20 random numbers between 1 & 5 inclusive.
- Type the number 0 to 5 in a column and, in the cell next to 1, type "`countif(x==1,list1)`". This returns the frequency of 1 in our list. Repeat for 2 to 5.
- Create a table of x and their frequencies.
- Create list2 and list3 of the 2 columns in your table respectively (list 2 must include the zero).
- Type in any cell "`histogram(list1,list2)`". A histogram of the data should now appear with the table in your graphics view.
- Try to include a box-plot of the data on your workspace.



Task 5

- Create 2 random double-digit numbers in your spreadsheet.
- In a third cell, add these 2 numbers together.
- On your graphics board, use a textbox to set up a simple add question, selecting the cells where your 2 random numbers are from the object list.
- Create a second textbox with the solution in it.
- Set up a checkbox that hides/shows your solution.





Creating Geogebra Worksheets

Task 5 was an example of how to set-up a simple worksheet for pupils to work from. A pupil could answer the question in their book and check their answer by clicking the checkbox. F9 could then be used to create a new question.

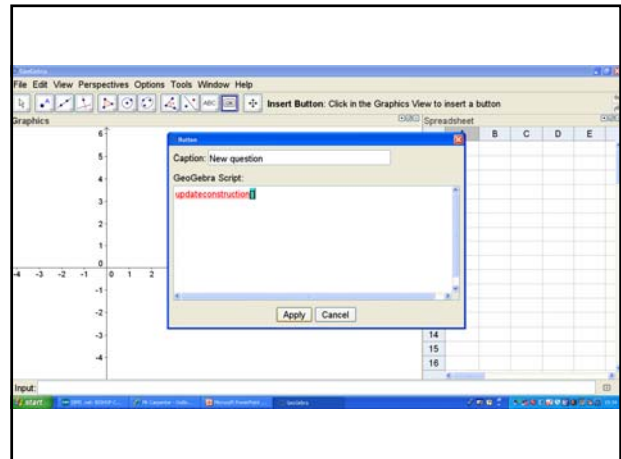
The worksheet could be upgraded by introducing a button and an input box.



Creating Geogebra Worksheets

Button:

- The button allows you to change entries at the push of a ...well, button!
- This is most useful for refreshing random numbers without using F9.
- Select "insert button" from the Action tool list and type "updateconstruction[]" in the script box, once you have given it a name like "new question".



Creating Geogebra Worksheets

Input box:

- The input box is a space where an entry can be made, which can result in some sort of reaction.
- This is most useful for pupils entering an answer to a question and it being automatically marked.
- Type "1" into any cell (lets say A1), then select "insert input box" from the Action tool list and select it from the linked object drop-down list. Also give the box a caption, like "=".



Creating Geogebra Worksheets

Input box:

- Whenever something is now typed into the input box, the cell changes to that entry.
- In order to mark the input, have the answer to the given question in another cell (B1), and then type in a 3rd cell (C1):
"if(A1==B1,"correct","wrong")"
- Now create a textbox that shows the response in C1.



Task 6

- Set up a worksheet that tests pupils times tables.
- Ensure the questions are random, there is an inbox for pupils to type their answers, which is then marked by the software, and that there is a button for a new question.



The screenshot shows the Geogebra interface with a 'New question' button and a text input field containing the equation $2 \times 8 = 16$. Below the input field, the text 'Correct, well done' is displayed. On the right side, a spreadsheet window is visible with columns A through F and rows 1 through 21.

Exporting your Worksheet

- Any Geogebra file can be exported to, for example, a school's Moodle.
- The file will then be available, via the internet, with all its dynamic capabilities, using Java. Anybody looking for access will not require Geogebra on their computer.



Exporting your Worksheet

- File: Export: Dynamic worksheet as webpage (html).
- Click on the "Export as Webpage" tab, then the "advanced" tab, followed by selecting "Clipboard html" from the drop-down list and clicking on "Clipboard".
- The html code is now saved as a copy and can be pasted into any html window to be displayed.
- Note: Ensure your screen is prepared, including size, as this is how it will be displayed in the webpage.



The screenshot shows the Geogebra interface with a 'New question' button and a text input field containing the equation $3 \times 10 = 0$. Below the input field, the text 'Try again' is displayed. The 'Dynamic Worksheet Export Dialog' window is open, showing the 'Export as Webpage' tab. The dialog has fields for Title, Author, and Date (27 October 2012). It has two main sections: 'General' and 'Advanced'. The 'General' section has checkboxes for 'Enable Right Click, Zooming and keyboard Editing', 'Enable Dragging of Labels', and 'Show Icon to Reset Construction'. The 'Advanced' section has checkboxes for 'Use Browser for JavaScript scripts', 'Show MenuBar', 'Show Toolbar', 'Show Inputbar', 'Allow Resizing', 'Show Menubar', 'Enable Save, Print & Undo', 'Show Toolbar Help', and 'Allow Resizing'. There are also fields for Width (697) and Height (521). At the bottom, there are buttons for 'Help', 'Clipboard', and 'Cancel'.



Using GeoGebra to Enhance Teaching and Learning in Mathematics

Introduction

GeoGebra is free dynamic geometry software that can enhance the experience of mathematics within the classroom. There seem to be three clear approaches to using GeoGebra:

- 1). Teacher demonstration.
- 2). Student exploration/demonstration.
- 3). "Traditional" randomly generated textbook exercises.

There are **five** activities within this pack. Have a go at one or two of them. As you complete each activity think about how the ideas you are covering could be extended to create other files. There are **extension activities** built in to each task. **Activity 0** might be helpful for those who have never used this software before. This should help you pick up some of the key features of the software.

Activity 0 Getting to know GeoGebra

Activity 1 Angles, polygons and lines

Activity 2 Randomly generating question banks

Activity 3 Gradient and intercept for straight line graphs

Activity 4 Area and circumference of a circle

Useful links

The following are useful web links. There are many GeoGebra files on the wiki, some are useful, others less so. It is often a case of hand picking files you want to use and doing a bit of searching first to find the right one.

To download.

<http://www.geogebra.org/cms/>

To download files and search ready-made classroom resources.

