Project Maths Tionscadal Mata
Development Team

National Centre for Technology in Education
Ionad Náisiúnta don Teicneolaíocht san Oideachas

NCTE PROFESSIONAL DEVELOPMENT

ICT AND MATHS – PART 2

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www.projectmaths.ie

Please note

- A support wiki, NCTE ICT and Maths 2 Support Wiki, is a companion to the course. It is available at: www.ncte.ie/ictmathswiki. Each participant will need to Request Access to join the wiki, details can be found in Appendix C.
- Participants are invited to share their own developed GeoGebra resources with other course participants in the Teachers Uploads area on the NCTE support wiki. Any work shared must be the original work of the participant uploading to the wiki. All participant uploads to the NCTE ICT and Maths 2 Support Wiki are subject to the conditions of this Creative Commons CCO 'No rights Reserved' license: http://wiki.creativecommons.org/CC0_FAQ. You may only upload files in the NCTE ICT and Maths Support Wiki that are compatible with this license which allows free use, free distribution, derivative work by others and the waiving of all copyright.
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- All linked pages on other web servers are subject to the copyright policies of those web servers. The NCTE disclaims any liability for contents in the ICT and Maths 2 Support Wiki added by others.
- Screenshots software titles used throughout the manual are from a PC using Windows Vista© and may appear different from those on computer screens used by participants.
- The World Wide Web is constantly evolving and content and URLs (Universal Resource Locators - website addresses) change over time. It is possible that the content located at some of the URLs listed throughout this manual may change over time.

Throughout this manual, course and the NCTE ICT and Maths *2* Support Wiki reference may be made to software titles and suppliers of Internet services. These references are made purely to illustrate or expound course content. Any such reference does not imply any endorsement by the NCTE of a product or company. The reader should be aware that typically there are many products and companies providing similar services in areas related to ICT.

Participants should be as informed as possible before making decisions on purchases of ICT products or services, see NCTE advice *www.ncte.ie/*ictgra*nt2010postprimary* and Schools ICT Procurement Frameworks advice *www.ncte.ie/ICTAdviceSupport/Purchasing.*

ICT AND MATHS – PART 2

USING DYNAMIC MATHEMATICS SOFTWARE TO SUPPORT THE TEACHING OF STRANDS 3, 4 AND 5

TABLE OF CONTENTS

COURSE OVERVIEW

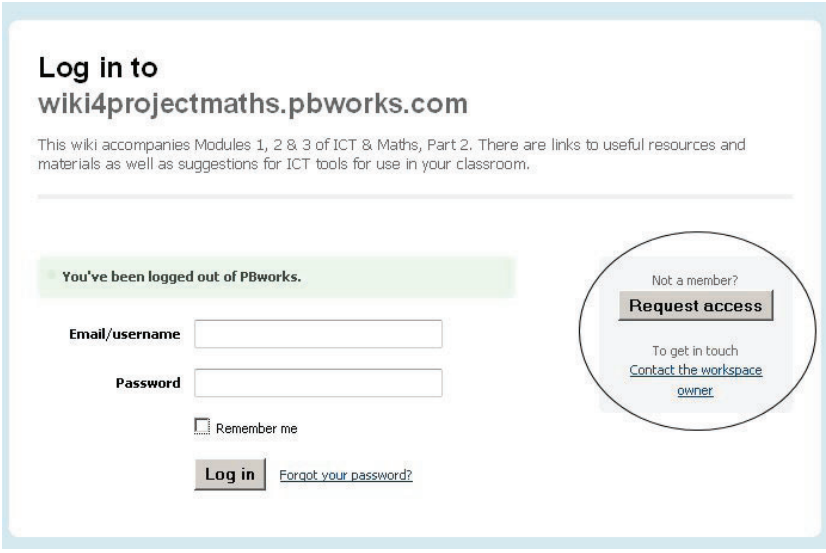
This 7.5 hour course is the second in a series of ICT and Maths courses presented by NCTE and Project Maths Development Team on the use of the free dynamic mathematics software, GeoGebra, to support the teaching of Strands 3, 4 and 5 of the post primary curriculum. The course will be delivered in three modules each consisting 2.5 hours. The purpose of the course is to enable teachers to effectively use GeoGebra as an aid to teaching Strand 3 (Number) Strand 4 (Algebra) and Strand 5 (Functions).

Module 1 consists of materials to support the teaching of Strands 3 and 4. Module 2 consists of materials to support the teaching of Strands 3, 4 and 5 while Module 3 consists of materials to support the teaching of Strand 5. Participants will have undertaken the first **ICT and Maths** course or will have a good understanding of using GeoGebra in the post primary curriculum.

Each participant will need to download GeoGebra and Java to take part in the course. The GeoGebra software package is available free at *http://www.geogebra.org/cms/*. It is recommended that the Download GeoGebra version be used, rather than the GeoGebra Webstart version. The notes and screenshots in the manual are based on Version 3.2.46.0 and the GeoGebra language used is English (UK). Instructions on changing the language used by the application are in Appendix A.

In order for GeoGebra to work on a computer, one also needs the latest version of Java; this is available free at *http://www.java.com/en/*. See Appendix B.

The Course Support Wiki at *www.ncte.ie/ictmathswiki* contains weblinks, videos, examples, and best practice of ICT and Maths as well as a Teachers' Uploads area so participants can share their work. For directions on how to request access to the course wiki see Appendix C.



Guides to the GeoGebra Interface, Toolbars and Drop-down Menus can be found in Appendix D while a guide to finding special keys on the keyboard used in constructions is located in Appendix F.

Instructions on saving GeoGebra files can be found in Appendix G and the steps to viewing a construction are in Appendix H.

COURSE OBJECTIVES

DURATION

7.5 hours (3 X 2.5 hour modules)

OBJECTIVES

This course aims to enable the participant to effectively use dynamic mathematics software to:

- **Teach Strand 3 (Number)**
- **Teach Strand 4 (Algebra)**
- **Teach Strand 5 (Functions)**

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ICT AND MATHS – PART 2

MODULE 1

MODULE 1

USING ICT AND MATHEMATICS SOFTWARE TO TEACH NUMBER AND ALGEBRA (STRANDS 3 AND 4)

DURATION

2.5 hours

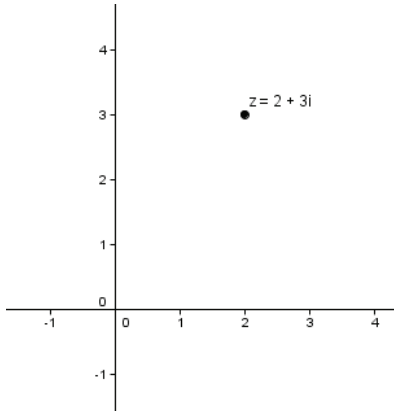
OBJECTIVES

This module aims to enable the participant to use ICT mathematics software to:

- >> Make the co-ordinates appear in complex format.
- >> Label the axes Real and Imaginary.
- >> Show the Modulus of a complex number.
- >> Demonstrate the addition of complex numbers.
- >> Demonstrate the complex conjugate.
- >> Demonstrate that multiplication by i rotates any complex number by 90°
- >> Show the value of i^n
- >> Demonstrate the fact that adding a complex number is the equivalent to a translation.
- >> Show a Number Line.
- >> Enable the x axis to show a tick at each whole number
- >> Demonstrate Integers on the Number Line.
- >> Demonstrate Decimal Numbers on the Number Line.
- >> Demonstrate a Linear Pattern.
- >> Change the colour, width etc. of the line.
- >> Draw only the section of the line beyond where it cuts the y axis.
- >> Draw a line to represent the growth pattern of a plant.

Note: At the end of each activity save each file.

ACTIVITY 1: HOW TO MAKE THE CO-ORDINATES APPEAR IN COMPLEX FORMAT



1. **Open GeoGebra.**

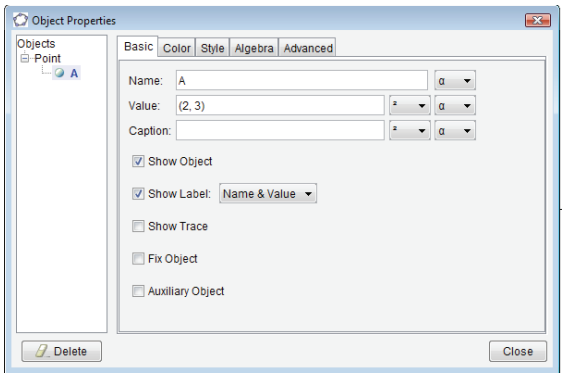
Method 1:

2. In the **Input Bar type** the real and imaginary part of the complex number for example **2+3i** and **press Enter. Note:** The points will be called z, z_1 etc.

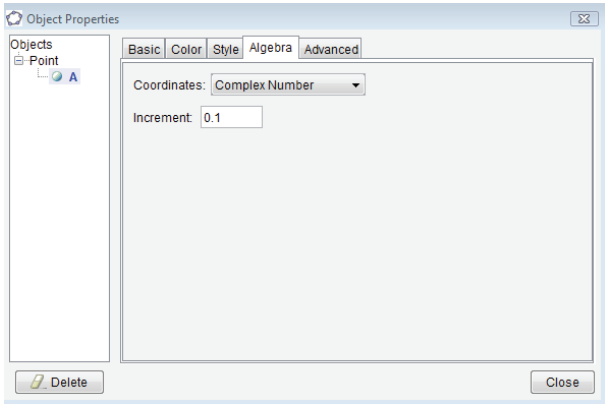
3. **Right click** the **point** and **choose Object Properties** and with the **Basic tab** open **click the Show Label** box and from the **Drop down menu click Name and Value.**
4. **Click Close.**

Method 2:

2. Alternatively **type (2,3)** in the **Input Bar** and **press Enter**. Then **Right click** on the point, **choose Object Properties** and with the **Basic tab** open **click the Show Label box** and from the **drop down menu click Name and Value. Note:** The points will be called A, B etc.



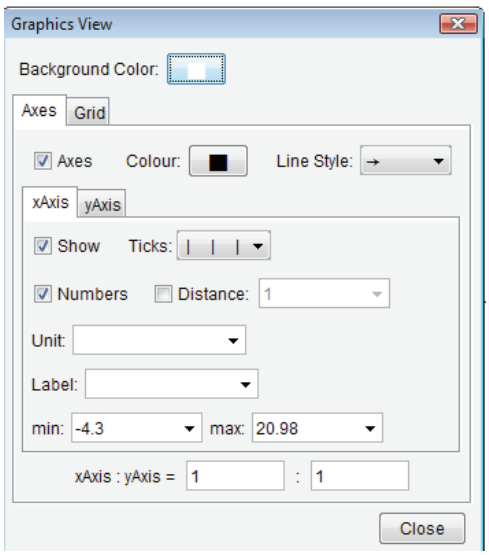
3. With the **Object Properties** box still on display, open the **Algebra tab** and from the **Drop Down Menu** at **Coordinates box** choose **Complex Number.**



4. **Click Close.**

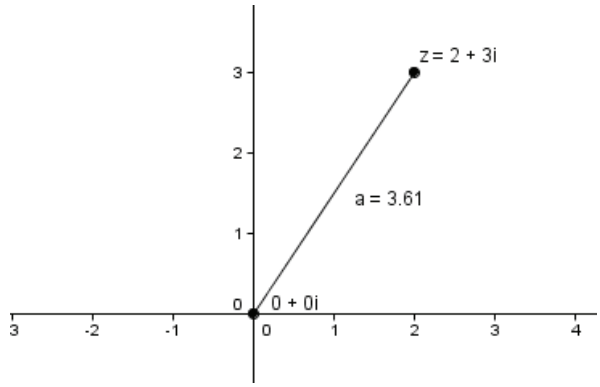
ACTIVITY 2: HOW TO LABEL THE AXES REAL AND IMAGINARY

1. **Go to File** and **choose New Window**.
2. **Right click** on the **Graphics View** and choose **Graphics View** and a new dialogue box appears.



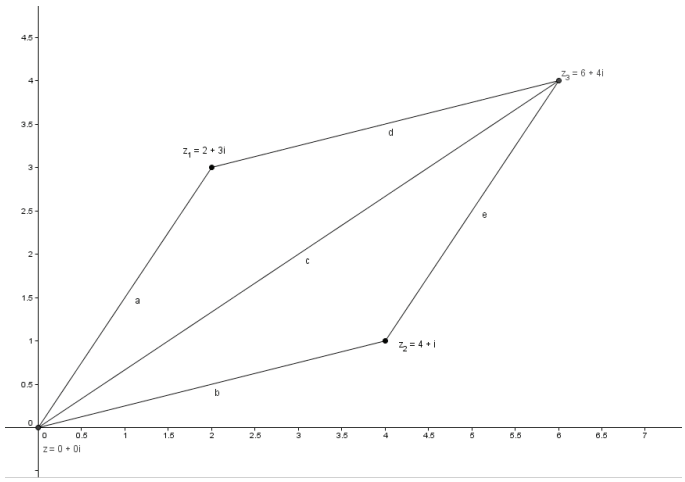
3. **Click** on the **xAxis tab** and in the **Label box** type **Real.**
4. **Click** on the **yAxis tab** and in the **Label box** type **Imaginary**.
5. **Click Close**.

ACTIVITY 3: TO SHOW THE MODULUS OF A COMPLEX NUMBER



1. **Go to File** and **choose New Window**.
2. **Plot** a **complex number of your choice** and the **origin**.
3. **Select** the **Segment between Two Points tool**  . **Click** on **the origin** and the **point representing the complex number** to **draw** a **line segment** from the **origin** to the **complex number.**
4. **Right click** on the **line segment** and **choose Object Properties**. With the **basic tab open click** the **show Label box** and from the **drop down menu choose Value.**
5. **Click Close**. **Move** the **complex number** to **see** the **modulus change**.

ACTIVITY 4: TO DEMONSTRATE THE ADDITION OF COMPLEX NUMBERS

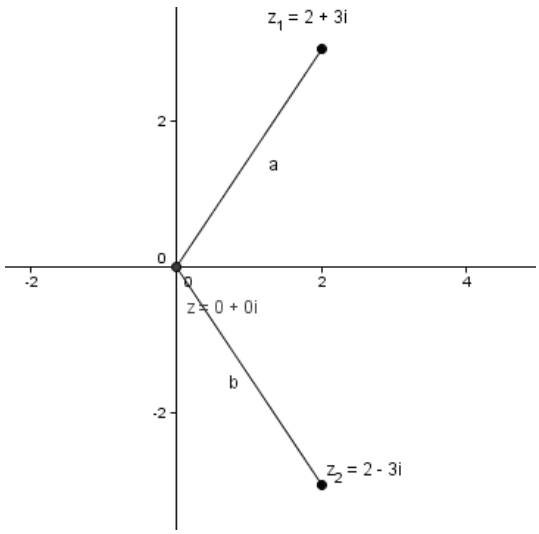


1. **Go to File** and **choose New Window**.
2. **Plot** the following **complex numbers z = 0 + 0i** by typing **z=0+0i** in the **Input Bar.**
3. **Plot** the **2 complex numbers** z_1 and z_2 you want to **add** for **example** z_1**= 2 + 3i** and z_2 **= 4 + i**. **Note**: For z_1 type **z_1=2+3i** in the **Input Bar**.
4. **Select** the **Segment between Two Points tool**  . **Draw** a **line segment** a from **the origin** to z_1 and a **line segment** b from the **origin** to z_2.
5. **In the Input Bar type z_1+z_2**.

Note: For z_1 **type z_1** using the **Input Bar method**. This will result in a **new point** z_3 appearing on the **Graphics View** which is equal to z_1+z_2.

6. **Select** the **Segment between Two Points tool**  . **Click** on **z** and z_3 to **draw** a **line segment** c from **z** to z_3.
7. **Select** the **Segment between Two Points tool**  . **Click on** z_1 **and** z_3 to **draw** a **line segment** d from z_1 to z_3.
8. **Select** the **Segment between Two Points tool**  . **Click** on z_2 **and** z_3 to **draw** a **line segment** e from z_2 to z_3.
9. **Move** z_1 or z_2 to see that the **addition of complex numbers** always **forms** a **parallelogram**.

ACTIVITY 5: TO DEMONSTRATE THE COMPLEX CONJUGATE

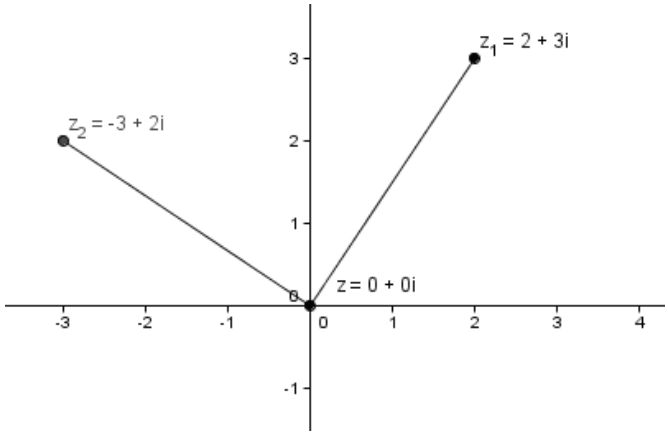


1. **Go to File** and **choose New Window**.
2. **Plot** the **complex number z = 0 + 0i**.
3. **Plot** the **complex number** that you wish to find the **conjugate of** for example $z_1 = 2 + 3i$.
4. **Select** the **Segment between 2 Points Tool**  to **draw** a **line segment a from z to** z_1.
5. **Select** the **Reflect Object in Line tool**  to **reflect the point** z_1 in the **Real Axis. Click the point** z_1 **and the Real axis.** This results in the complex number z_2 which is the complex conjugate of z_1.
6. **Select** the **Segment between 2 Points Tool**  and select the **origin** and z_2. This **draws** a **line segment** from **the origin** to z_2.

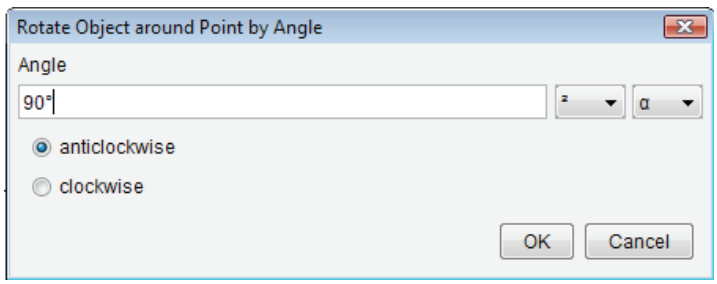
Note: **(i)** The **sum** of the **angles** z_1 and z_2 make with the real axis is **360°.**

(ii) In order to get $\overline{z_2}$ in a **textbox, type \overline{z_2}** in the textbox. **Click** the **LaTeX button** and **Click OK.**

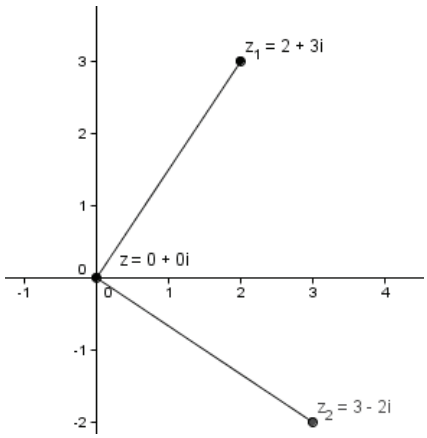
ACTIVITY 6: TO DEMONSTRATE THAT MULTIPLICATION BY i ROTATES ANY COMPLEX NUMBER BY 90°



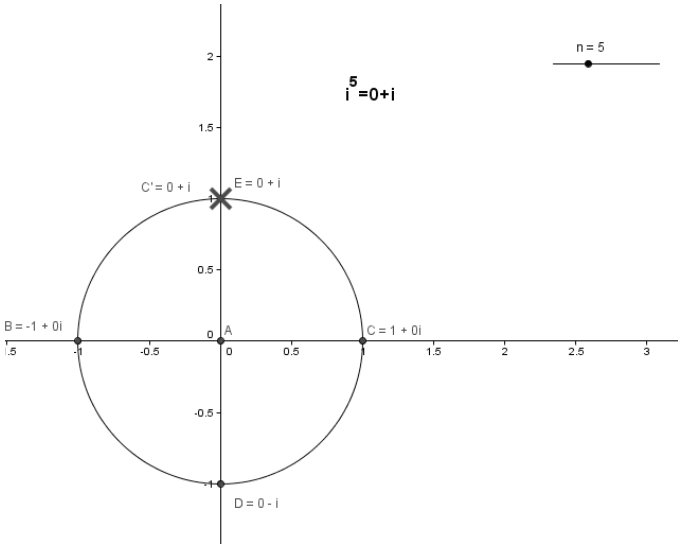
1. **Go to File** and **choose New Window**.
2. **Plot** the **complex number z = 0 + 0i**.
3. **Plot** the **complex number** you wish to **rotate**, for example **z_1 = 2 + 3i**.
4. **Select** the **Rotate Object around Point by Angle tool**  . **Click** on **z_1 and z.** A new dialogue box appears.