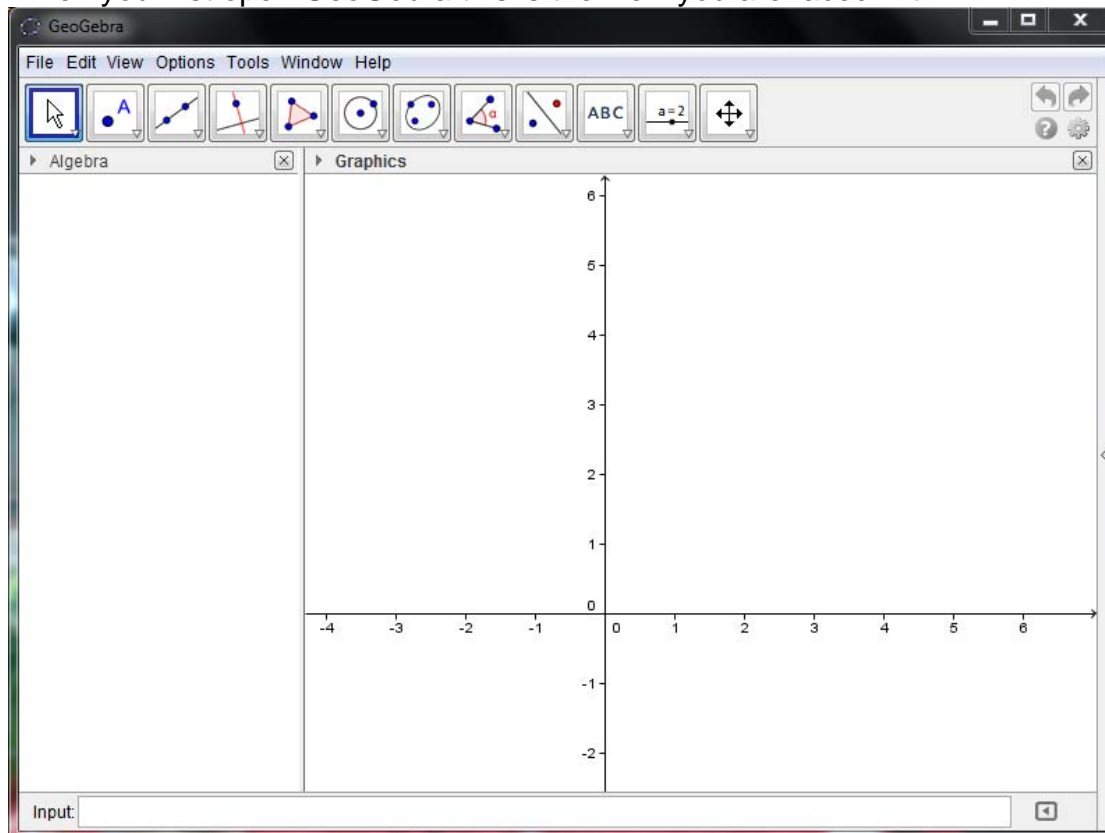
<http://www.geogebra.org/>

For all help with GeoGebra through the wiki.

<http://wiki.geogebra.org/en/>

Activity 0 Getting to know GeoGebra

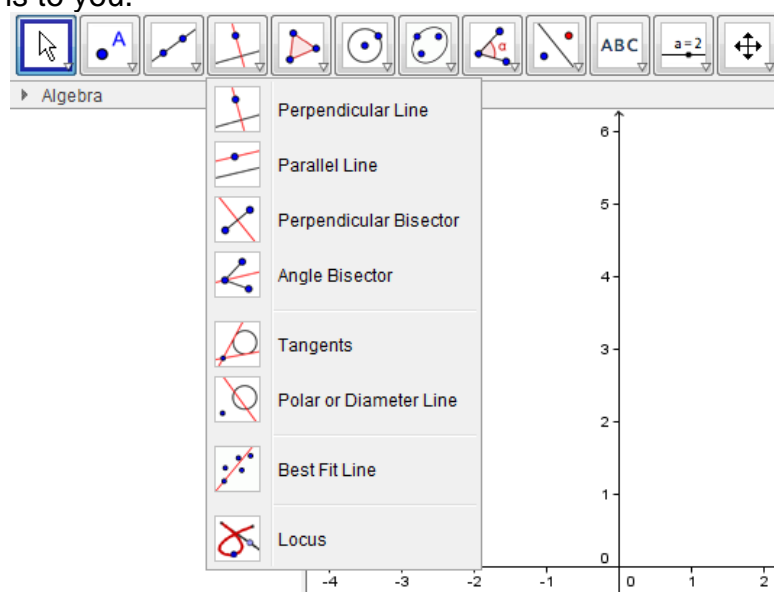
When you first open GeoGebra this is the view you are faced with.



Note the *graphics* and *algebra* view. The key menus you need are the GeoGebra tools.



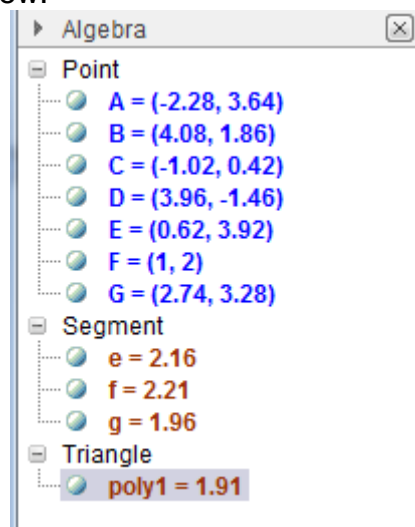
If you click on the small triangle in the corner of each menu button it will reveal more options to you.



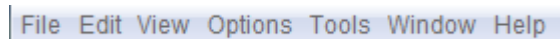
Once you select a tool it will stay with this tool until you change it.

KEY NOTE: To cancel a tool quickly, just press the **escape key**.

As you create objects in the graphics view their algebraic descriptions will appear in the algebra view.



There are also menus at the top of the screen. These can be used to modify the appearance of the graphics view etc.

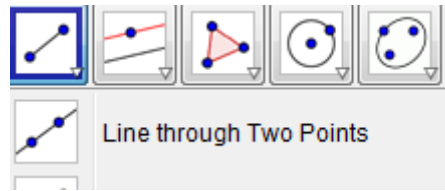


Try creating some objects on the graphics view and play around with some of the tools.

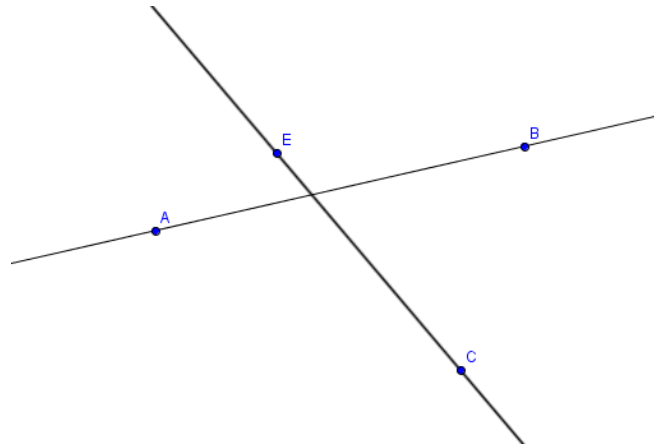
Activity 1 Angles, polygons and lines

Activity 1.1

Use the *line through two points* tool to create a straight line.



Create another straight line that is not parallel to the first one.



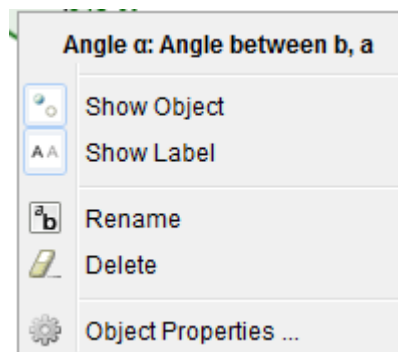
Using the *angle* tool measure some of the angles in your straight line.



Create a point where your two lines intersect using the *new point* tool.



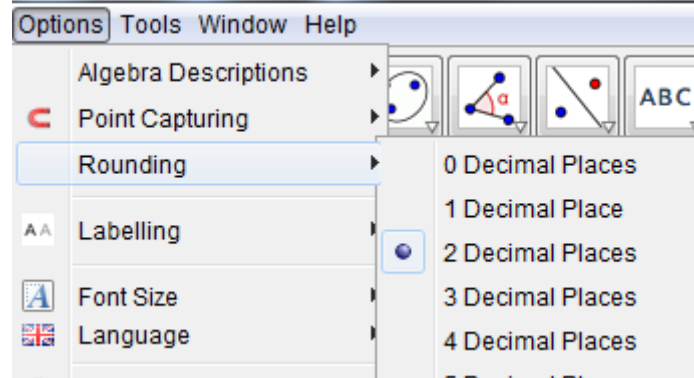
To measure an angle, either click on two lines or click on three points in a clockwise motion. If you accidentally create a reflex angle simply right click on the angle and select object properties.



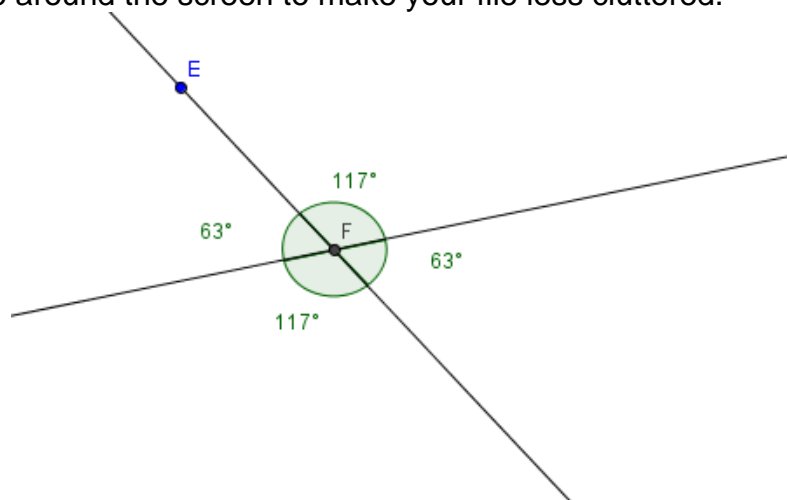
Then in the angle between box select your chosen size.

Angle Between: 0° and 360°

NOTE: To round angles to the nearest degree, go to the *options* menu and select *rounding* and then chose the appropriate degree of accuracy.



Your finished file should look something like this. You can drag the labels for each angle around the screen to make your file less cluttered.



Extension

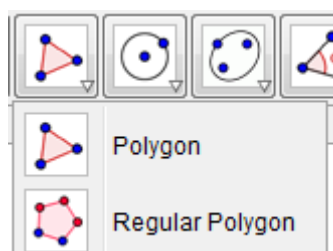
Could you create a file to show angles on a straight line?

Could you create a file to show angles round a point?

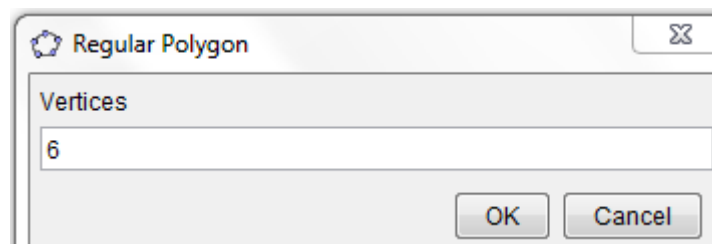
Now move some of your points around and see what happens to the size of the angles.

Activity 1.2

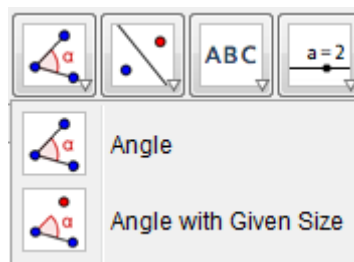
Use the *regular polygon* tool.



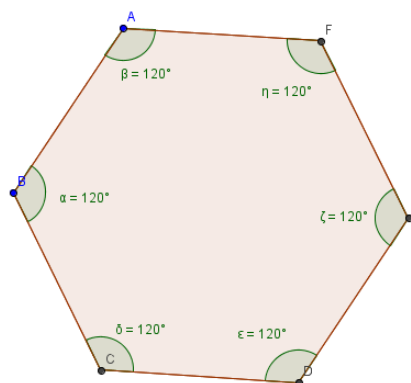
Create a hexagon (or other polygon). Produce the first two corners by clicking on the grid and then enter the number of vertices you require.