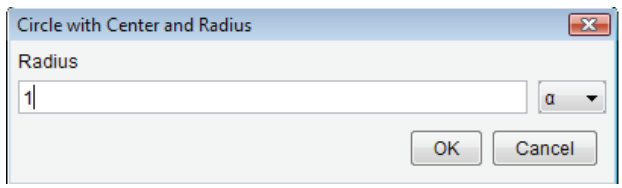
5. **Insert 90°** in the dialogue box and **click OK**. **Note: i(2+3i) = –3+2i** and also note if instead of **90°** we inserted **-90°** it would be the **same as division by i**.



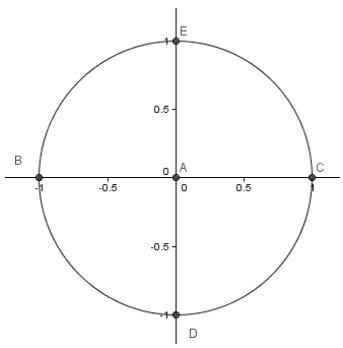
ACTIVITY 7: TO SHOW THE VALUE OF i^n



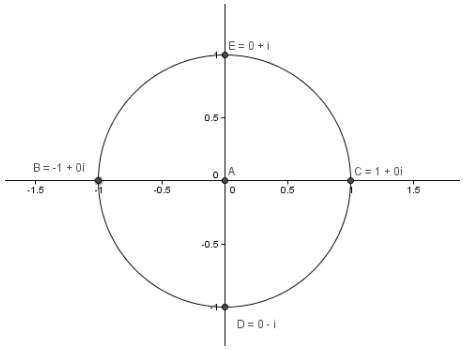
1. **Go to File** and **choose New Window**.
2. **Create** a **point** A to represent **the origin.**
3. **Select** the **Circle with Centre and Radius tool**  . **Click** on the **origin** and a **new dialogue box appears**. **Type 1** in this **dialogue box** to **draw** a **circle** at the **origin** with **radius 1.**



4. **Click OK.**
5. In order to make your drawing larger if necessary go to **the Zoom In tool**  and **click** on the **Graphics View**. **Note:** If your **mouse** has a **scroll wheel** you can use it to **zoom in and out**.
6. **Select** the **Intersection Two Objects tool**  . **Click** on the **circle** and **x axis** to find the **points of intersection of the circle** and the **x axis**
7. **Select** the **Intersection Two Objects tool**  . **Click** on the **circle** and the **y axis** to find the **points of intersection of the circle** and the **y axis.**
8. **Right click point B** and **select Object Properties**. With the **Algebra tab** open **select Complex Number**, with the **Basic Tab** open **click the Show Label** box and select **Name and Value** from the **drop down menu. Click Close.**

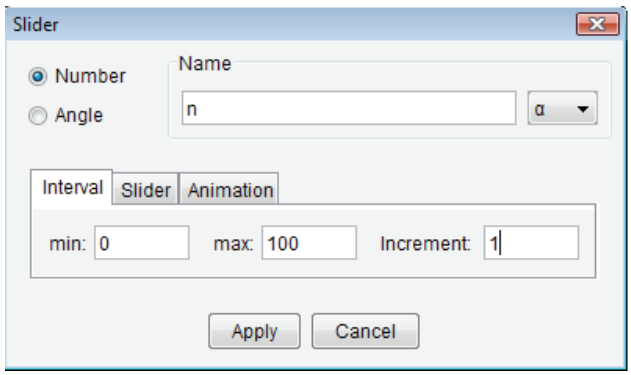


9. **Repeat** the **previous step** for points **C, D and E**.

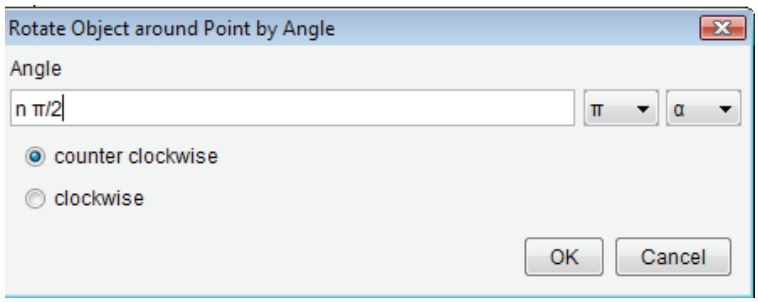


10. **Select the Slider tool** 

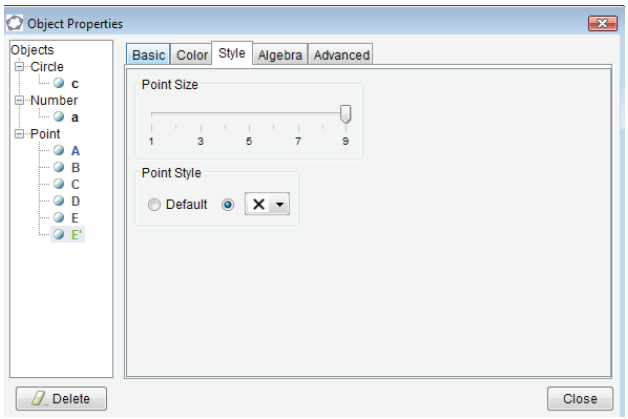
. Click on the Graphics View and create a **slider** called **n** with **min: = 0**, **max: = 100** and **Increment: = 1**.



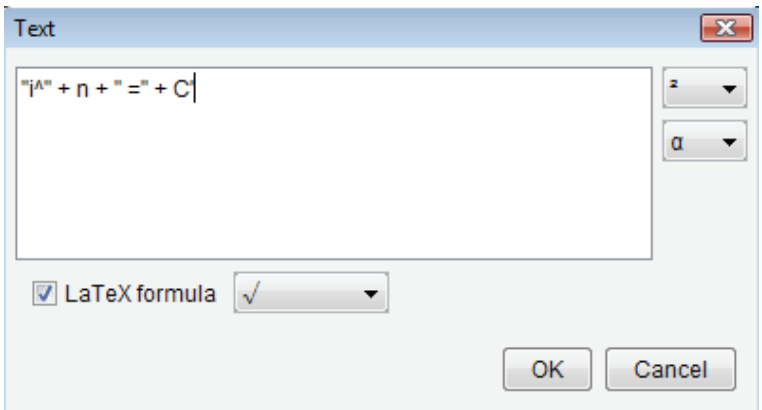
11. **Click Apply.**
12. **Select** the **Rotate Object around Point by Angle tool**  . **Click** the **point C** and the **point A.** A new window appears.



13. In this new window **type** "**n π/2**". Notice the symbol π can be got by following the **first drop down menu** in this new window. **Note:** There is a **space between** the **n** and the π .
14. **Click OK**. A new point **C'** appears at the **point E**.
15. **Right click** on the point **C'** and **choose Object Properties**, with the **Color tab** open **choose** a bright colour and with the **Style tab open choose Point Size 9** and **Point Style X** and with the **Algebra tab** open **choose Complex Number**.

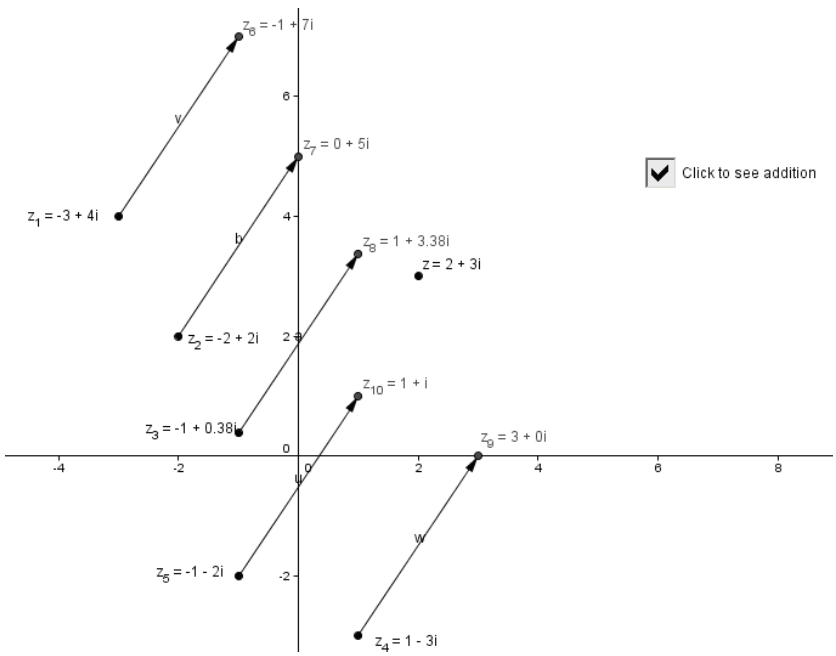


16. **Select the Move tool**  **move** the **slider** to **see** the **value of** i^n.
17. **Go** to **Insert Text tool**  and in the **new window** that appears **type "i^" + n + " =" + C'**



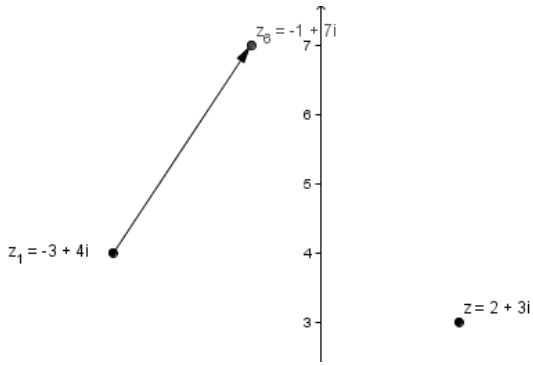
18. **Click** the **LaTeX box** and **click OK.**

ACTIVITY 8: TO DEMONSTRATE THE FACT THAT ADDING A COMPLEX NUMBER IS THE EQUIVALENT TO A TRANSLATION



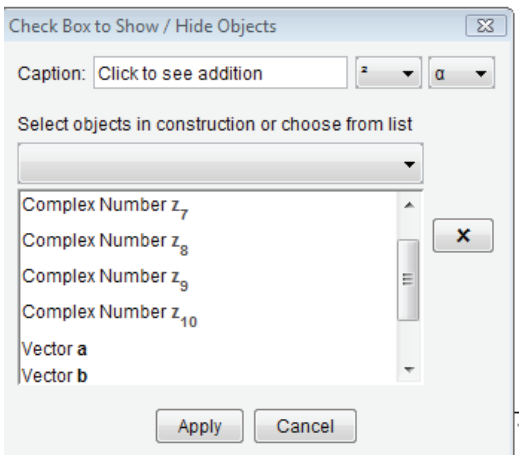
1. **Go to File** and **choose New Window**.
2. **Plot** a **complex number** for example **z= 2+3i** that you **wish to add** to all the **other complex numbers**.
3. **Create** at least **5 more complex numbers** called z_1, z_2, z_3, z_4 **and** z_5 on the **Graphics View**.
4. In the **Input Bar type z+z_1** and **press return**, this results in z_6, which is **equal** to $z + z_1$.

5 **Select** the **Vector between Two Points tool**  . **Click** on z_1 and z_6 to **draw** a **line segment with an arrow** between z_1 and z_6.



6. **Repeat** the **last two steps** for z_2, z_3, z_4 and z_5.
   Notes: **(i)** If some of the images do not appear on the screen you may have to use the **Zoom Out tool**  to **enlarge** the area of the **Graphics View** on view.

   (ii) A nice time saver here for the typing part is to **click your mouse** into the **Input Bar** and **use the up arrow key on your keyboard to see what you typed before** and it should be easy to change **z+z_1 to z+z_2.**
7. **Select** the **Check Box to Show/ Hide Objects tool**  . **Click** on the **Graphics View** and a new dialogue box will appear. Complete this dialogue box as follows. Type **Click to see Addition** in **the Caption and under Select objects in construction or choose from list pick** the 5 complex numbers z_6, z_7, z_8, z_9 **and** z_{10} formed by the additions and the **5 vectors.**

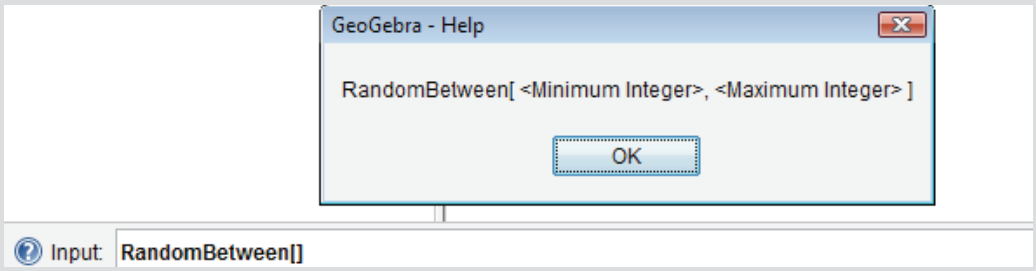


4. **Click Apply**.
   Note: To make a checkbox larger go to **Options** and **Click Checkbox** and then select Large.

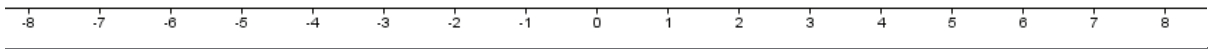
PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

To obtain help with any of the commands in the Input Bar.

***Select** the required command for example **RandomBetween[]** and **press F1** on the **keyboard** and this will tell you the format of the instructions needed with this particular tool.*



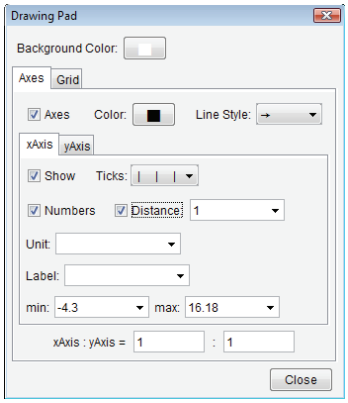
ACTIVITY 9: TO SHOW A NUMBER LINE



1. **Go to File** and **choose New Window**.
2. **Go to Options** and choose **Graphics View** or **right click** on the **Graphics View** and **choose Graphics View.**
3. With **the y axis tab open unclick** the **Show click box.**
4. **Click Close**.

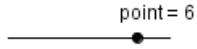
Activity 9.1: To Enable the X Axis to Show a Tick at Each Whole Number (Useful When You Zoom Out)

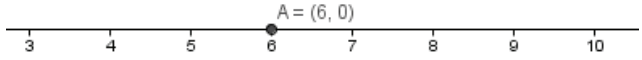
1. **Go to Options** and **choose Graphics View** or **right click** on the **Graphics View** and **choose Graphics View.**



2. With **the xAxis tab open**, **click** the **distance click box** and **insert 1** on the **box beside distance**.
3. **Click Close**.

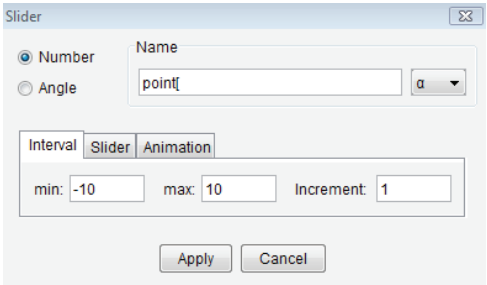
Activity 9.2: To demonstrate Integers on the Number Line





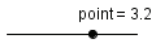
1. **Select the Slider tool** 

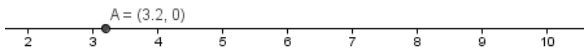
. Click on the Graphics View and create a **slider** called **point** with **min: = -10, max: = 10** and **increment: =1**.



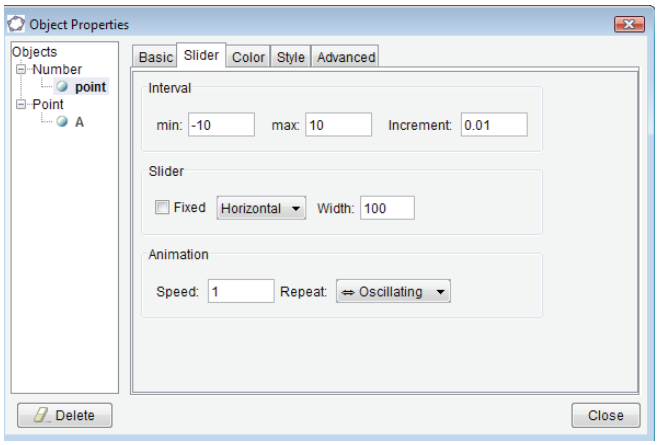
2. In the **Input Bar type (point, 0)** and **press Enter**. **A new point** called **A** appears on the **Number Line**.
3. **Use the Move tool**  to move the **slider** to see **the point** on the **Number Line change**.

ACTIVITY 10: TO DEMONSTRATE DECIMAL NUMBERS ON THE NUMBER LINE





1. **Go to File** and **choose New Window**.
2. **Repeat** as for **Activity 9** only make **the Increment** in the **slider a decimal for example 0.01**.

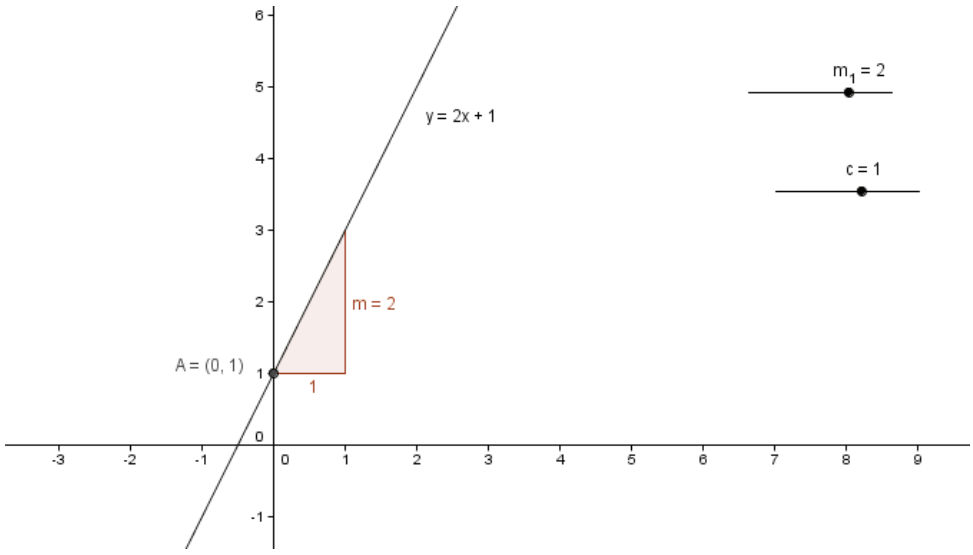


3. If you wish to increase **the scale** of the **Number Line** go to the **Move tool**  , **click** on **the x axis** and **drag to the right**.

Notes: **(i)** Using the **Move tool**  to **extend or squash the x-axis or y-axis** when **you have a quadratic/cubic function** can be very effective. It will make the function look like one a student in class might draw i.e. too short or too thin.

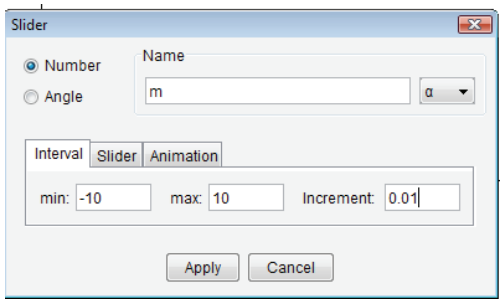
(ii) To adjust the circles which look like ellipses **Right-click the Graphics View** and click **Standard View** to correct this **or** set the **x axis:y axis** ratio to **1:1.**

ACTIVITY 11: TO DEMONSTRATE A LINEAR PATTERN

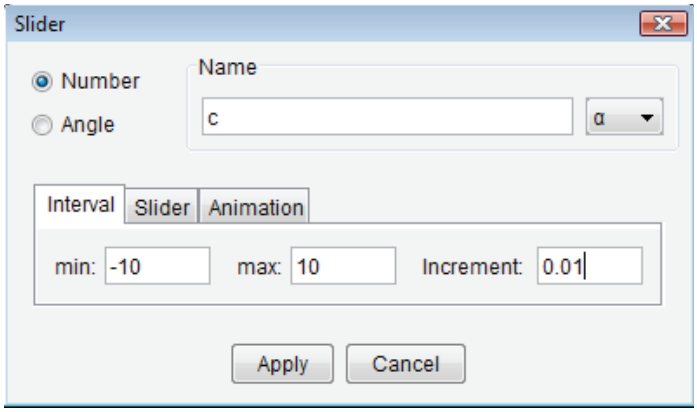


1. **Go to File** and **choose New Window**.