Now measure each angle using the *angle* tool. To measure an angle simply click round the three points you require in a *clockwise* motion.



You should now have a file that looks something like this.



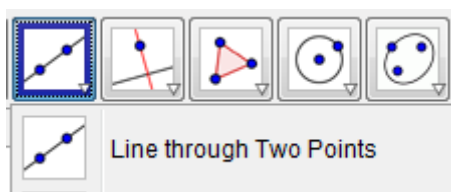
Extension

How could this be used to teach interior and exterior angles of regular polygons?

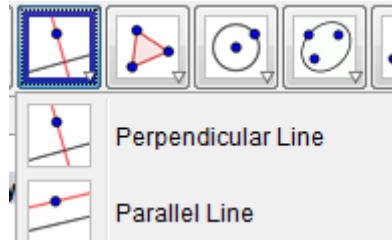
Can you work out how to add on the exterior angles to your polygon?

Activity 1.3

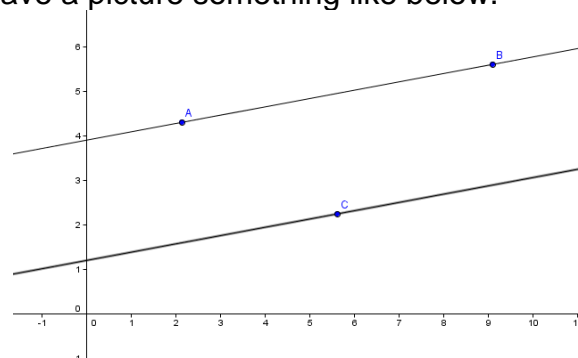
Use the *line through two points* tool to create a straight line.



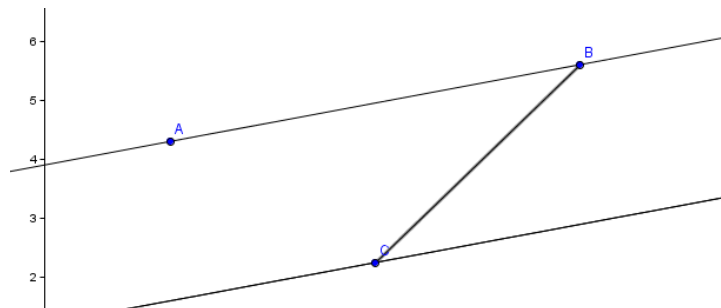
Use the *parallel line* tool to create a line parallel to your original line. Simply click a point away from your line and then click on the line to create a parallel version.



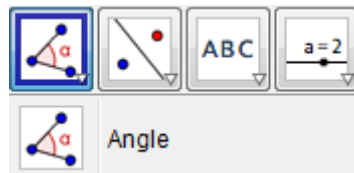
You should now have a picture something like below.

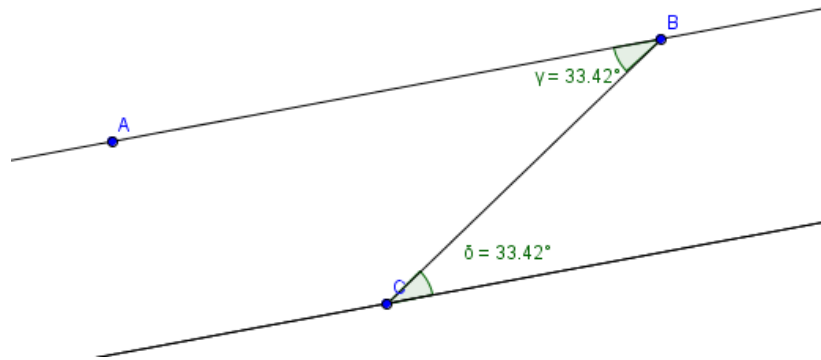


Connect up two of your points e.g. B and C using the *segment between two points* tool. See picture below.



Now measure some angles using the *angle* tool.





Now move your points around and see what happens.

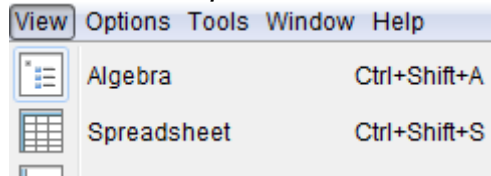
Extension

How could this be used to teach alternate and corresponding angles?

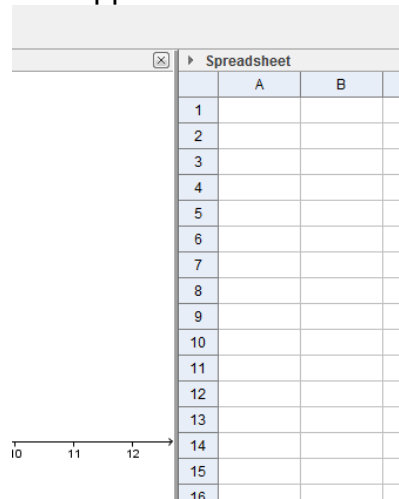
How could students use the dynamic nature of the file to discover angle facts rather than just be told them?

Activity 2 Randomly generating question banks

Click on the *view* menu and select *spreadsheet*.



The spreadsheet should now appear in a side window.



The next command is extremely useful. Type

=randombetween[2,12]

into cell A1 of your spreadsheet. Using the square at the bottom corner of cell A1, drag this cell down to produce 10 random numbers in cells A1 down to A10.

	A	B
1	7	
2	4	
3	8	
4	11	
5	8	
6	4	
7	7	
8	6	
9	10	
10	12	

In cell B1 enter the following command (including the speech marks).