2. **Select the Slider tool**  . **Click on the Graphics View and create** a **slider** called **m** making sure to change the min, max and increment as shown in the diagram below.



3. **Select the Slider tool**  . **Click on the Graphics View and create** a **slider** called **c** making sure to change the min, max and increment as shown in the diagram below.

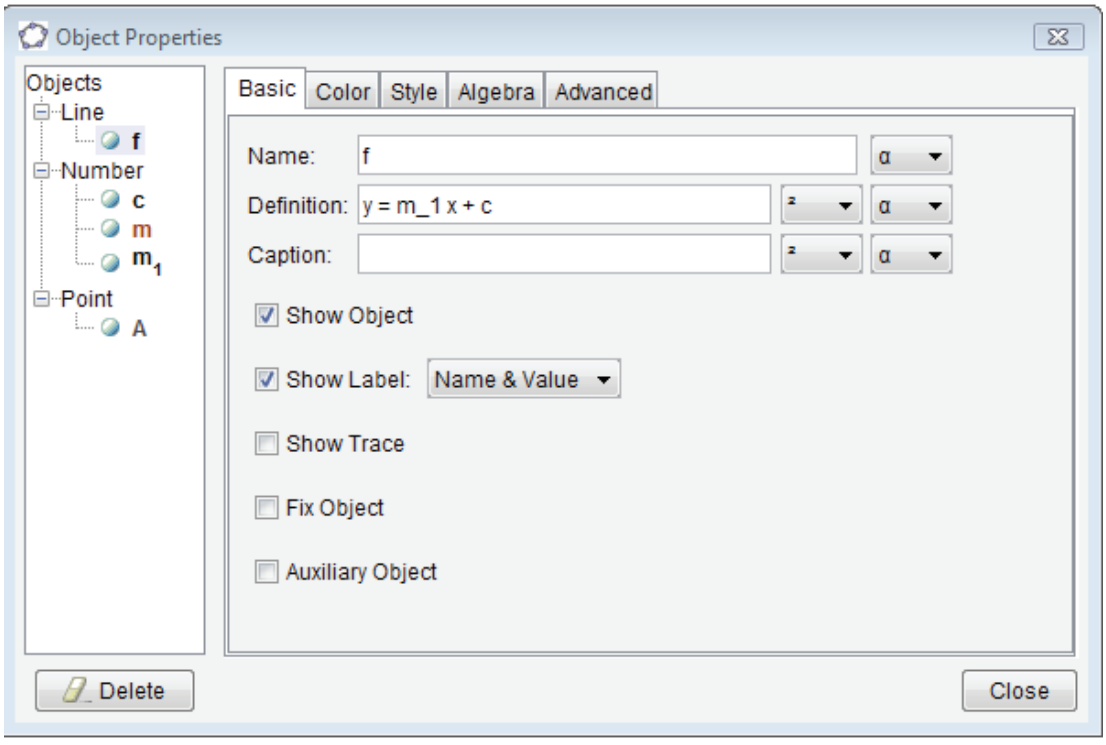


4. **Type y = m x+c** in the **Input Bar**. Note: The **space between** the **m** and the **x**.

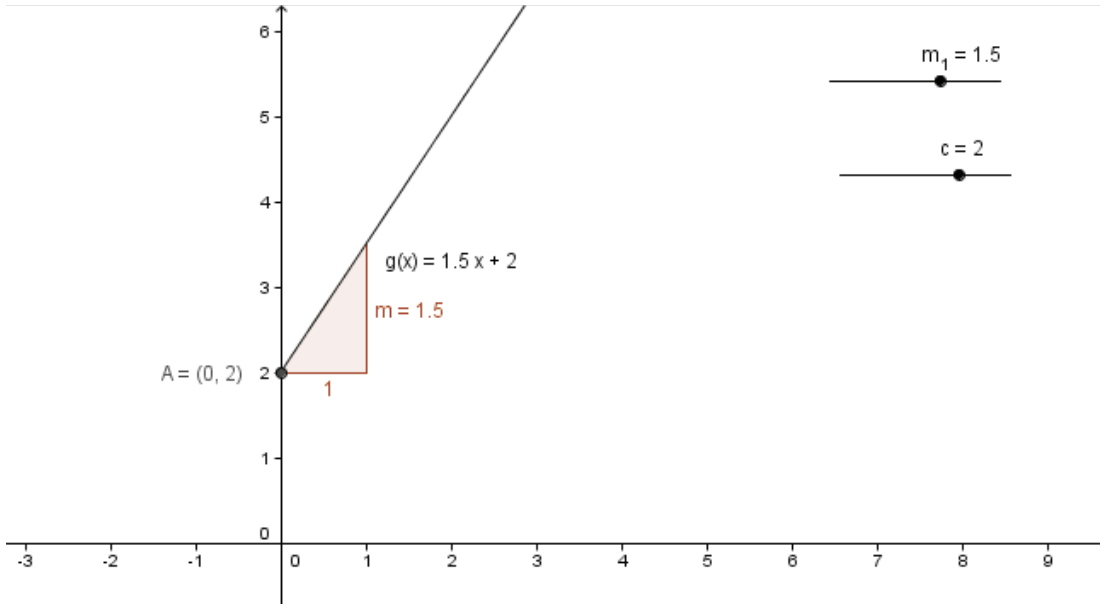
5. **Select** the **Intersect Two Objects tool**  and **click** on the **y axis** and the **line y to** give the **point A**.
6. **Move** the **slider c** and see the impact on the line. **Where does the line cut the y axis in each case?**
7. **Select** the **Slope tool**  and then **click** on the **line f** to **find** the **slope** of this line. What is the slope of this line? **Move** the **slider m** and **see** the **impact on the line**.
   Note: As **m** is always used for **slope your slider will now be called m_1** and **the slope will be called m**.

Activity 11.1 To change the colour, width etc. of the line

1. **Right click** on the **line**, **choose Object Properties** and **modify the colour, width etc.** of the **line** as required.



ACTIVITY 12: TO DRAW ONLY THE SECTION OF THE LINE BEYOND WHERE IT CUTS THE Y AXIS



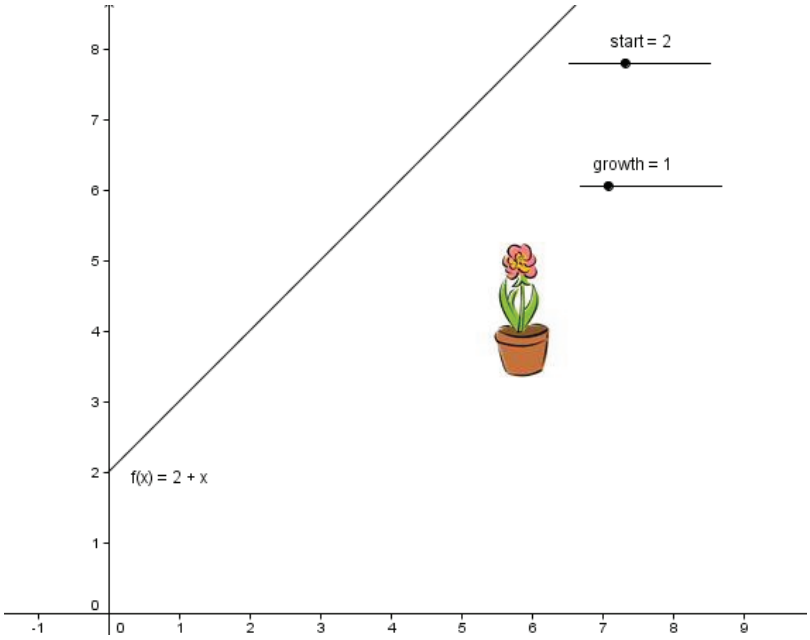
1. **Go to File** and **choose New Window**.
2. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **m** with **min: = -10, max: = 10** and **Increment: = 0.1.**
3. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **c** with **min: = -10**, **max: = 10** and **Increment: = 0.1.**
4. In the **Input Bar select** the **command Function[]** from the **drop down menu** at the **extreme right** of the **Input Bar.** Inside the brackets **type the function**, followed by **comma**, the value of *x* that you want as **the start value for the function**, followed by **comma** and the **end value of x**.

The **function** in the above example is m x +c.

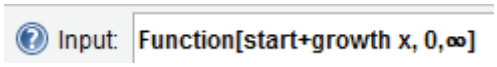
Notes: **(i)** There is a **space between** the **m** and the **x. 0** is the **start value** and ∞ is the **end value**. **The symbol** for ∞ can be found by following the **first drop down menu** on the **Input Bar**.

(ii) This command is very useful for **patterns when only the positive values of x** are **relevant**.

ACTIVITY 13: TO DRAW A LINE TO REPRESENT THE GROWTH PATTERN OF A PLANT



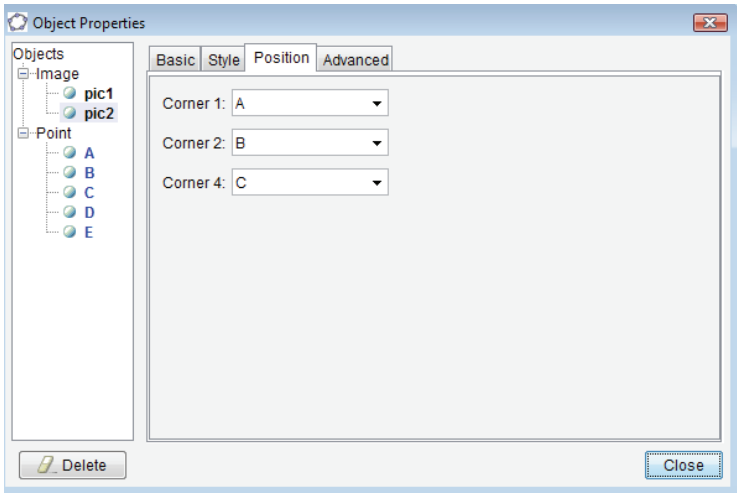
1. **Go to File** and **choose New Window**.
2. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called "**start**" to **represent** the **start height of the sunflower**.
3. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called "**growth**" to **represent** the **daily rate of growth per day for the sunflower**.
4. In the **Input Bar** select the **command Function[].** Inside the brackets **type start+growth x, 0, ∞ .** Note the space between growth and x. **Press enter**.

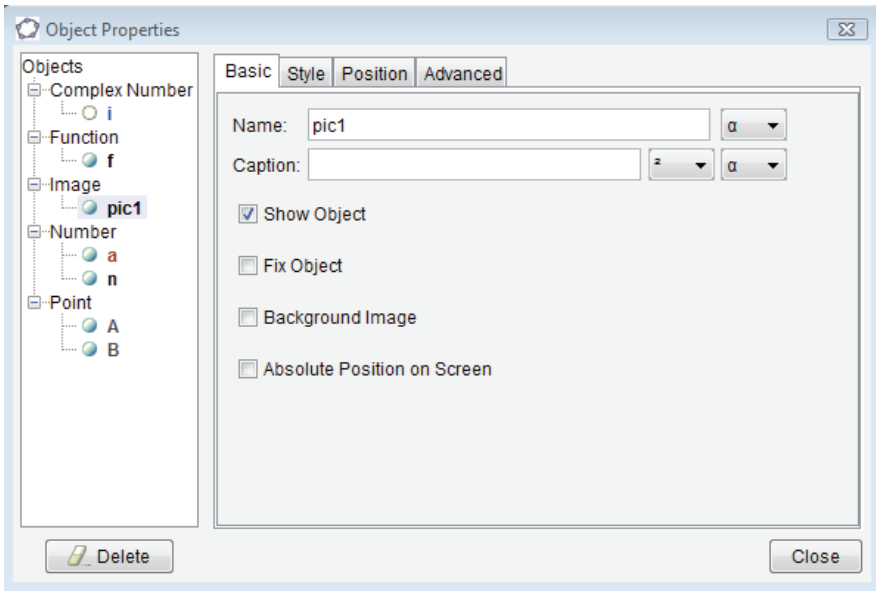
5. **Move** the **sliders** to **change the start height of the sunflower** and **the daily rate of growth of the sunflower**.
6. **Select** the **Insert Image tool**  and **click** on the **Graphics View**, where you require the **image** to be **located.**
7. **Browse to** the **location** in your computer where the required image is stored. **Click Open.**

   Notes: (i) If the image you inserted is too large: Create 3 points A, B and C on the Graphics View. Click on the **picture** and go to **Object Properties**. **Complete** the **new dialogue box** that appears **as follows** and **click close**. **To change** the **sizes move** the points **A, B** or **C**.

   (ii) Corner 1 is **bottom left. Corner 2** is **bottom right. Corner 4** is **top left.**



(iii) To insert a **picture as a background, insert** the **picture** in the **normal way, right click the picture** and **choose Object Properties** and with the **Basic tab open click Background Image and Close.**



PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

Take a moment in pairs to explore how you might use the materials in Module 1 with your students. Discuss how you might apply what you have learned in your classroom and share links to websites or web tools that you find useful.

Teaching ideas and suggestions:

Your Tutor will gather the group's ideas and suggestions and post them to the wiki **www.ncte.ie/ictmathswiki** where you will be able to share your teaching ideas with other Maths teachers.

Project Maths Tionscadal Mata Development Team

National Centre for Technology in Education
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NCTE PROFESSIONAL DEVELOPMENT

ICT AND MATHS – PART 2

MODULE 2

MODULE 2

USING ICT AND MATHEMATICS SOFTWARE TO TEACH NUMBER, ALGEBRA AND FUNCTION (STRANDS 3, 4 & 5)

DURATION

2.5 hours

OBJECTIVES

This module aims to enable the participant to use ICT mathematics software to:

- >> Demonstrate the use of the Trapezoidal Rule to find the approximate area between the curve and the x axis.
- >> Geometrically construct $\sqrt{2}$
- >> Geometrically construct $\sqrt{3}$
- >> Find the Highest Common Factor.
- >> Find the Least Common Multiple of 2 numbers.
- >> Draw a sphere.
- >> Draw a cone.
- >> Draw a cylinder.
- >> Demonstrate the Perimeter of an L-Shape.
- >> Draw the graph of a linear function.
- >> Animate the above line.
- >> Show the Trace of the above line.
- >> Remove the trace of an object.
- >> Change the colour, etc. of a line or curve.
- >> Draw a section of a function.
- >> Draw the graph of the quadratic function f(x) = (x+s) (x+t)
- >> Draw the graph of the quadratic function f(x) = ax2+bx+c
- >> Investigate a quadratic of the form f(x) = a*(x+b)^2+c
- >> Demonstrate the Turning points of a Quadratic.
- >> See how the equation of the curve changes as the sliders change or as the curve is dragged on the screen.

ACTIVITY 14: TO DEMONSTRATE THE USE OF THE TRAPEZOIDAL RULE TO FIND THE APPROXIMATE AREA BETWEEN THE CURVE AND THE X AXIS

Diagram 1

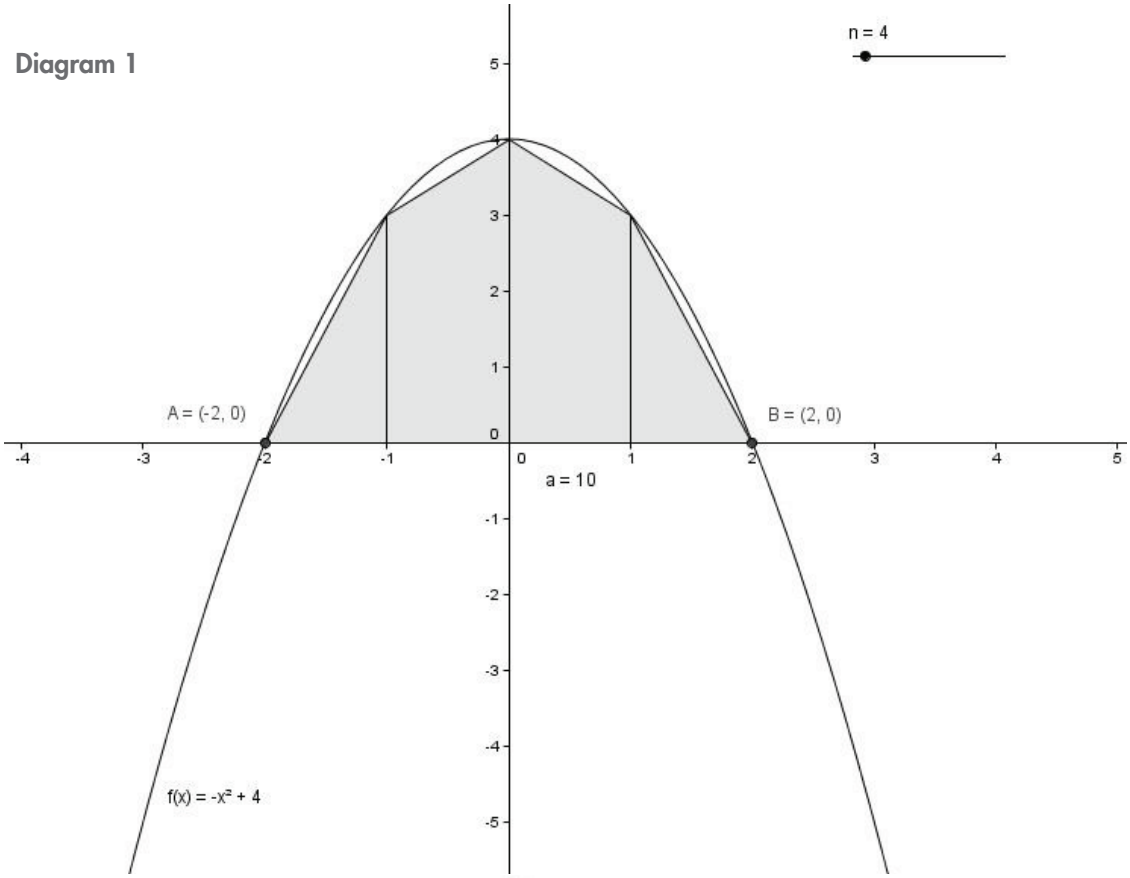
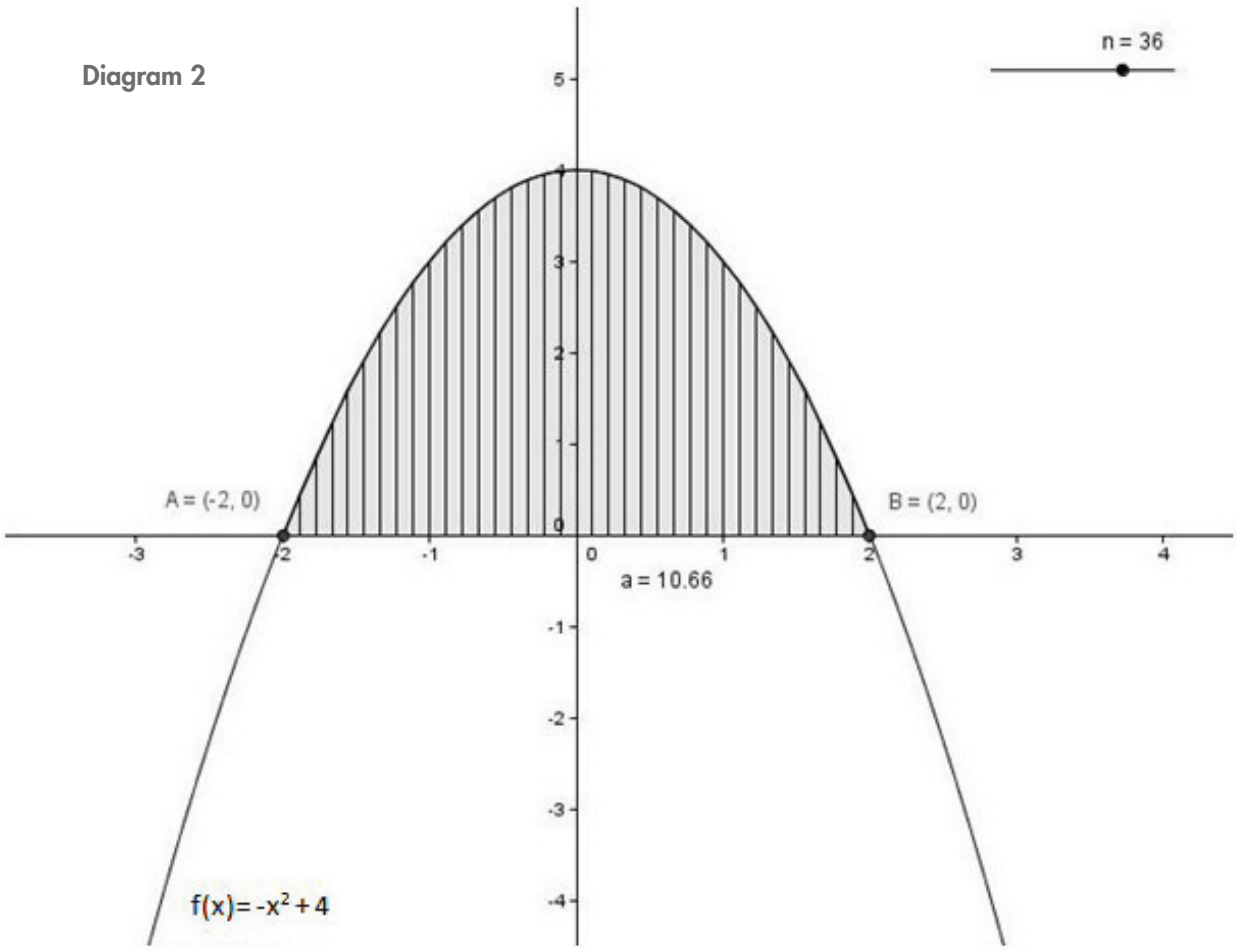


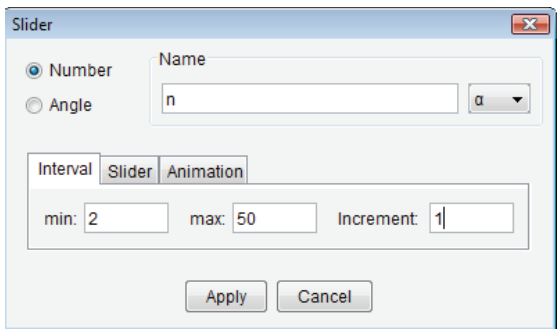
Diagram 2



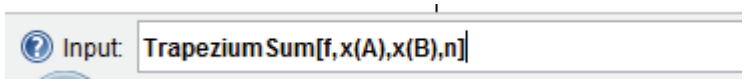
1. **Go to File** and **choose New Window**.
2. In the **Input Bar type the algebraic form of the function** you want to **create.** For example **-x^2+4** to **create** the **function f(x)= -x²+4.**
3. Select the **Intersect Two Objects tool**  **Click f** and the **x axis** to **find** the **intersection** of **f** and the **x axis**.

   Alternatively: **Type root[f]** in the **Input Bar** and **press Enter**.
4. **Select the Slider tool.** 

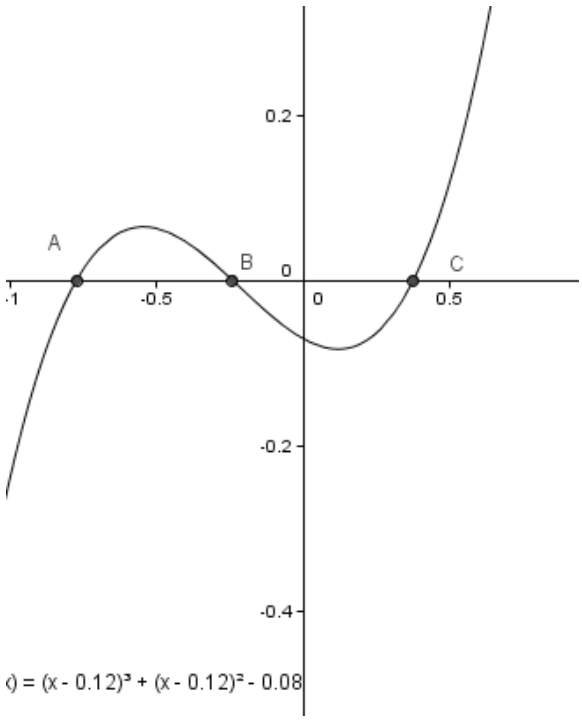
Click on the Graphics View and create a **slider** called **n** with **min: = 2**, **max: = 50** and **Increment: = 1** to represent the number of **trapezoids.**



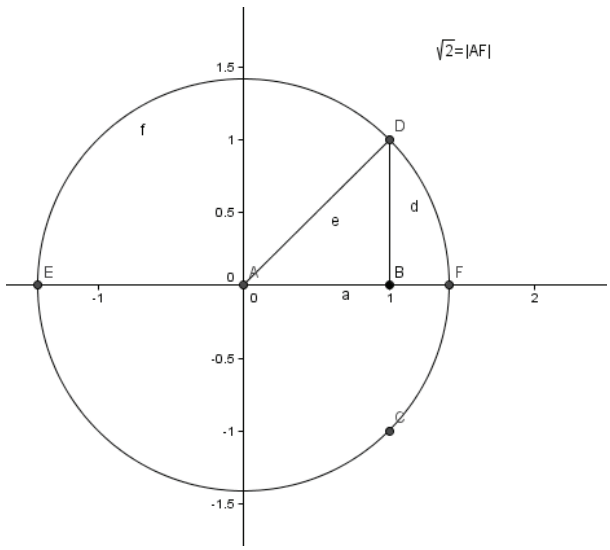
5. In the **Input Bar choose** the command **TrapeziumSum[].**
6. In the **square brackets insert** the **f,x(A),x(B),n.** Where **f** is the **equation** of the **semicircle**, the **beginning point**, **x(A)** is the **x coordinate** of **A**, **x(B)** is the **x coordinate** of **B** the **end point** and **n** is the **number of trapezoidals**.
   Note: Take note of the **order** of **A** and **B otherwise** you get a **negative area**.



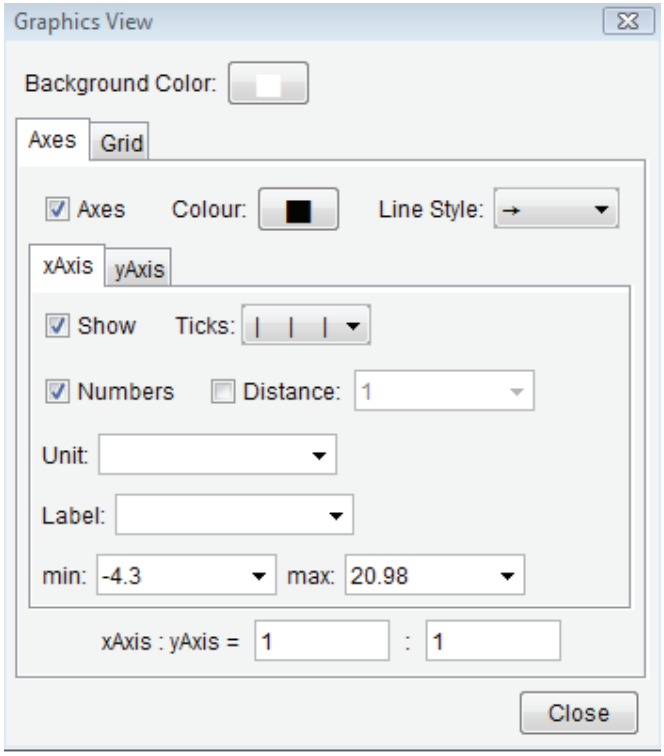
7. **Press Apply.**
8. **Move** the **slider n** to **5** so that the **trapezoids appear**.
9. **Go** to **Options in the Menu, Rounding** and **choose 5 Decimal places.**
10. **Move** the **slider n** and **watch the value** of **a** change that is the **area between the curve** and the **x axis starting** at **B** and **going** to **A**.
    Note: Watch out if the **curve** has a **section above the x axis** and a **section below the x axis**. In this case one gets the **area between B** and **C**, **then** the **area between A and B** and then **adds the two areas**.



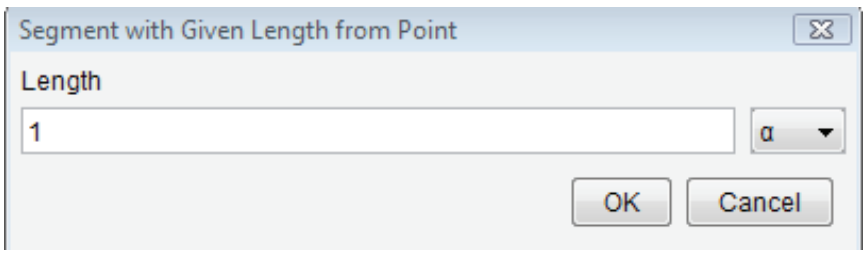
ACTIVITY 15: TO GEOMETRICALLY CONSTRUCT $\sqrt{2}$



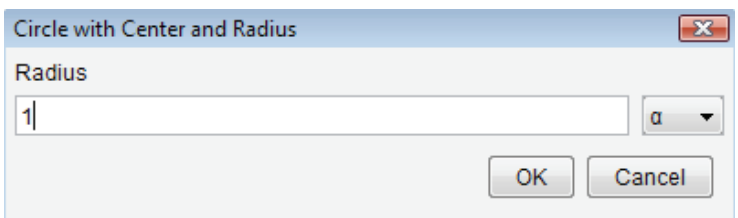
1. **Go to File** and **choose New Window**.
2. **Right click on the Graphics View, choose Graphic View** and **set** the **xAxis:yAxis ratio** to **1:1**.



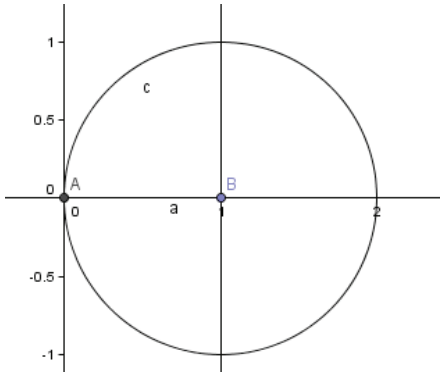
3. **Click close.**
4. **Select** the **Intersect Two Objects tool**  and **select** the **x axis** and the **y axis** to find the **point A** i.e. the origin**.**
5. **Select** the **Segment with Given Length from Point tool**  . **Click** on the **point A.** In the **new dialogue box** that appears **insert 1**. **Click OK**. A new **line segment a** and a **point B** has been **created**.



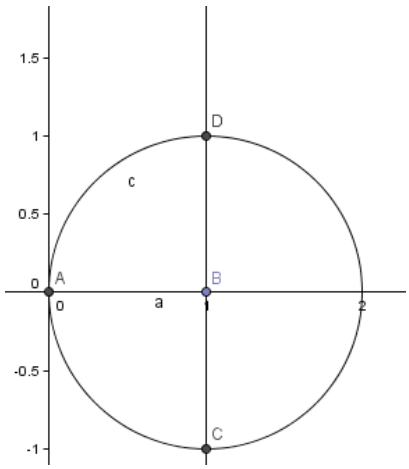
6. **Select** the **Perpendicular Line tool**  . **Click** on the **x axis** and the **point B** to **draw** a **line b perpendicular** to the **x axis at B**.
7. **Select** the **Circle with Centre and Radius tool**  . **Click** on the **point B** to **draw** a **circle c** with **centre** at the **point B**. **Insert 1** for the **radius** in the **new dialogue box** that **appears**.



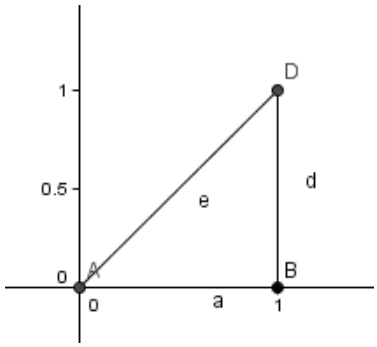
8. **Click OK**.



9. **Select** the **Intersect Two Objects tool**  . **Click** on **line b** and **circle c**, to find the **point of intersection D** of the **line b** and the **circle c.**

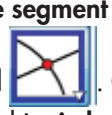


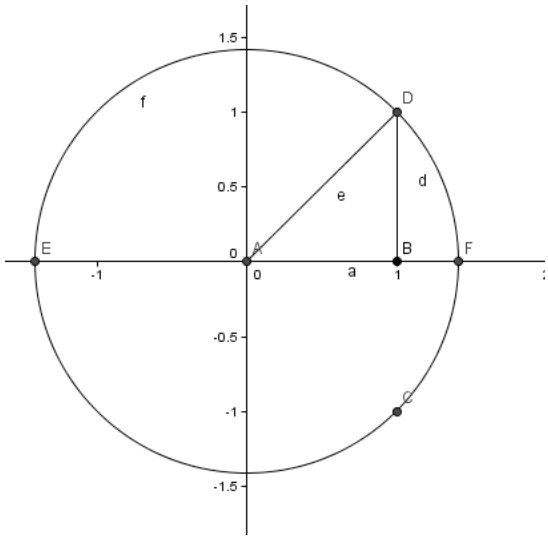
10. **Right click** the **line b** and **unclick Show Object**.
11. **Right click** the **circle c** and **unclick Show Object**.
12. **Right click** the **point C** and **unclick Show Object.**
13. **Select** the **Segment between Two Points tool**  . **Click** on the **points B** and **D** and then **A** and **D**, to **draw** the **line segments BD** and **AD**.



Note: As **AB** and **BD** are **both of length 1**, and are **at right angles** to **each other using Pythagoras theorem the length of AD must be square root of 2**.

14. To **show** the **length** of **root 2**, on the **number line select** the **Circle with Centre through a Point tool**  . **Click on the point A** and then **click** on the **point D** to **create** a **circle** with **radius equal** to the **length** of the **line segment AD**.

15. **Select** the **Intersect Two Objects tool**  . **Click** on the **circle** and then **click** on the **x axis**. The **distance from F** the point where this **circle cuts** the **x axis and the point A(0,0)** is **equal** to the **square root** of **2**.

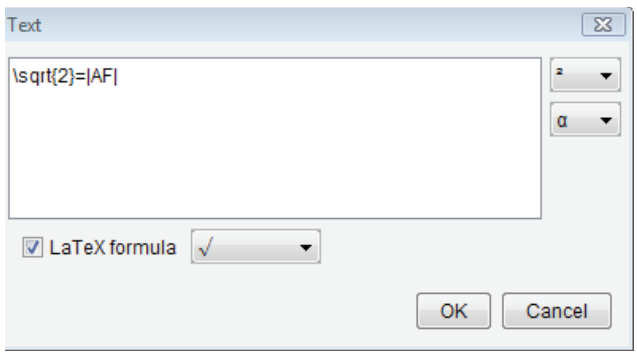


16. **Right click** the **circle f** and **unclick Show Object** to **hide** the **circle**.

17. **Right click** the **point E** and **unclick Show Object** to **hide** the **point E.**

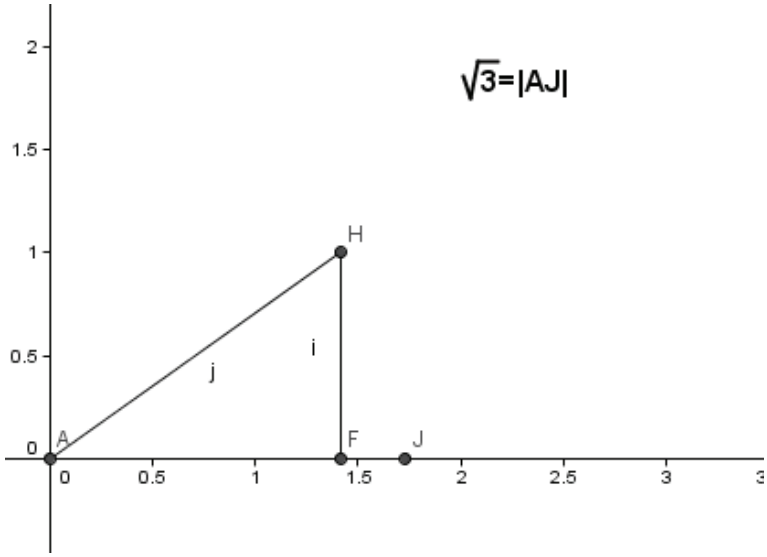
18. **Select** the **Insert Text tool**  . **Click** on the **Graphics View** and when a **new dialogue box** appears **type** the following **text** in the box **\sqrt{2}=|AF|**

19. **Click** the **LaTeX formula button** in this **dialogue box** and **click OK.**

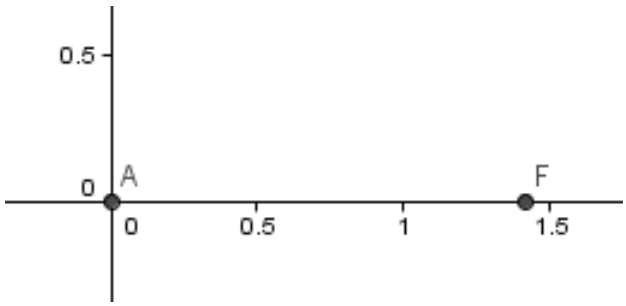


Note: To get the **"|"symbol**, **click** on the  **key** on the **keyboard while simultaneously pressing the shift key**. See also Appendix F: A Guide to Special Keys on the Keyboard.

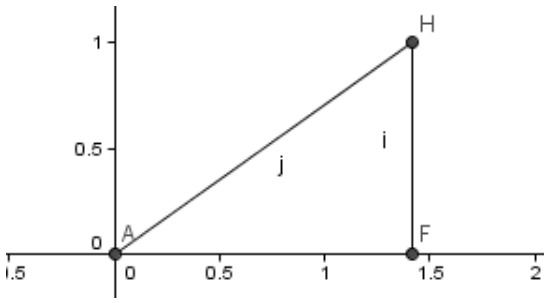
ACTIVITY 16: TO GEOMETRICALLY CONSTRUCT $\sqrt{3}$



1. **Go to File** and **choose New Window**.
2. **Continuing** from the **previous file** where on the **x axis** you **drew AF** = $\sqrt{2}$ as above.
3. **Right click** on all the **points, line segments etc**. **apart from A and F** and **unclick** the **Show Object option**.

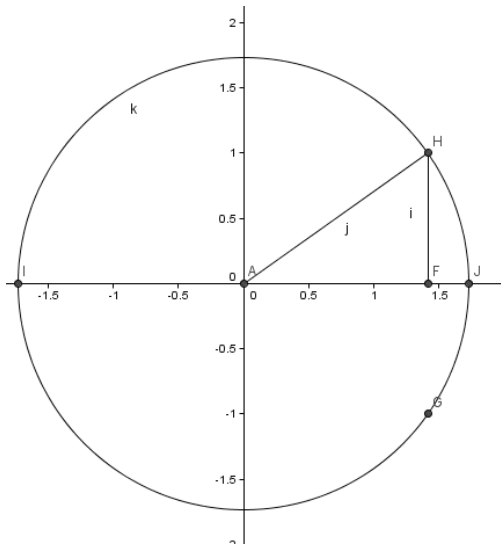


4. **Select** the **Perpendicular Line tool**  . **Click** on **point F** and the **line segment AF** to **draw** a **line perpendicular** to **AF** at the **point F**.
5. **Select** the **Circle with Centre and Radius tool**  . **Click** on the **point F** and in the **dialogue box that appears insert 1** to **draw a circle h** of **radius 1** at the **point F**.
6. **Select** the **Intersect Two Objects tool**  . **Click** on the **line g** and the **circle h** to find the **point of intersection H** of **line g** and **circle h**.
7. **Right click** the **line f** and **unclick Show Object**.
8. **Right click** the **circle g** and **unclick Show Object**.
9. **Select** the **Segment between Two Points tool**  . **Click** on the **points F** and **H** and then **A** and **H** to **draw** the **line segments FH** and **AH**.



Note: As **FH** is of length 1 and **AF** is of length equal to **the square root of 2** using **Pythagoras theorem** the **length** of **AH** must be **square root of 3**.

10. **Select** the **Circle with Centre through a Point tool**  . **Click** on the **point A** and then the **point H** to **draw** a **circle** of **radius** length equal to **AH**. The **distance** from **the point A(0,0)** to where this **circle cuts** the **x axis** is **equal to** the **square root of 3**.