“+”

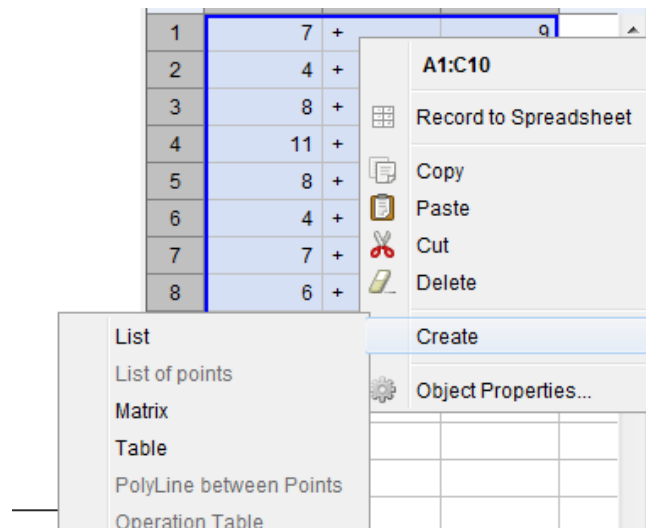
Again drag this down cells B1 to B10. Your spreadsheet should now look as follows.

	A	B
1	7	+
2	4	+
3	8	+
4	11	+
5	8	+
6	4	+
7	7	+
8	6	+
9	10	+
10	12	+

Again using the `randbetween` command, create some more random numbers in cells C1 to C10.

Spreadsheet			
	A	B	C
1	7	+	9
2	4	+	4
3	8	+	8
4	11	+	4
5	8	+	4
6	4	+	5
7	7	+	4
8	6	+	7
9	10	+	7
10	12	+	10

Highlight all the cells you have just created and right click. Select *create* and then *matrix*.



In the *input bar*,

type the following command,

tabletext[list1]

You should now have the following picture.

```
2 + 5
2 + 7
8 + 5
10 + 10
10 + 4
9 + 10
5 + 10
10 + 3
9 + 10
2 + 7
```

Press the F9 key and note what happens.

Extension

How could you include answers to these questions?

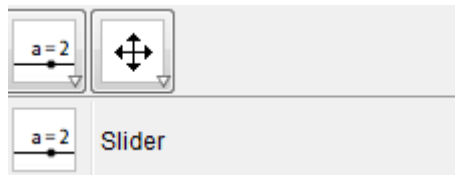
Can you introduce a “checkbox” to show/hide answers?

How could this idea be extended to produce “textbook” exercises for other number/algebra topics? E.g. decimal addition etc.

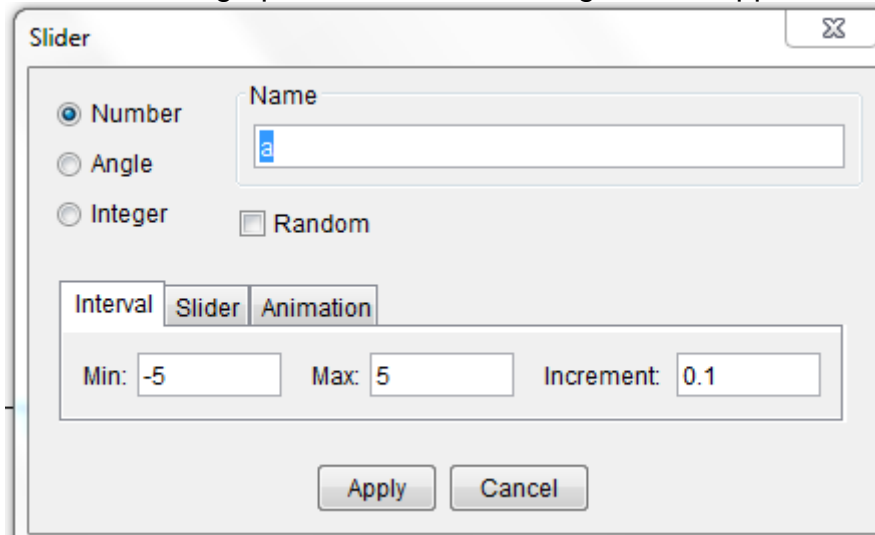
Could you easily differentiate the questions that are set?

Activity 3 Gradient and intercept for straight line graphs

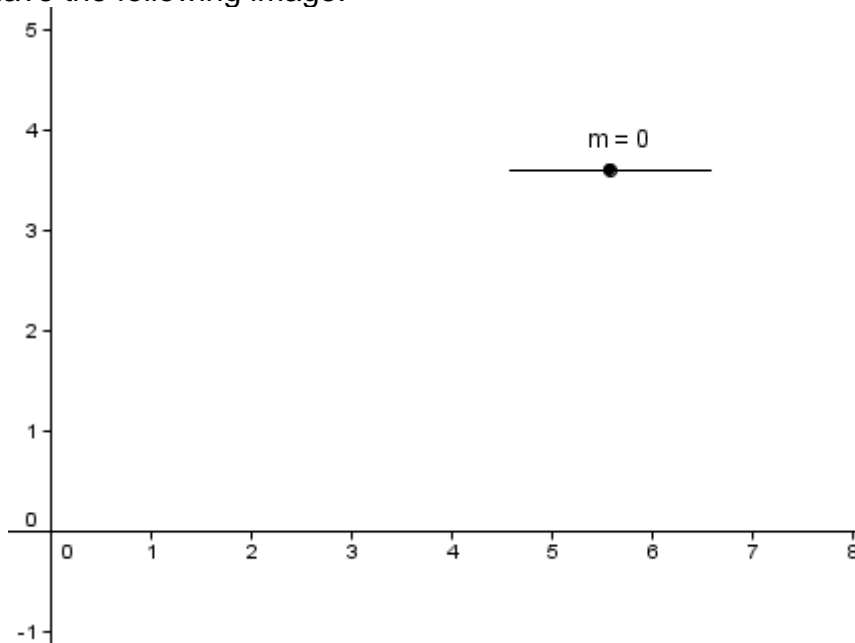
Select the *slider* tool.



When you click on the graphics view the following box will appear.



Note how you could create an angle slider or an integer slider. I am going to make my slider an integer from -3 to 3 and call it *m* in the *name* field. You should have the following image.



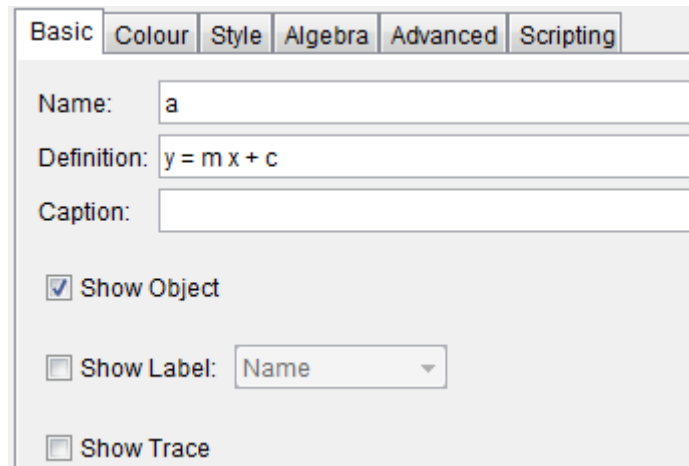
In the same way, create another integer slider called *c*. It is up to you what range you give for this slider. Now in the input bar type the following command

Input: $y=mx+c$

NOTE: You might need spaces between m and x in some versions of GeoGebra.

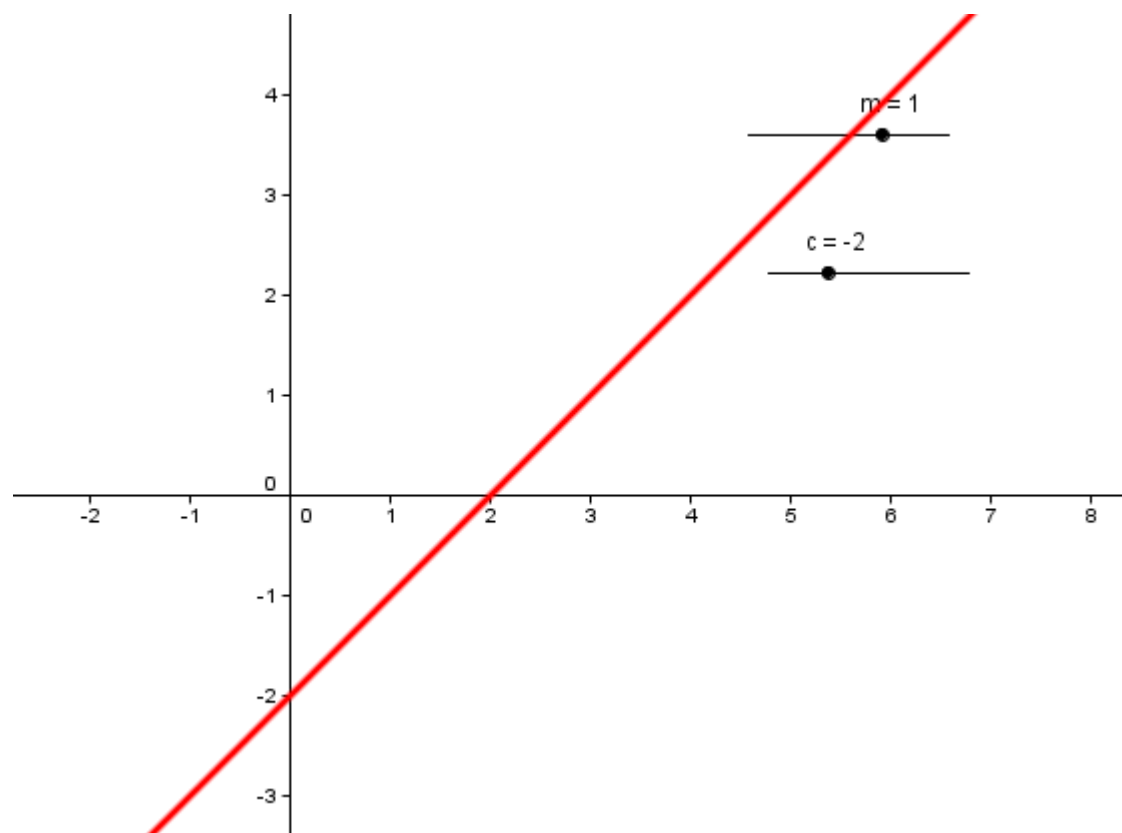
You should now see a line appear in the graphics view. Move the sliders and see what happens.

If you want to modify the appearance of your line i.e. change the colour and make it thicker, right click on the line itself and select *object properties*.

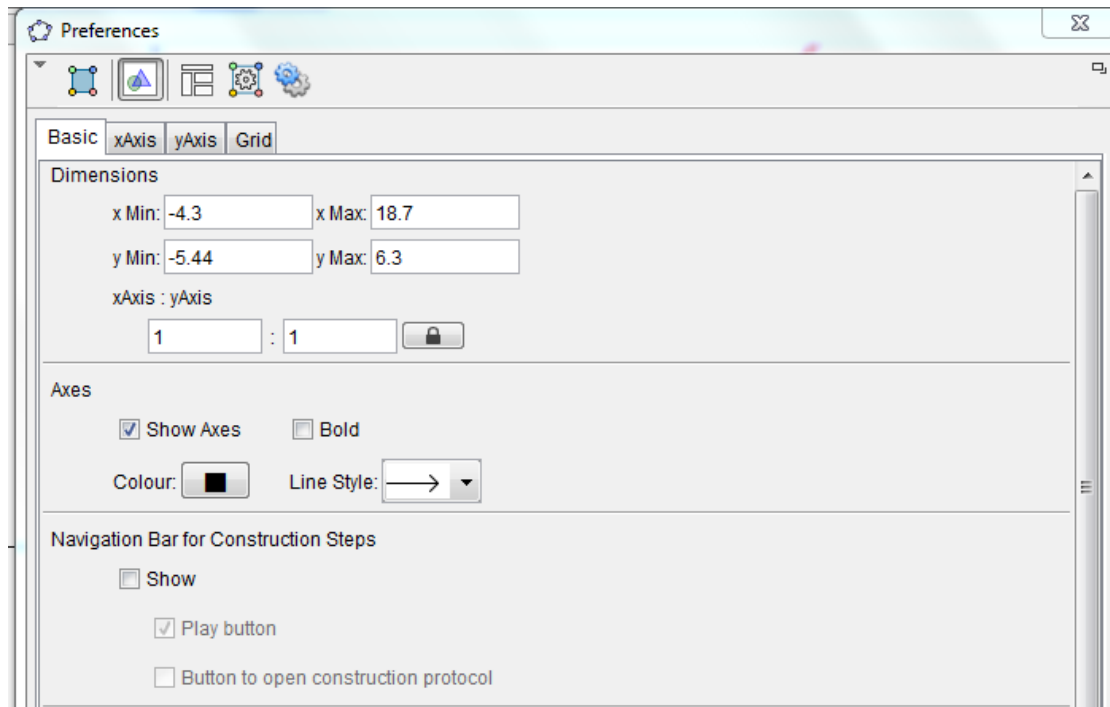


The screenshot shows the 'Object Properties' dialog for a line in GeoGebra. The 'Basic' tab is selected, and the 'Name' field contains 'a'. The 'Definition' field contains the equation $y = m x + c$. The 'Caption' field is empty. There are three checkboxes: 'Show Object' is checked, 'Show Label' is unchecked with a dropdown menu set to 'Name', and 'Show Trace' is unchecked.