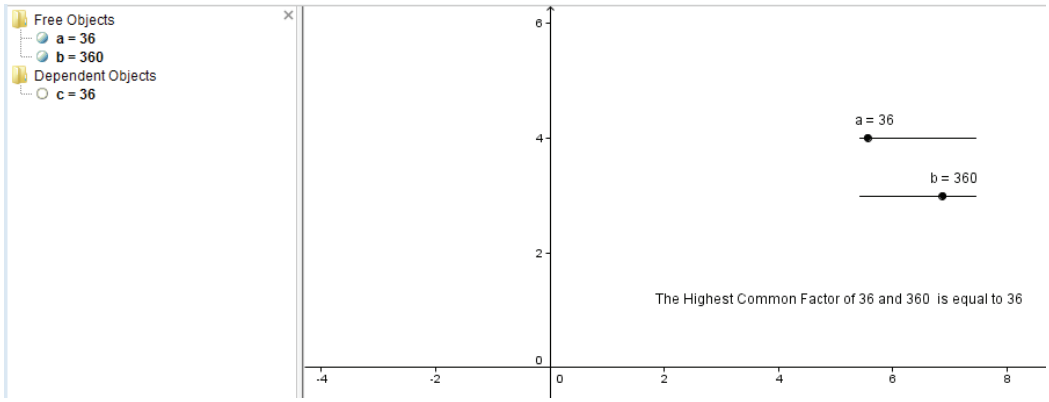


11. **Select** the **Intersect Two Objects tool**  . **Click** on the **circle k** and the **x axis** to find the **intersection** of the **circle k** and the **x axis.**

12. **Right click** the **circle k** and **unclick Show Object**.

13. **Select** the **Insert Text tool**  . **Click** on the **Graphics View** and when a **new dialogue box** appears **type** the following **text** in the box **\sqrt{3}=|AJ|**. **Click** the **LaTeX formula button** in this **dialogue box** and **click OK.**

ACTIVITY 17: TO FIND THE HIGHEST COMMON FACTOR



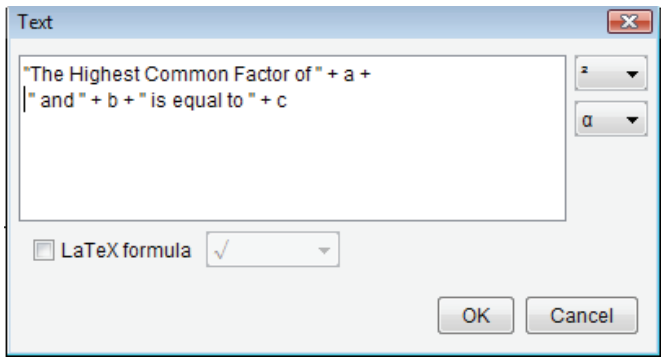
1. **Go to File** and **choose New Window**.
2. **Make sure** the **language option** for **Geogebra is English (UK),** by going to **Options in the Menu** and from the **drop down menu choose Language** and **English(UK).**
3. **Select the Slider tool** 

. Click on the Graphics View and create a **slider** called **a** with **min: =1**, **max: =100** and **Increment: =1**.
4. **Select the Slider tool** 

. Click on the Graphics View and create a **slider** called **b** with **min: =1**, **max: =100** and **Increment: =1**.
5. To **find** the **Highest Common Factor** of **a** and **b choose** the **HCF command** from the **drop down menu** at the **extreme right** of the **Input Bar** and inside the **brackets type a,b**.

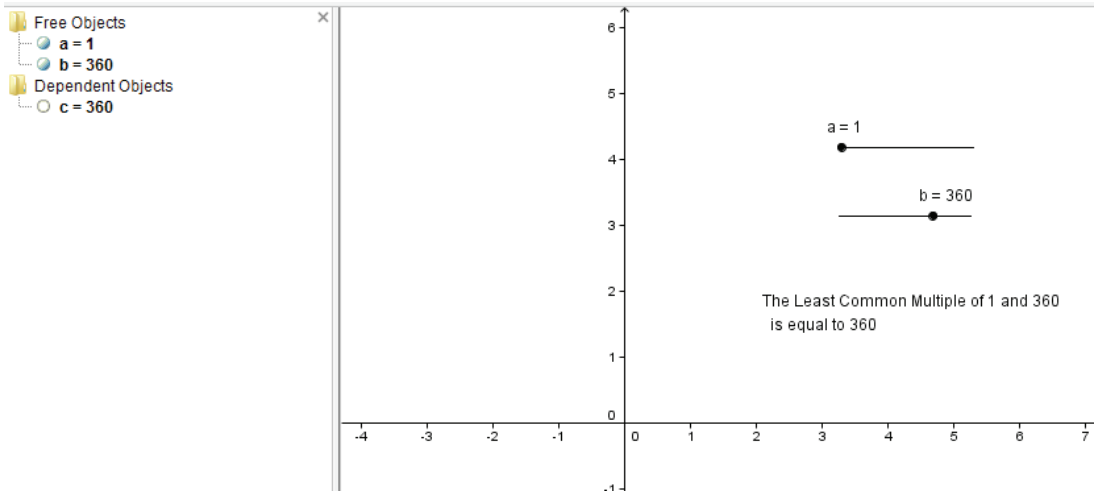
6. The **Highest Common Factor a** will appear in the **Algebra View** as **c**.
7. **Select** the **Insert Text tool** 

. Click on the **Graphics View** and when a **new dialogue box** appears **type** the following **text** in the box **"The Highest Common Factor of " + a + " and " + b + " is equal to " + c**

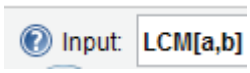


Note: What is **between** the **" and "** is just **text**, whereas **a**, **b** and **c** are picking up the **numerical values** of the **variables a**, **b** and **c**.

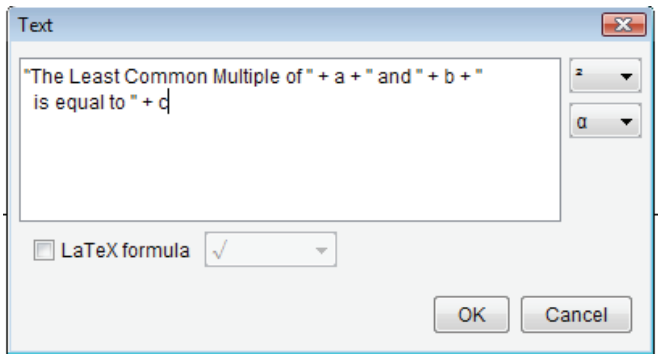
ACTIVITY 18: TO FIND THE LEAST COMMON MULTIPLE OF 2 NUMBERS



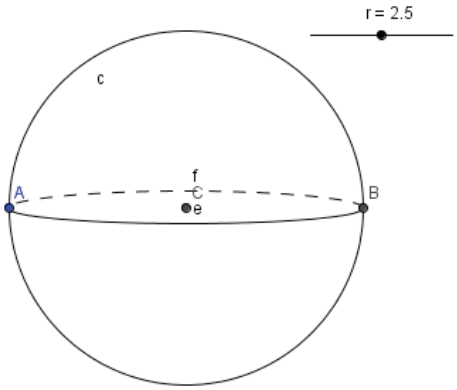
1. **Go to File** and **choose New Window**.
2. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **a** with **min: =1**, **max: =100** and **Increment: =1**.
3. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **b** with **min: =1**, **max: =100** and **Increment: =1**.
4. To **find** the **Least Common Multiple** of **a** and **b choose** the **LCM command** from the **drop down menu** at the **extreme right** of the **Input Bar** and inside the **brackets type a,b**.



5. The **Least Common Multiple a** will appear in the **Algebra View** as **c**.
6. **Select** the **Insert Text tool**  **. Click** on the **Graphics View** and when a **new dialogue box** appears **type** the following **text** in the box **"The Least Common Multiple of " + a + " and " + b + " is equal to " + c**.



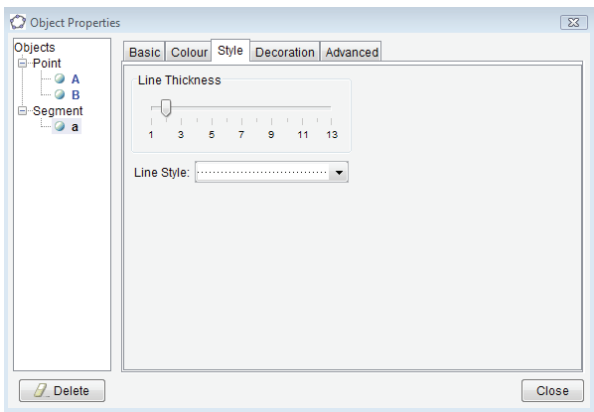
ACTIVITY 19: TO DRAW A SPHERE



1. **Go to File** and **choose New Window**.
2. **Select** the **New Point tool**  . **Create** the **point A(1,1).**
3. **Select** the **Slider tool**  . **Create** a **slider** called **r** with **min: = 0**, **max: = 5 and Increment: = 0.1**.
4. In the **Input Bar type (x(A)+2 r, y(A))**, creating a **point B**.

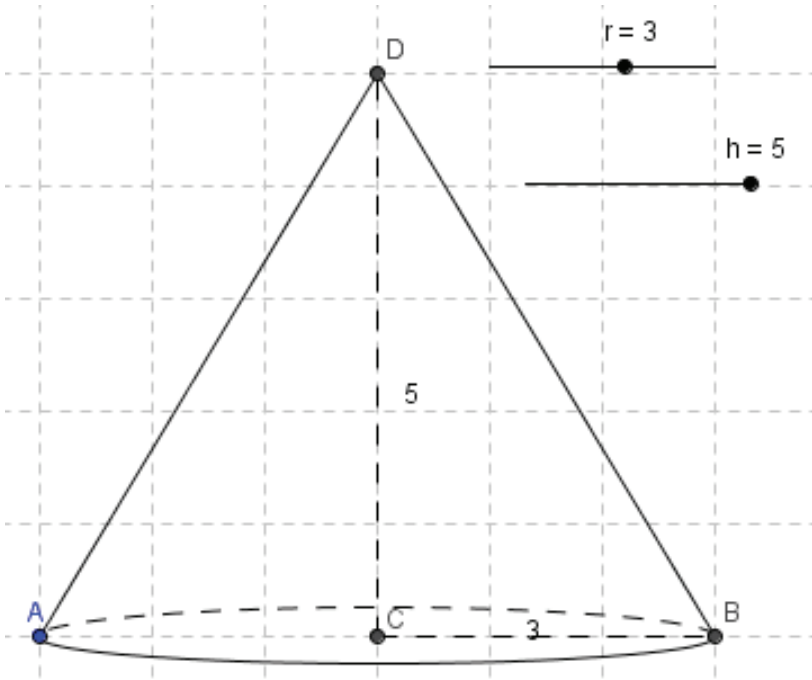
   Notes: **(i)** Take note of the **space between** the **2** and the **r** and note the **double brackets** at the **end**.

   (ii) Distance A to **B** will be **1 diameter length** to the **right of A**.
5. **Select** the **Midpoint tool**  . **Click** on the **points A** and **B** to **create** a **point C**, the **midpoint** of **A** and **B**.
6. **Select** the **Circle with Centre through a Point tool**  . **Click** on the **point C** and then the **point B** to **create** a **circle** with **centre C passing through** the **point B**.
7. In the **Input Bar type Ellipse[A, B, r+0.01]. Press Enter**. This makes an ellipse d.
8. **Right click** on the **ellipse d** and **unclick Show Object** to **hide** the ellipse d**.**
9. In the **Input Bar type Arc [d,B,A]. Press Enter**. This makes an **arc e** based on the **ellipse d**.
10. In the **Input Bar type Arc [d,A,B]**. **Press Enter**. This makes an **arc f based on the ellipse d.**
11. **Right-click** on the **top arc**, **choose Object Properties** and with the **Style tab open change** the **Line Style to dotted**.

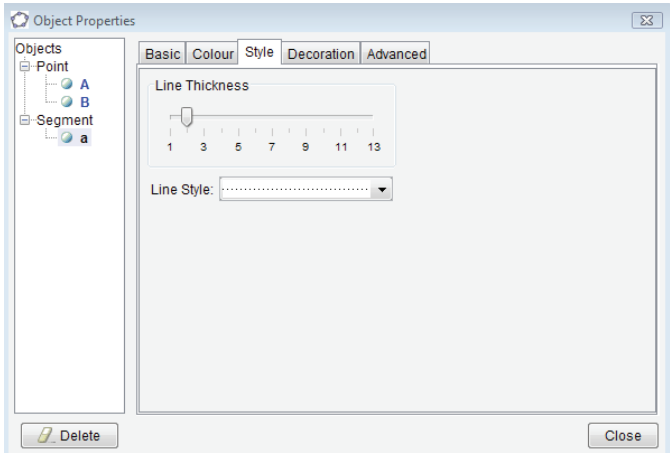


12. **Move** the **slider** to **see** the **sphere's size change**.

ACTIVITY 20: TO DRAW A CONE



1. **Go to File** and **choose New Window**.
2. **Select** the **Slider tool**  . **Create** a **slider** called **r** with **min: = 0**, **max: = 5** and **Increment: = 0.1.**
3. **Select** the **Slider tool**  . **Create** a **slider** called **h** with **min: = 0**, **max: =5** and **Increment: = 0.1.**
4. **Select** the **Point tool**  **. Create** the **point A(1, 1).**
5. In the **Input Bar type (x(A)+2 r,y(A))** , creating a **point B** which is **1 diameter length** to the **right of A**. Note the **space between** the **2 and the r** and the **double brackets** at the **end**.
6. **Select** the **Midpoint tool**  . **Click** on the **points A** followed by **B** to **create** a **point C**, the **midpoint** of **A** and **B.**
7. In the **Input Bar type (x(C),y(C)+h)**, **creating** a **point D** which is **1 height length** above C. **Press Enter.**
8. In the **Input Bar type Ellipse[A, B, r+0.01]**.
9. **Hide** this **ellipse** by **right clicking** on the ellipse and **unclick Show Object.**
10. In the **Input Bar type Arc[c,A,B]**. Note the order of **A** and **B**.
11. In the **Input Bar type Arc[c,B,A]**. Note the order of **A** and **B**.
12. **Right-click** on the **arc**, **choose Object Properties** and with **Style tab open** from the **drop down menu change** the **Line Style** to **dotted**.



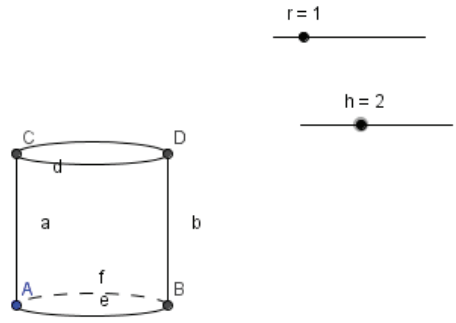
13. **Select** the **Segment between Two Points tool**  . **Click** on the **points A** and **D** followed by the **points B** and **D** to **create line segments [AD]** and **[BD]**.

14. **Move** the **sliders** to **see** the **cone size changing**.

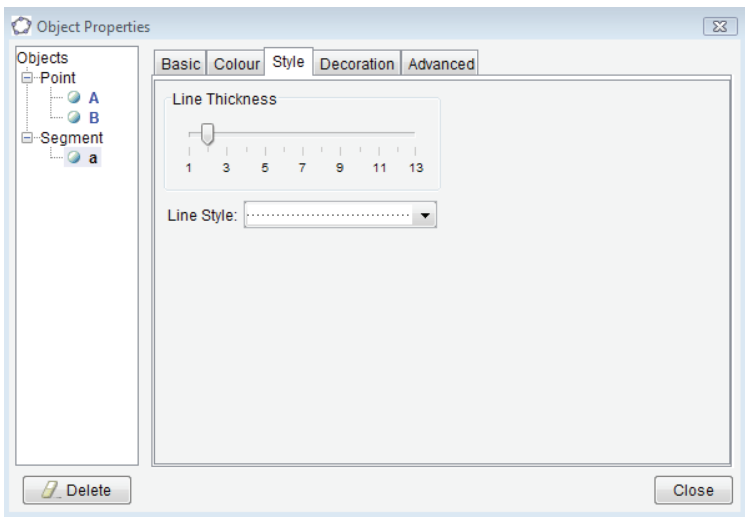
PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

1. ***Hide*** *the* ***points A, B, C*** *and* ***D***.
2. ***Hide*** *the* ***labels*** *of the* ***segments a*** *and* ***b***.
3. ***Create*** *a* ***segment between C*** *and* ***B.*** **Make** *the* ***line style*** *of this* ***segment dotted.*** ***Show*** *the* ***Value*** *of this* ***segment.***
4. ***Create*** *a* ***segment between C and D.*** ***Make*** *the* ***line style*** *of this* ***segment dotted.*** ***Show*** *the* ***Value*** *of this* ***segment.***

ACTIVITY 21: TO DRAW A CYLINDER



1. **Go to File** and **choose New Window**.
2. **Select** the **Slider tool**  . **Click** on the **Graphics View** to **create** a **slider** called **r** with **min: = 0**, **max: = 5** and **Increment: = 0.1.**
3. **Select** the **Slider tool**  **. Click** on the **Graphics View** to **create** a **slider** called **h** with **min: = 0**, **max: = 5** and **Increment: = 0.1.**
4. **Select** the **Point tool**  **. Click** on the **Graphics View** at the **appropriate location** to **create** the **point A(1,1).**
5. In the **Input Bar type (x(A)+2 r,y(A))** , creating a **point B** which is 1 diameter length to the right of A. Note the space between the 2 and the r and the **double brackets** at the **end**.
6. In the **Input Bar** type **(x(A),y(A)+h)**, **creating** a **point C** which is **1 height length above A**.
7. In the **Input Bar** type **(x(B),y(B)+h)**, **creating** a **point D** which is **1 height length above B**.
8. In the **Input Bar** type **Ellipse[A, B, r+0.01]**.
9. In the **Input Bar** type **Ellipse[C, D, r+0.01]**.
10. **Hide** the **bottom ellipse**.
11. In the **Input Bar** type **Arc[c,A,B]**.
12. In the **Input Bar type Arc[c,B,A]**.
13. **Right-click** on the **top arc**, **choose Object Properties** and with the **Style tab open** from the **drop down menu change** the **Line Style** to **dotted**.

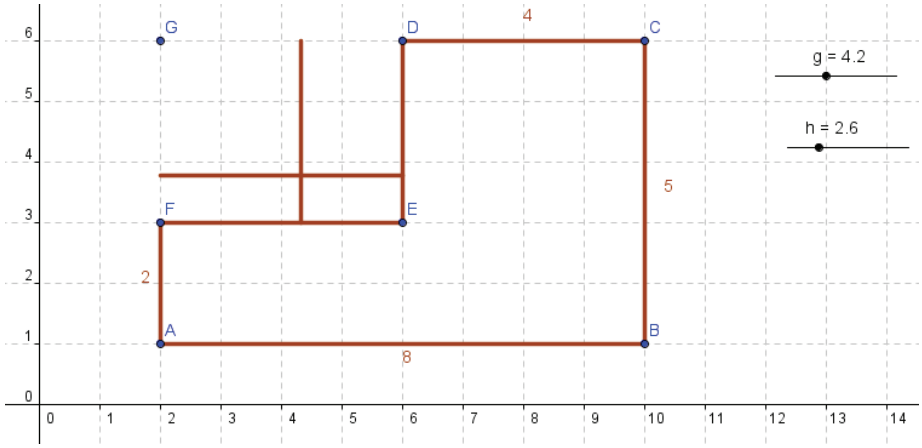


14. **Select** the **Segment between Two Points tool**  . **Click on the points A and C to create** the **line segments [AC]** and then **click** on the **points B** and **D** to **create** the **line segment [BD]**.
15. **Move** the **sliders** to **see** the **cone size** changing.

PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

1. ***Hide*** *the* ***points A, B, C*** *and* ***D***.
2. ***Hide*** *the* ***labels*** *of the* ***segments a*** *and* ***b***.
3. ***Create*** *a* ***midpoint between C*** *and* ***D. Show*** *the* ***Name and Value*** *of this* ***segment.***
4. ***Show*** *the* ***Name and Value*** *of the* ***segment [BD].***

ACTIVITY 22: PERIMETER OF AN L-SHAPE



1. **Go to File** and **choose New Window**.
2. **Right click on the Graphics View and click Grid.**
3. **Use** the **Polygon tool**  to **draw** an **L-shape** by **clicking** on these coordinates **(2,1), (10,1), (10,6), (6,6), (6,3), (2,3)** and **finally (2,1) again.**
4. **Select** the **New Point tool**  **create** a **point G** at **(2, 6).**
5. **Select the Slider tool**  . **Click on the Graphics View and create a slider** called **g** with a **min: = 0, max: = 10** and **Increment: = 0.1**.
6. **Select the Slider tool**  . **Click on the Graphics View and create** a **slider**  called **h** with **min: =0, max: =10** and **Increment: = 0.1**.
8. In the **Input Bar type Point[F, Vector[F, G] / 10 h].** Note the **space after** the **10**.
9. In the **Input Bar type Point[E, Vector[F, G] / 10 h].** Note the **space after** the **10**.
10. **Select** the **Segment between Two Points tool**  . **Click** on the **points H** and **I** to draw a **line segment** between **H** and **I**.

11. In the **Input Bar type Point[D, Vector[D, G] / 10 g]**. Note the **space after** the **10**.
12. In the **Input Bar type Point[E, Vector[E, F] / 10 g]**. Note the **space after** the **10**.
13. **Select** the **Segment between Two Points tool**  . **Click** on the **points J** and **K** to **create** a **line segment between J and K**.
14. **Select** the **Move tool**  . **Change** the **sliders g** and **h**.

Note: Point [F, Vector[F, G] / 10 h] uses the **points F** and **G** to **create** a **new point H** that has been moved a **fraction of the distance** between **F** and **G**. **h** is a **slider** that **varies between 0 and 10**

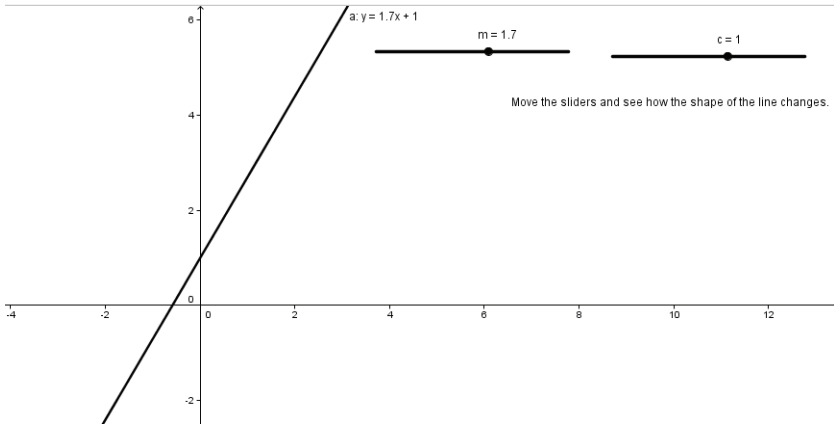
PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

1. *To make your construction look better hide all the points, axes and grid.*
2. *Show the labels for 4 of the 6 sides.*

GEOGEBRA STRAND 5

Note: When drawing a function use *f(x)* = rather than *y* =, because when *y* = is used some of the commands from the Input Bar do not work for the function.

ACTIVITY 23: DRAW THE GRAPH OF A LINEAR FUNCTION



1. **Go to File** and **choose New Window**.
2. **Select the Slider tool**  . **Click on the Graphics View and create** a **slider** called **m** with **min: equal to -10**, **max: equal to 10** and **Increment: equal to 0.1**.
3. **Similarly create** a **slider** called **c**, with **min: equal -5**, **max: equal to 5** and **Increment: equal to 0.1**.
4. In the **Input Bar type f(x)=m x+c** Note the **space between** the **m** and the **x**, **alternatively** one can **type f(x)=m*x+c** and **press Enter**.

5. **Select** the **Intersect Two Points tool** 

. **Click** on **f** and the **y axis** to find the **point of intersection** of **f** and the **y axis**.
6. **Move** the **sliders** and **see how the line changes**.
7. **Save** the **file** as a **.ggb file** and as **an interactive webpage**. **See** Appendix G for both **instructions**.

   Note the **relationship between** where this **line cuts** the **y axis** and **c** and how **the slope** of the line changes as m changes.

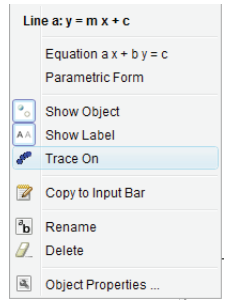
PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

1. ***When** the **slider m=0** and **the slider c=0**, why is there **no line showing?***

Activity 23.1: To animate the above line

1. **Right click** on **slider m** and from the **drop down menu choose Animation On**.
2. A **new icon**  **will appear** at the **bottom left hand corner** of the **Graphics View**. **Click on** this **icon to stop** and **start** the **animation**.

Activity 23.2: To show the Trace of the above line



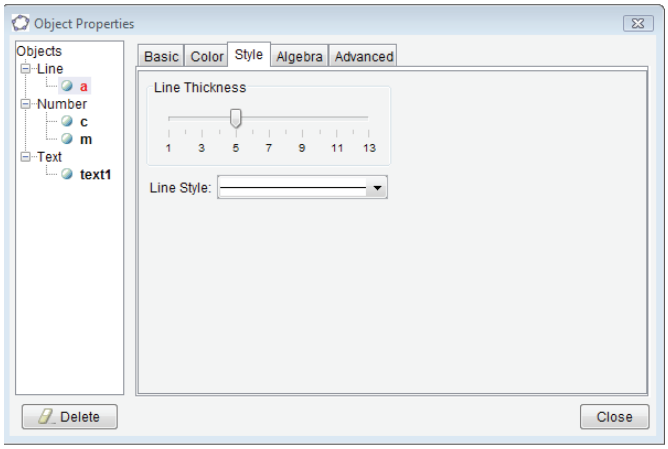
1. **Right click** the **line** and from the **drop down menu select Trace On**.
2. **Select** the **Move tool**  to **move** the **slider**.

Activity 23.3: To remove the Trace of an object

1. **Right click** on the **object** in the **Algebra View** or on the **Graphics View** and **click** on **Trace On** again. Alternatively **use** the **keyboard shortcut Ctrl+F**.

Activity 23.4: To change the colour, etc. of a line or curve

1. **Click** on the **line or curve**, **right click** and **choose Object Properties**. A **new dialogue box appears**.



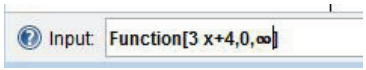
2. **With** the **Color tab open change** the **colour** and **with** the **Style tab open change** the **style** using the **drop down menu**.

3. **With** the **Basic tab open**, **click** the **Show Label button** and **choose Name and Value** from the **drop down menu** to enable the **name of the line or curve** and **its equation** both to **be shown**.
4. **Click Close**.

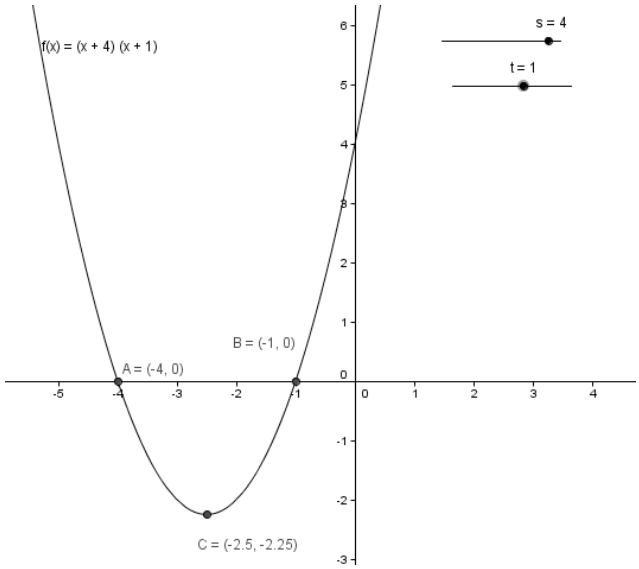
ACTIVITY 24: TO DRAW A SECTION OF A FUNCTION

For example, if you wish to draw the segment of the function f(x) = 3x+4 between 0 and ∞

1. **Go to File** and **choose New Window**.
2. In the **Input Bar choose** the **Function command** and **inside the square brackets** type **3 x+4, 0, ∞**
   Note: The **symbol ∞** can be found by following the first drop down menu in the Input Bar.



ACTIVITY 25: TO DRAW THE GRAPH OF THE QUADRATIC FUNCTION f(x) = (x+s) (x+t)



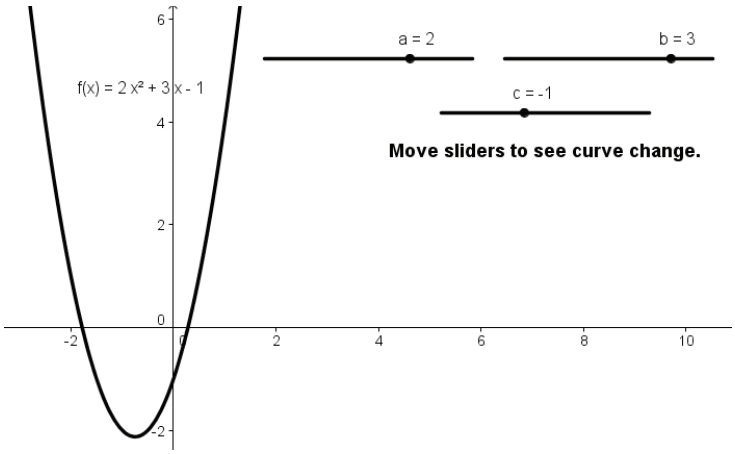
1. **Go to File** and **choose New Window**.
2. **Select the Slider tool** 

. Click on the **Graphics View** and **create** a **slider** called **s** with **min: = -5**, **max: = 5** and **Increment: = 1.**
3. **Select** the **Slider tool** 

. **Click** on the **Graphics View** and **create** a **slider** called **t** with **min: = -5**, **max: = 5** and **Increment: = 1**.
4. In the **Input Bar type f(x)=(x+s) (x+t)**.
   Note: Take note of the **space between** the **(x+s)** and **(x+t)** as they are multiplied or alternatively type **f(x)=(x+s)*(x+t)**.

5. **Select** the **Intersect Two Objects Tool**  . **Click** on the **x axis** and the **curve f**. This will **create** the **points A** and **B**, the **point(s) of intersection** of the **x axis** and **the curve f**. The **x values** of the **points A** and **B** will **demonstrate** the **solution** of **f(x) =0**.
Note: Alternatively **type root[f]** in the **Input Bar** and **Press Enter**.
6. **Move** the **sliders** and **see how** the **curve changes**.
Note: There is **only one point A**, **when** the **slider a** and **b** have the **same value**.
7. **Right click** on the **curve f** and **choose Object Properties** to **change** the **color**, **style etc.** of the **curve**.

ACTIVITY 26.1: TO DRAW THE GRAPH OF THE QUADRATIC FUNCTION $f(x) = ax^2+bx+c$



1. **Go to File** and **choose New Window**.
2. **Select the Slider tool** 

. Click on the Graphics View and create a **slider** called **a** with **min: = -5**, **max: = 5** and **Increment: = 1**
3. **Select the Slider tool** 

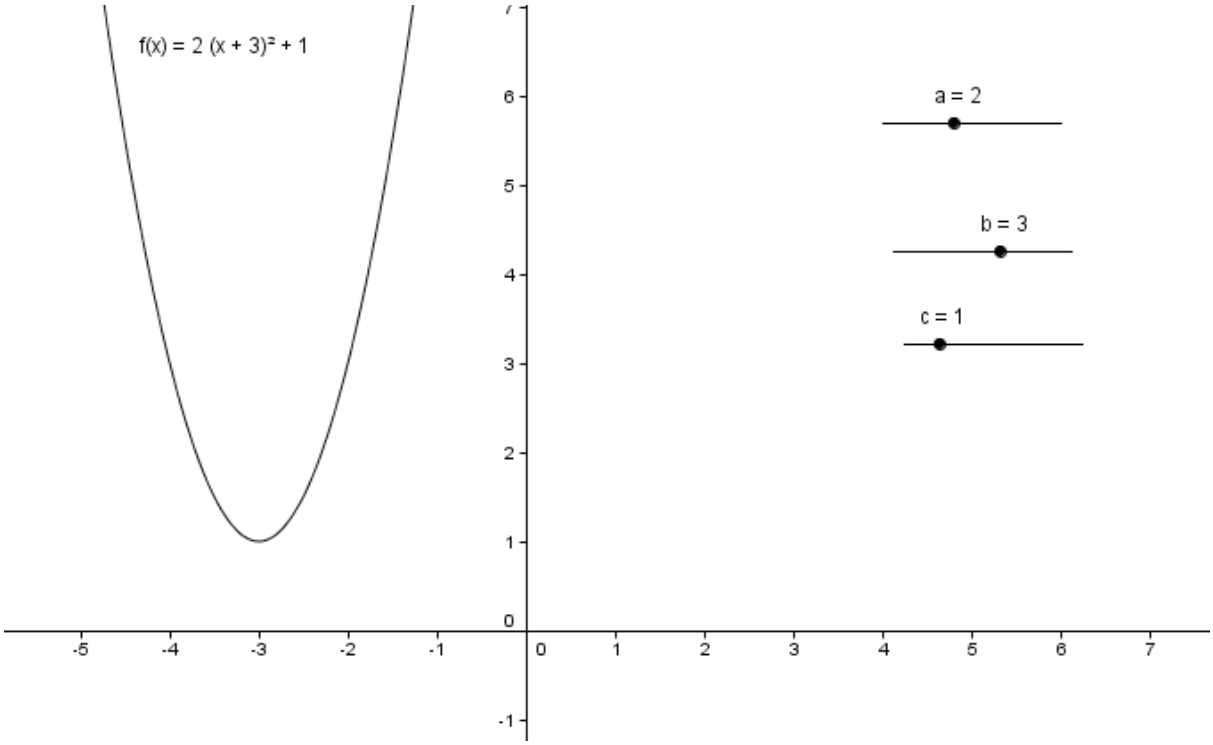
. Click on the Graphics View and create a **slider** called **b** with **min: = -5**, **max: =5** and **Increment: = 1**
4. **Select the Slider tool** 

. Click on the Graphics View and create a **slider** called **c** with **min: = -5**, **max: =5** and **Increment: = 1**
5. In the **input Bar type f(x)=a x^2+b x+c**
Note: The **spaces can be replaced** by an ***.**
6. **Select** the **Intersection Two Objects tool**  and **click** on the **x axis** and the **curve f**. This will demonstrate the points of intersection of the x axis and the curve. The **x values** of these points **A** and **B** will **demonstrate** the **solution of f(x) = 0**.
7. **Move** the **sliders** and **see how** the **curve changes**.

PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

1. ***What is*** *the* ***effect of changing*** *the* ***"a" slider?***
2. ***What is*** *the* ***effect of changing*** *the* ***"b" slider?***
3. ***What is*** *the* ***effect of changing*** *the* ***"c" slider?***

ACTIVITY 26.2: TO INVESTIGATE A QUADRATIC OF THE FORM f(x) = a*(x+b)^2+c



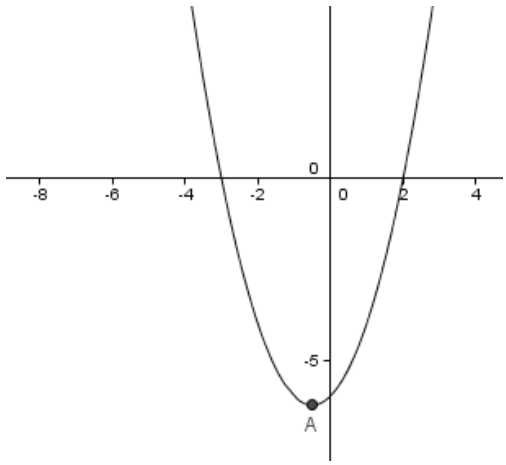
1. Go **to File** and **choose New Window**.
2. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **a** with **min: = -5**, **max: = 5** and **Increment: = 1**
3. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **b** with **min: = -5**, **max: =5** and **Increment: = 1**
4. **Select the Slider tool**  **. Click on the Graphics View and create** a **slider** called **c** with **min: = -5**, **max: =5** and **Increment: = 1**
5. In the **input Bar type f(x)=a (x+b)^2+c Note:** The **space can be replaced** by an *.

6. **Select** the **Intersection Two Objects tool**  and **click** on the **x axis** and the **curve f**. This will demonstrate the points of intersection of the x axis and the curve. The **x values** of these points **A** and **B** will **demonstrate** the **solution of f(x) = 0**.
7. **Move** the **sliders** and **see how** the **curve changes**.

PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

1. ***What is** the **effect of changing** the **"a" slider?***
2. ***What is** the **effect of changing** the **"b" slider?***
3. ***What is** the **effect of changing** the **"c" slider?***

ACTIVITY 27: TO DEMONSTRATE THE TURNING POINTS OF A QUADRATIC



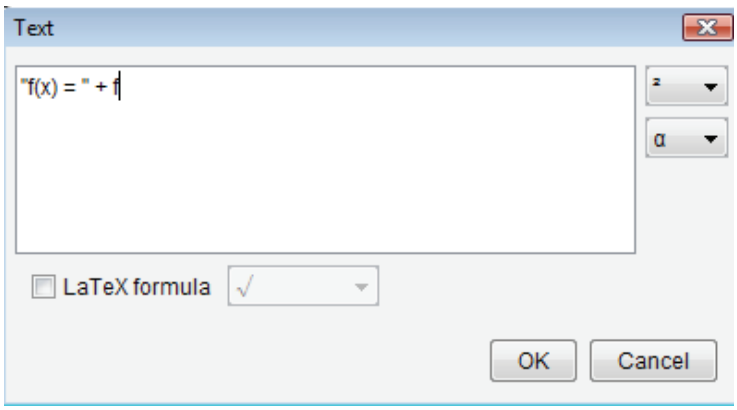
1. **Go to File** and **choose New Window**.
2. **Create** a **quadratic curve of the form f(x)=a x^2+b x+c, where a, b and c are sliders**.
3. In the **Input Bar** type **TurningPoint[f]**.

ACTIVITY 28: TO SEE HOW THE EQUATION OF THE CURVE CHANGES AS THE SLIDERS CHANGE OR AS THE CURVE IS DRAGGED ON THE SCREEN

1. **Go to File** and **choose New Window**.
2. **Create** a **quadratic ax^2+bx+c** using **sliders a, b** and **c**.
3. **Open** the **Algebra View** and **watch** the **value for f(x) change** as the **sliders change**.
   Note: Alternatively, right click the **curve** and **select Object Properties.** With the **Basic tab open** at the **Show Label button, select Name and Value from the drop down menu. Click Close. Drag** the **curve** and **see** the **equation change.**

   Or complete steps a and b below:

a. **Select** the **Text tool**  and **click** on the **Graphics View** at the **position** you **want** the **formula for the curve to appear. A new dialogue box appears**.



b. **Type** the **following "f(x) = "+f** in the **space provided** and **click OK**.

Notes: **(i)** This **is** a **LaTeX formula.** The **text** in the **inverted commas** should appear **exactly** as it will **appear** in the **text.** This **is followed by +** and the **name of the object you want to change, f** in this example. In **this case it does not matter** if the **LaTeX formula box** is **clicked or not.**

(ii) **A piece of text** can be **positioned to stay beside** a **point** on the **Graphics View** as it moves by **right clicking the text box**, **select Object Properties**, and with the **Position tab** open from the **drop down menu choose** the **point** you want the **text box to follow**.

PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

Take a moment in pairs to explore how you might use the materials in Module 2 with your students. Discuss how you might apply what you have learned in your classroom and share links to websites or web tools that you find useful.

Teaching ideas and suggestions:

Your Tutor will gather the group's ideas and suggestions and post them to the wiki **www.ncte.ie/ictmathswiki** where you will be able to share your teaching ideas with other Maths teachers.