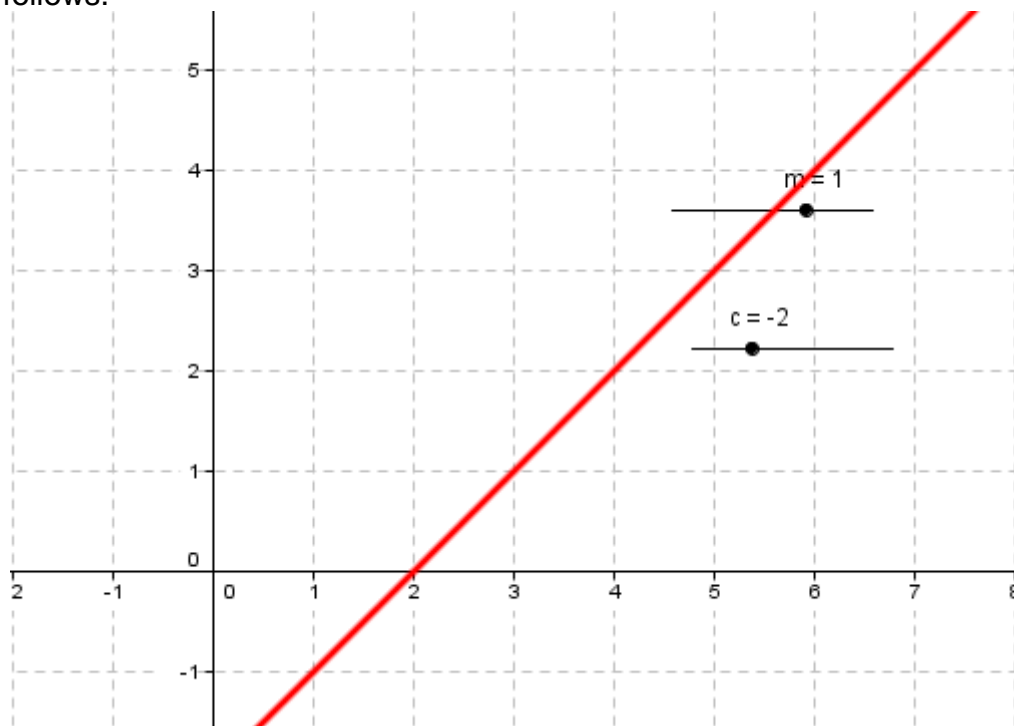
By selecting the colour and style tabs you should be able to change the appearance of your line with ease. Here is my file.



When dealing with gradients it would be helpful to have a grid displayed. To do this go to the *view* menu then select *layout*. You should see the following prompt box.



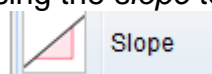
Select the grid tab and then tick the *show grid* box. Your file should now look as follows.



Extension

How could you modify this file to look at gradients of parallel and also perpendicular lines?

Could you show the gradient using the *slope* tool?



How could you use the random between command (see activity 2) to make your line automatically change when you press F9?

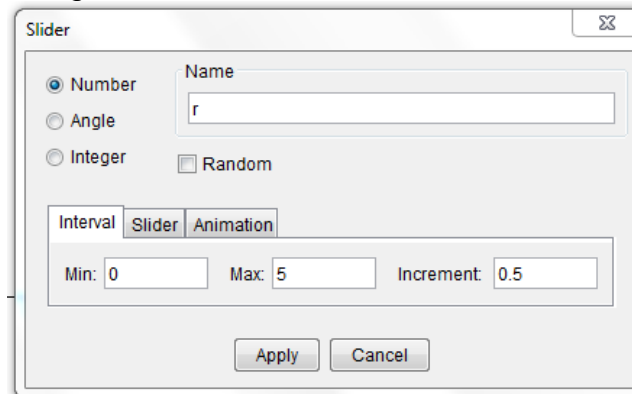
Could you create a similar file for quadratic graphs using sliders to change coefficients?

Activity 4 Area and circumference of a circle

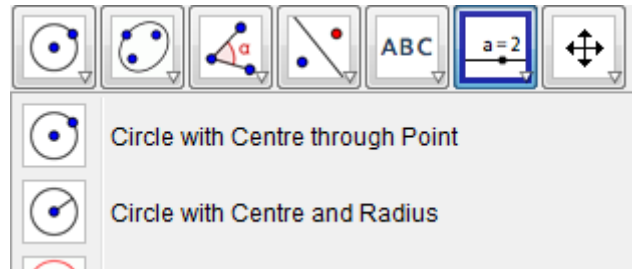
Use the *slider* tool to create a new slider.



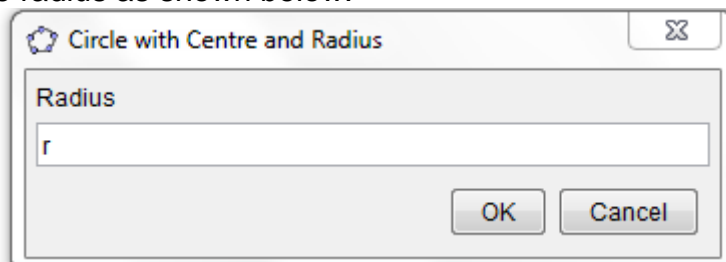
Set your slider to range between 0 and 5 in increments of 0.5. Call it r.