Project Maths Tionscadal Mata
Development Team

National Centre for Technology in Education
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NCTE PROFESSIONAL DEVELOPMENT

ICT AND MATHS – PART 2

MODULE 3

MODULE 3

USING ICT AND MATHEMATICS SOFTWARE TO TEACH FUNCTIONS (STRAND 5)

DURATION

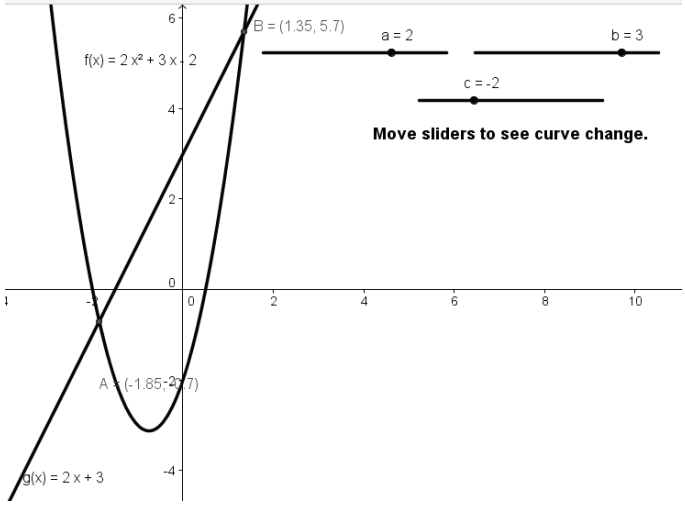
2.5 hours

OBJECTIVES

This module aims to enable the participant to use ICT mathematics software to:

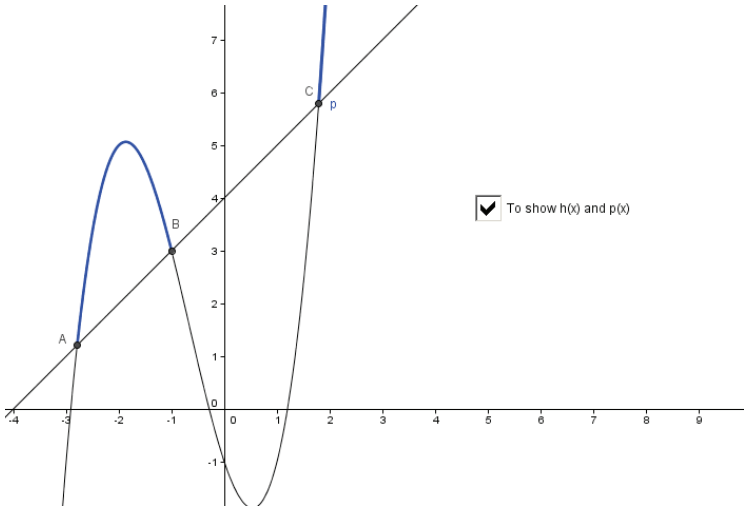
- >> Find where a quadratic curve and a line meet.
- >> Highlight where one function is above another function.
- >> Draw the graph a cubic function.
- >> Draw a polynomial.
- >> Draw the absolute value of a function.
- >> Draw e^x, $\ln(x)$ and look at the (inverse) relationship between them.
- >> Draw specific points on a quadratic curve and introducing the Spreadsheet View.
- >> Automatically fill a column of cells in the Spreadsheet View.
- >> Draw a section of quadratic curve.
- >> Show a function appearing bit by bit.
- >> Demonstrate Turning Points, Roots, Derivatives, Integrals.
- >> Demonstrate derivative and slope.
- >> Demonstrate integration and area.
- >> Demonstrate Integration and the Trapezoidal Rule.
- >> Find the area between a curve and the x axis, where there is a section below and a section above the x axis.
- >> Demonstrate the average value of a curve between 2 points.

ACTIVITY 29: FIND WHERE A QUADRATIC CURVE AND A LINE MEET



1. **Go to File** and **choose New Window**.
2. **Draw** the **quadratic curve f(x)** and the **line g(x).**
3. **Select** the **Intersection Two Objects tool**  . Click on the **curve** and the **line to find** their **points of intersection.**
   Point(s) will **appear** at the **intersection** of the **line** and the **curve**.
   Notes: **(i)** Alternatively the **intersection** of the **two functions** can be found by **clicking** the **Intersect Two Objects tool**  and **clicking** the **functions f** and **g in the Algebra View**.
   (ii) Another method is in the **Input Bar type Intersect[f,g]** and **press Enter.**

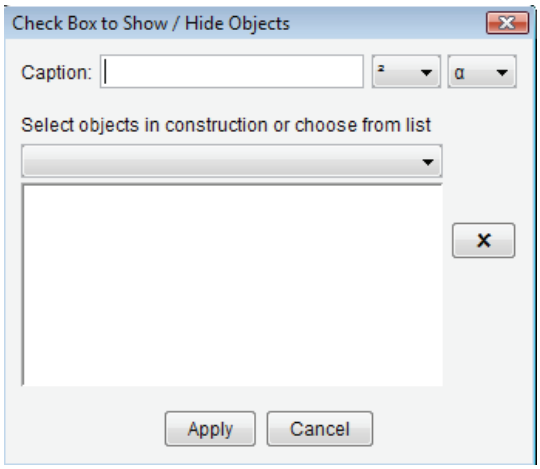
ACTIVITY 30: HIGHLIGHTING WHERE ONE FUNCTION IS ABOVE ANOTHER FUNCTION



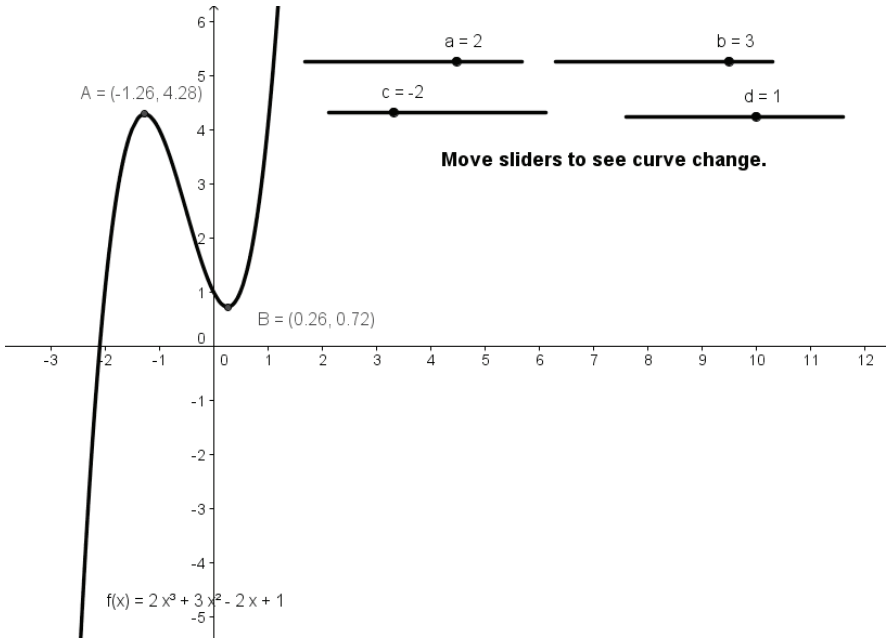
1. **Go to File** and **choose New Window**.
2. In the **Input Bar type f(x)= x^3+ 2 x^2–3 x–1 to create the function f(x) = x^3+ $2x^2$–3x–1.**
   Note the spaces between 2 and x^2 and between 3 and x.
3. In the **Input Bar type g(x)=x+4** to **create** the **function g(x)=x+4.**

4. Input **Intersect[f,g]** which **creates three points A, B** and **C**.
5. Input **Function[f,x(A),x(B)]**
   A **function** called **h(x) = x^3+2x^2-3x-1** now **appears** in the **Dependant Objects list** in the **Algebra View**. **Right click** on **h(x)** in the **Algebra View** and **change** the **colour** of this to **blue** and its **line style** to be **thicker**.
6. Input **Function[f,x(C), ∞]**

   A **function** called **p(x) = x^3+2x^2-3x-1** now **appears** in the **Dependant Objects list** in the **Algebra View**. **Right click** on **h(x)** in the **Algebra View** and **change** the **colour** of this to **red** and its **line style** to be **thicker**.
7. **Create** a **checkbox** to **show/hide h(x)** and **p(x).** To do this select the **Check Box to Show /Hide Object** tool  . **Click** on the **Graphics View** and when the **dialogue box** appears type in some **suitable text** and then from the **drop down menu** under **Select objects in construction or choose from list** select **h(x)** . **Repeat** this procedure for a **Tick box** to **show/hide p(x).**

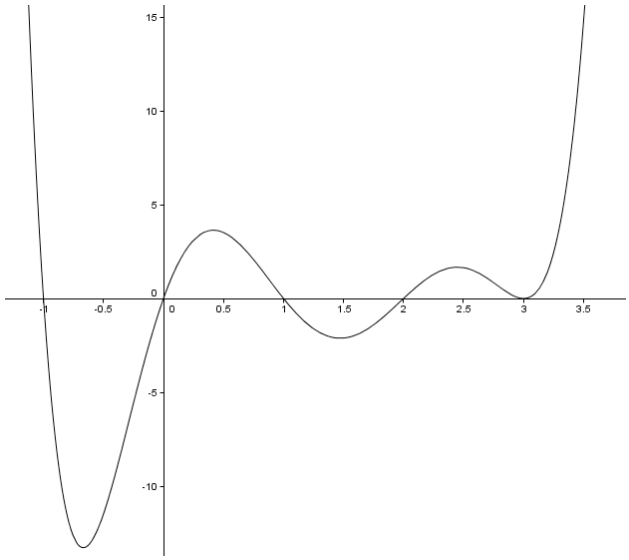


ACTIVITY 31: TO DRAW THE GRAPH A CUBIC FUNCTION



1. **Go to File** and **choose New Window**.
2. **Select the Slider tool**  **. Click on the Graphics View and create sliders a, b, c and d**.
3. In the **Input Bar type f(x)=a x^3+b x^2+c x+d**.
   Note: The **spaces** between **a and x** and between **b and x can be replaced by** an ***.
4. **Turning points etc.** can be **found** in the **same way** as for the **quadratic**.

ACTIVITY 32: TO DRAW A POLYNOMIAL

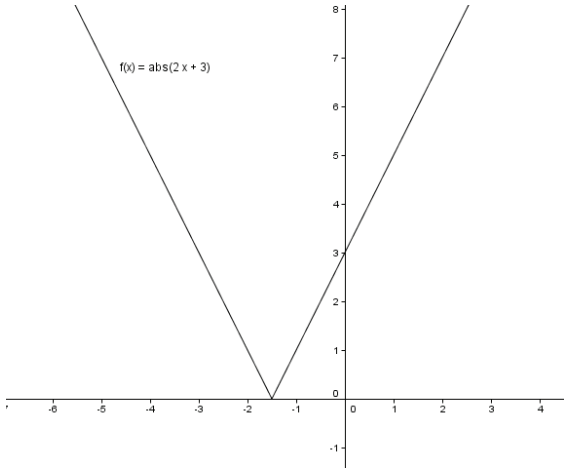


1. **Go to File** and **choose New Window**.
2. In the **Input Bar type** the equation of the **polynomial** for example
   f(x) = x (x + 1) (x - 1) (x - 2) (x - 3) (x - 3)

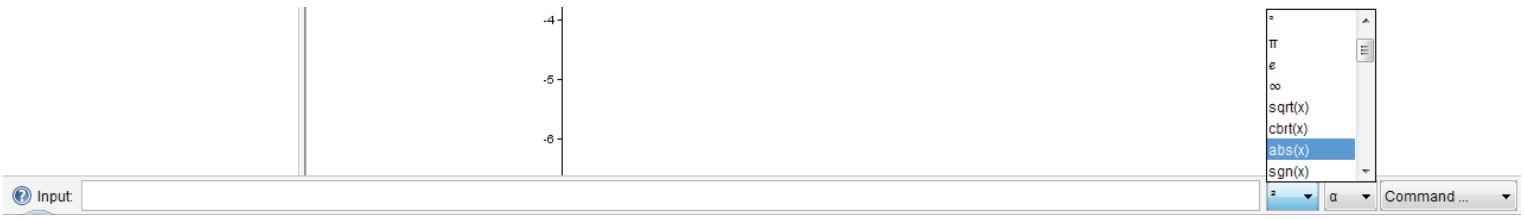
   Note: The **spaces between** the **brackets** can be **replaced by an** *.

3. In order to get a more detailed view of the graph use the **Move tool**  , **click** on the **x axis** and **drag** to the **right.**

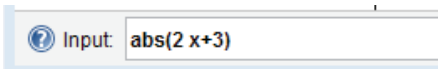
ACTIVITY 33: TO DRAW THE ABSOLUTE VALUE OF A FUNCTION



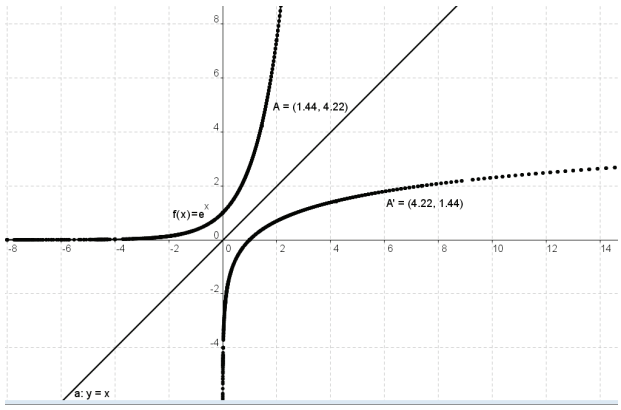
1. **Go to File** and **choose New Window**.
2. In the **Input Bar choose abs**(x) under the **first drop down menu** in the **Input Bar**.



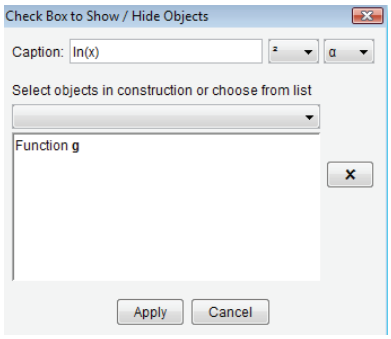
3. In the **brackets replace x with** the **function for example 2 x+3** and **press enter**.
Note the **space between** the **2** and the **x**.



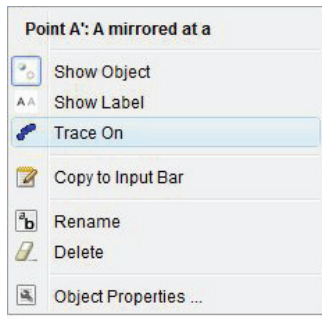
ACTIVITY 34: TO DRAW e^x, ln(x) AND LOOK AT THE (INVERSE) RELATIONSHIP BETWEEN THEM



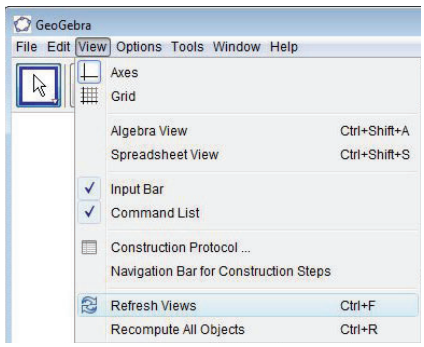
1. **Go to File** and **choose New Window**.
2. In the **Input Bar type f(x)=exp(x)**
3. In the **Input Bar type g(x)=ln(x)**
4. In the **Input Bar type y=x**
5. **Select** the **Check box to Show / Hide Objects tool**  . Insert the **caption ln(x)** and in the **drop down menu** under **Select objects in construction or choose from list choose** the **function g**.



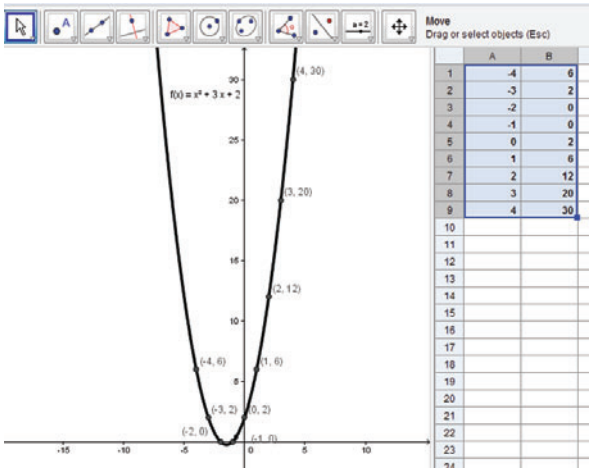
6. **Select** the **New Point tool**  . Click on the **exp(x) function** to **create** a **point A** on this curve.
7. **Select** the **Reflect Object in Line tool**  . **Click** on the **point A** and then the **line y=x to reflect** the **point A** in the **line y=x**. This **creates** a **point A'**.
   Note: Reflecting in the **line y = x produces** the **inverse function**.
8. **Right click** on **A'** and **click Trace On.**



9. **Select** the **Move tool**.  **Click** on the **point A** and **move** it along the **curve f(x) = exp(x)** (slowly is best). **A'** should **trace out a path**.
10. **Click** the **checkbox** you created earlier and compare the path of **A'** to the **ln(x) function**.
    Note: Clicking View in the **Menu** and **Refresh Views** from the **drop down menu** will **clear** the **trace**. **Ctrl+F** also works to **clear the trace**.



ACTIVITY 35: TO DRAW SPECIFIC POINTS ON A QUADRATIC CURVE AND INTRODUCING THE SPREADSHEET VIEW



	A	B
1	-4	6
2	-3	2
3	-2	0
4	-1	0
5	0	2
6	1	6
7	2	12
8	3	20
9	4	30

1. **Go to File** and **choose New Window**.
2. **Open Spreadsheet View** by going to **View in the Menu** and **choose Spreadsheet View** from the **drop down menu**.
3. **Insert** the **numbers {-4,-3,-2,-1, 0, 1, 2, 3, 4}** in the **A column**.
4. In **cell B1**, insert your formula for example **=A1^2+3*A1+2**, if you want to draw points on the **curve $y=x^2+3x+2$**. **Press Enter**.
   Note: This is using the **contents** of the **cell A1** as the **input** to the **quadratic function f(x)**.

	A	B	C	D	E
1	-4	=A1^"+3*A1+2			
2	-3				
3	-2				
4	-1				
5	0				
6	1				
7	2				
8	3				
9	4				
10					
11					
12					

5. **Click** on **cell B1**. A **blue rectangular box** will now **surround this cell**. **Click** on the **dot at the right hand corner of this box** and **drag the dot** to **cover cells B1 to B9**.
6. **Highlight** the **cells A1: B9**. **Right click** and from the **drop down menu choose Create List of Points**. Notice **these points** are **now graphed** on the **Graphics View**.
7. **To show** the **co-ordinates** of the **points**, **press** the **Control button** Ctrl on the **keyboard** and **continue** to have this **key pressed** while **selecting each of the points** on the **curve**. **Right click** and **choose Object Properties**. With the **Basic tab open**, in the **drop down menu beside Show Label select Value**. The **co-ordinates** of the **points should now be displayed**.
8. In the **Input Bar select** the **FitPoly function** from the **drop down menu** of **commands** on the **extreme right** of the **Input Bar** and in the **square brackets insert list1** followed by **comma and 2** and **press Enter**. The **2** is **because** it is a **curve of degree 2** that you require.

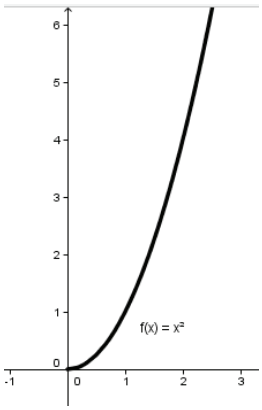
Note: To **change** the **colour or size** of the **points**, **hold down the Ctrl key** Ctrl and **select** all the **points**. **Right click** and **choose Object Properties**. With the **color tab open**, select the **colour** of **your choice**. To **change** the **appearance** of the **point**, **open** the **Style tab** and **change** the **Point Style** and/or **Point Size**.

ACTIVITY 36: TO AUTOMATICALLY FILL A COLUMN OF CELLS IN THE SPREADSHEET VIEW

1. To **automatically fill** a **column of cells** from **A1 to A10 with the values 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 Type** the **lowest value you require** in **cell A1**. In **cell A2 type A1+1**. **Highlight cells A1** and **A2** by keeping the **Shift Key held down** while **clicking** on the **middle** of **both cells.** A **blue rectangular box** will now **surround these cells**. **Click** on the **dot at the right hand corner** of this **box** and **drag** the **dot to cover cells A3 to A10**.

   Note: **Variables created** by **sliders** in the **Graphics View** can be **used** in **Spreadsheet View calculations.**

ACTIVITY 37: TO DRAW A SECTION OF QUADRATIC CURVE



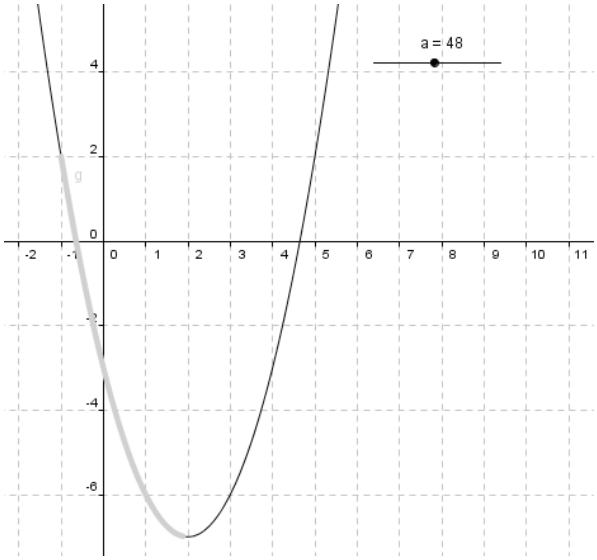
1. **Go to File** and **choose New Window**.
2. From the **drop down menu of commands** on the extreme right of the **Input Bar select** the **command Function**.