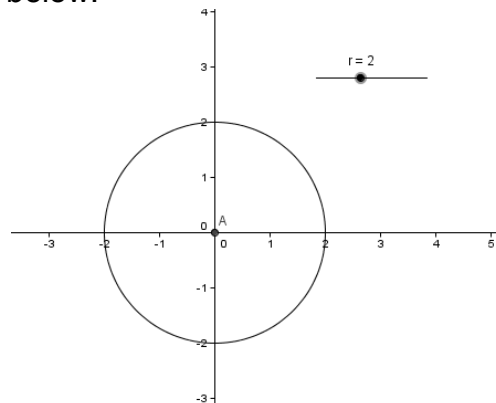
Now use the *circle with centre and radius* tool to create a circle.



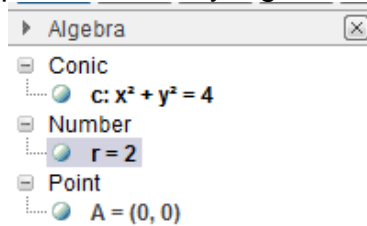
Click on the origin to create the centre and when the prompt box appears enter r for the radius as shown below.



Now move your slider and note how the circle changes. You should have a file similar to the one below.



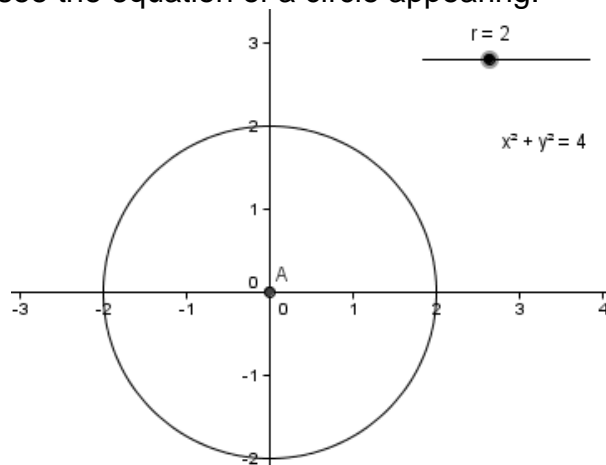
You may now want to improve the existing file to give some more information. First we are going to include the equation of the circle. You will need to make sure the *algebra view* is open. Here is my algebra view.



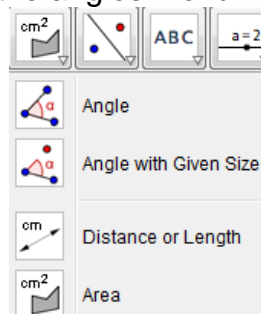
In my algebra view the circle is called c. In the input bar enter the following command **text[c]**.

Input:

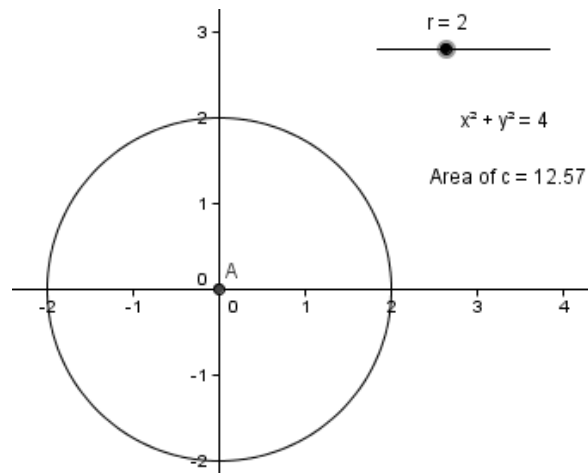
You should now see the equation of a circle appearing.



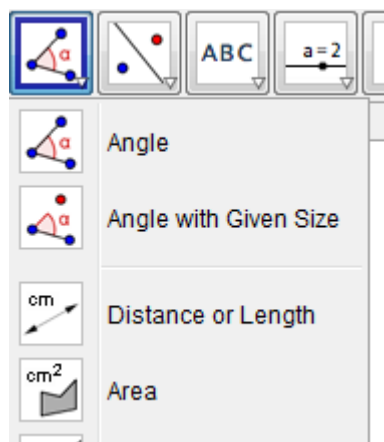
Now use the *area* tool under the angles menu



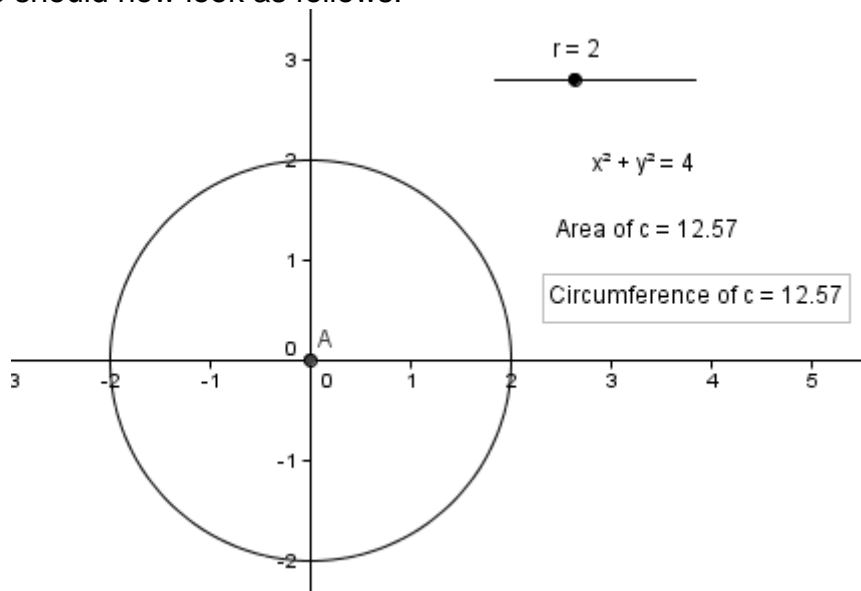
and click on your circle in the graphics screen. You should now see the area appear as text. As you move the slider watch the area change.



Using the *distance/length* tool, click on your circle to add another text box with the circumference.



Your file should now look as follows.



Extension

Introduce check boxes to show and hide the area/equation of the circle etc. Can you add a text box that shows the working needed to calculate the area and perimeter of a circle?