3. In the **square brackets after Function type** your **function** for example **x^2** in this case for **x²** followed by **comma**, **your starting point** and **another comma** followed by **your finishing point**.

4. **Press Enter**.

   Note: **If you follow** the **arrow in the first set of options** on the **Input Bar** you get the **symbol ∞** for **infinity**.

ACTIVITY 38: TO SHOW A FUNCTION APPEARING BIT BY BIT



1. **Go** to **File** and **choose New Window**.
2. In the **Input Bar type** the **f(x)=x^2-4 x-3** to **create** the **function f(x) = x^2-4x-3**

   Note: Take note of the space between the 4 and the x.
3. **Hide** the **function f**.
4. In the **Input Bar type start=–1**.

   In the **Input Bar type end=5**.

   This is defining two numbers. The numbers could be called anything e.g. a and b, but start and end make more sense later.
5. **Select** the **Slider tool** 

. Click on the **Graphics View** and **create** a **slider** called **a** with **min: = 0**, **max: = 100** and **Increment: = 1**.
6. In the **Input Bar type function[f,start,start+(end-start)/100 a].**

   Note: Take note of the space between 100 and a. This **draws** a new function which is the old function divided into 100 parts and can be revealed 1 part at a time.

function[f,start,start+(end-start)/100 a]

The part of the function to the right of start is being divided into 100 pieces.

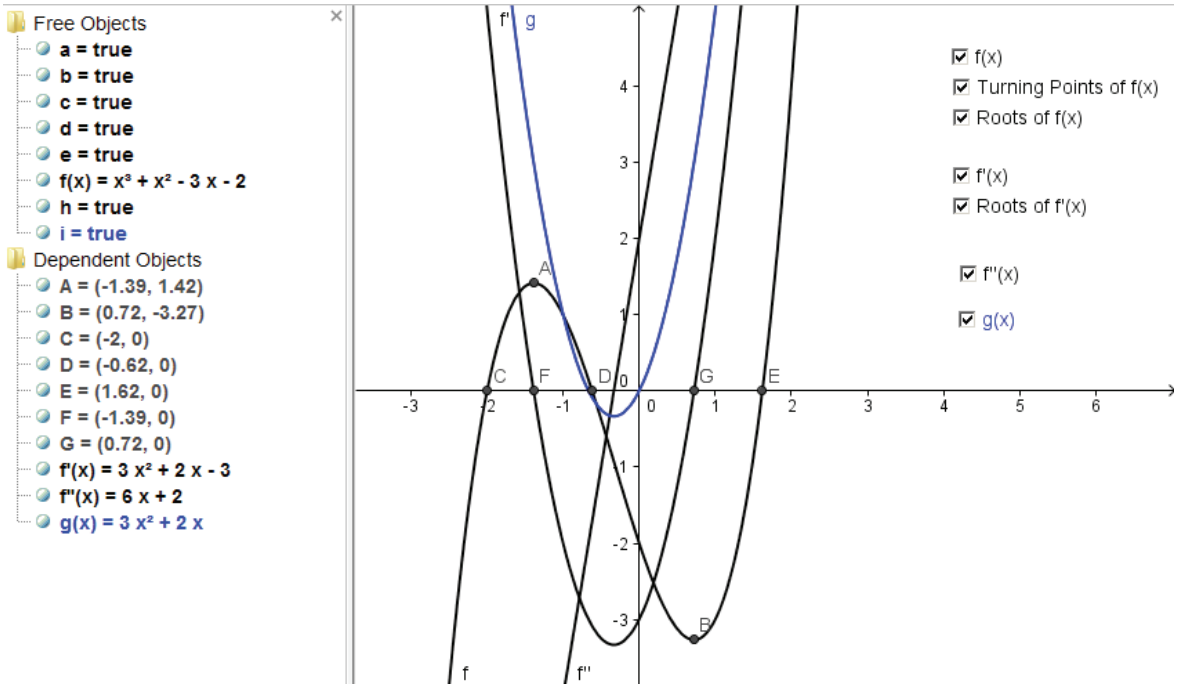
If your slider a=23 then 23 of the 100 pieces of the function to the right of start will be shown

7. **Right click** on the **function g** and **choose Object Properties** and with the **color tab** open **change** the **colour** of **function g**.
8. **Adjust** the **value** of the **slider a** to **reveal** the **function in sections**.

   Notes: **(i)** You can **change** the values of the **start** and **end numbers later by double-clicking** on them in the **Algebra View** or by typing e.g. **start=2** into the **Input Bar**.

   (ii) The **same technique** could be used for **cubics or trigonometric functions** (e.g **Type f(x) =sin(x), hide f**. Then **set start=0 end=2 pi**, create a slider a from 0 to 100 and **type function[f,start,start+(end-start)/100 a]** in the **Input Bar**.

ACTIVITY 39: TURNING POINTS, ROOTS, DERIVATIVES, INTEGRALS



1. **Go to File** and **choose New Window**.
2. In the **Input Bar type f(x) = x^3+x^2-3 x-2**.
3. To find the turning points A and B in the **Input Bar type TurningPoint[f]** or from the **drop down menu** on the **extreme right** of the **Input Bar**, **select TurningPoint** and type **f** in the **square brackets**.

   Notes (i) If the **language** is **English (US)** then you will have to use **Extremum[f]**.

   (ii) By **right clicking** the **points A** and **B** and **choosing Object Properties** you can **change the names** of the **Turning Points** to something more suitable such as **turn1** and **turn2**.
4. To draw the points C, D, and E where the function f crosses the x axis or the **roots** of the function f in the **Input Bar type root[f]**.
5. To draw the **derivative** of f in the **Input Bar type derivative[f]**. This creates a new function called f′(x).

   Note: An **alternative** here would have been to **type f′(x)** into the **Input Bar**.
6. If you wanted to compare f′(x) with f(x) then **type root[f′]**in the **Input Bar** and look at the x values of the roots of f′(x) and the turning points of f(x).
7. To **graph** the **second derivative of f** in the **Input Bar type derivative[f′]. This creates a new function called f″(x)**.

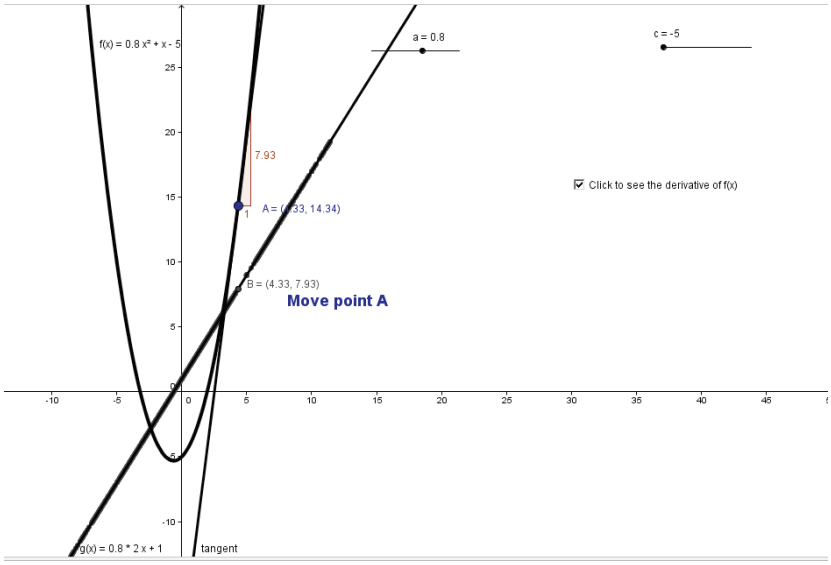
   Note: An **alternative** here would have been to **type f″(x)** into the **Input Bar**.
8. In the **Input Bar type Integral[f″].** This draws the integral of f″(x) and names it **g(x)**. It is very similar to the graph of f′(x). f′(x)=$3x^2$+2x-3 and g(x)= $3x^2$+2x.

   Notes: (i) The **integral[]** command doesn't add in the **"c"** bit of the integration.

   (ii) **Use of colour** and **show/hide checkboxes** can **make things a little clearer here**.

   (iii) Another **good command** to learn for function is **intersect []**. You will see later how the command **tangent []** is **useful to explain what the derivative is**, **comparing f(x)** and **f′(x)** in a lot **more detail than step 5.**

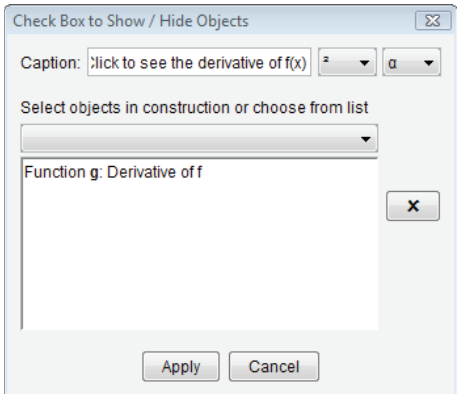
ACTIVITY 40: TO DEMONSTRATE DERIVATIVE AND SLOPE



1. **Go to File** and **choose New Window**.
2. **Select** the **slider tool**  . **Click** on the **Graphics View** and **create** a **slider** called **a**.
3. **Select** the **slider tool**  . **Click** on the **Graphics View** and **create** a **slider** called **c**.
4. **By typing f(x) =a x^2+x+c** in the **Input Bar create** a **quadratic**.
5. **Right click** on the **curve** and **go to Object Properties** and **change** the **colour** and the **style** of the **curve as required**.
6. **Select** the **New Point tool**  . **Click** on **f** and **create** a **point A** on **f(x).**
7. In the **Input Bar** type the word **Tangent[A, f(x)].**

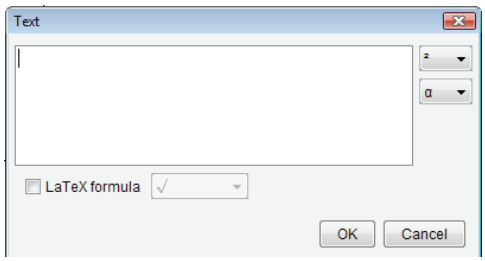
8. **To find** the **slope of the tangent** at the **point A**. **Select** the **Slope Tool**  . **Click** on the **Tangent**.
9. **To create** a **point B**, type **B=(x(A), m)** in the **Input Bar.**
10. **Right click** on the **point B** and **click** the **Trace on box**.
11. In the **Input Bar type g(x)=f'(x).**

    Note: Take note of the **relationship between the trace when you drag point A** and the **curve** of the **function of g(x).**
12. **Select** the **Check Box** to **Show / Hide Object Tool**  . **Click** on the **Graphics View** and **complete** the **new dialogue box** that appears as **follows**:



13. **Click Apply**.
14. **Move** the **point A**.
    Note: The **route of the trace of the point B follows** the **g(x)** which is the **derivative of f(x)**.
15. **Select** the **Insert Text tool** 

. **Click** on the **Graphics View** and a **new dialogue box appears**.



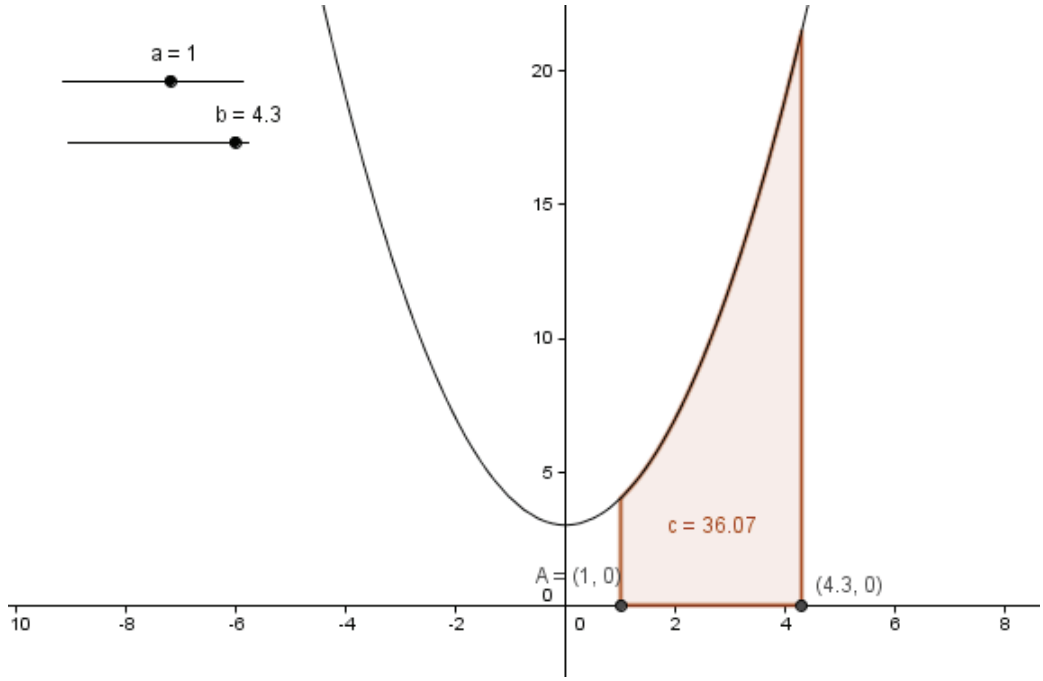
16. **Type** the following in the **dialogue box**: **"f(x) = "+f**
17. **Click** on the **Insert Text tool** 

. A **new dialogue box appears**.
18. **Type** the following in the **dialogue box**:

    "g(x) = "+g
19. **Change** the **colours** of the **graphs** to **make** it **easier** to **distinguish between them**.

    Note: The **Differentiation of a cubic function** can be **demonstrated** in the **same manner** as the **quadratic above**.

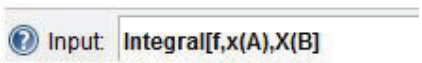
ACTIVITY 41: TO DEMONSTRATE INTEGRATION AND AREA



1. **Go to File** and **choose New Window**.
2. **By typing f(x)=x^2+3 draw** the **function f(x) = x^2+3**.
3. **Select** the **Slider tool** 

. Click on the **Graphics View** and **create** a **slider** called **a.**
4. **Select** the **Slider tool** 

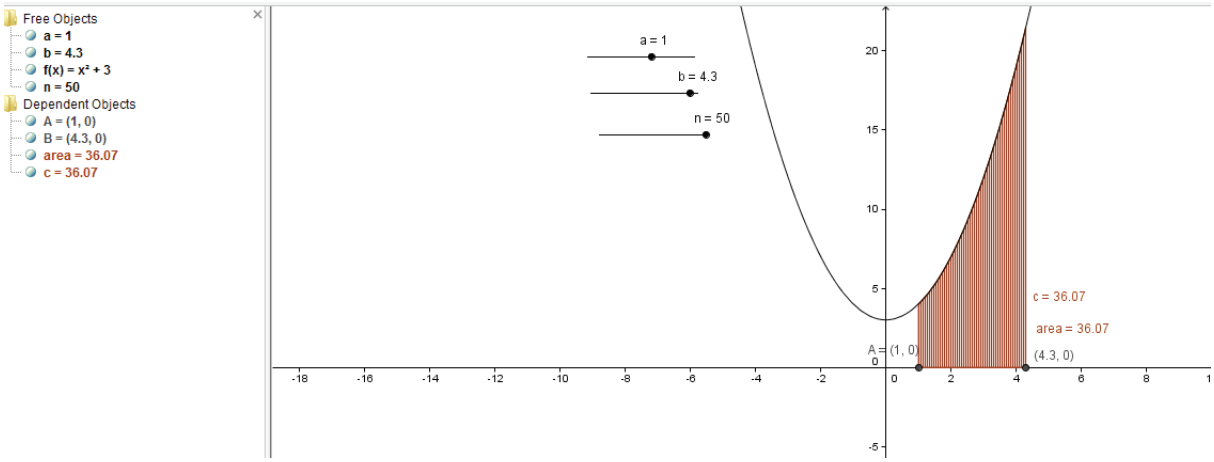
. Click on the **Graphics View** and **create** a **slider** called **b.**
5. **Move** the **slider b** to a **different value** to **a.**
6. In the **Input Bar type (a, 0)** and **press return**. The **point A(a,0)** will **now** be **marked** on the **diagram**.
7. In the **Input Bar type (b, 0)** and **press return**. The **point B(b,0)** will now be **marked** on the **diagram**.
8. In the **Input Bar choose** the **command Integral** from the **drop down menu** at the extreme right of the **Input Bar** and **inside the brackets type f,x(A),x(B).**



Note: x(A) takes the x value of the point A.

9. **Move** the **points A** and **B** to see **how the area c changes**.

ACTIVITY 42: INTEGRATION AND THE TRAPEZOIDAL RULE

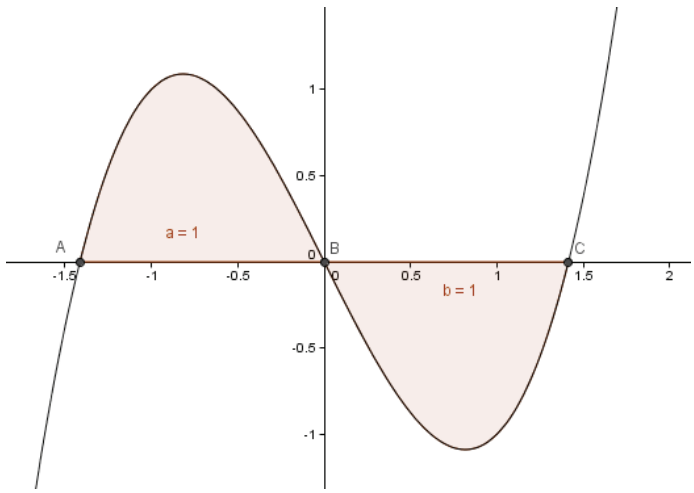


1. **Go to File** and **choose New Window**.
2. **Create** and find the **integral of the function** as in the **activity above**.
3. **Select** the **Slider tool** 

. Click on the **Graphics View** and **create** a **slider** called **n** with **min:=1**, **max: =50** and **Increment:= 1**.
4. In the **Input Bar** type **b= TrapeziumSum[f,x(A),x(B),n].**
5. **Move** the **slider n** and as **n gets larger check** the **relationship between c** and **area.**

Note: The **value** for the **Trapezoidal area** should have the **same value** as **c**, **the integral value between A** and **B** when **n = 50**.

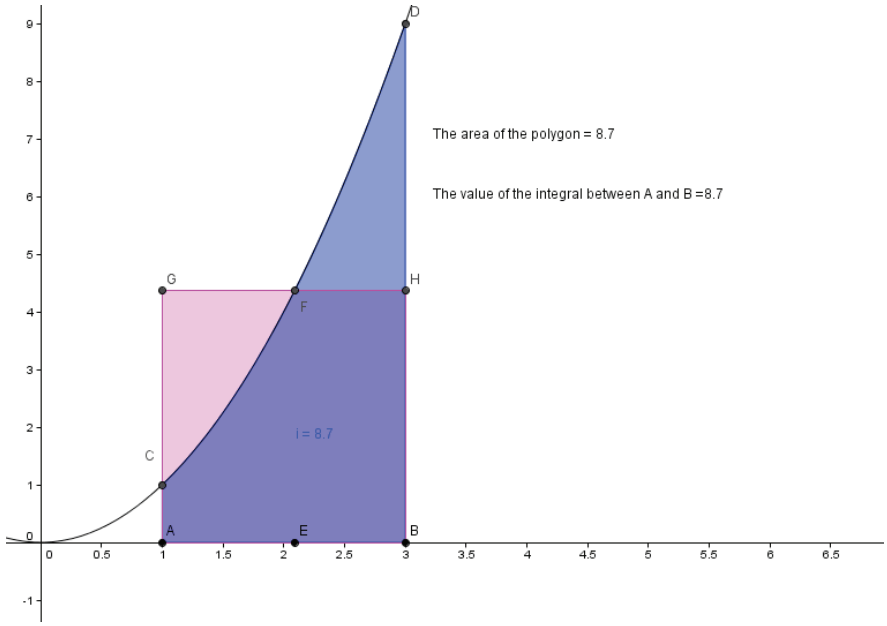
ACTIVITY 43: TO FIND THE AREA BETWEEN A CURVE AND THE X AXIS, WHERE THERE IS A SECTION BELOW AND A SECTION ABOVE THE X AXIS



1. **Go to File** and **choose New Window**.
2. **Draw** a **curve** for example **f(x) = x^3-x** by typing **f(x)=x^3-x** in the **Input Bar**.
3. **Select** the **Intersect Two Objects tool** 
. Click on the **curve** and the **x axis** to **find** the **points of intersection A, B** and **C** of the **curve** and the **x axis**.

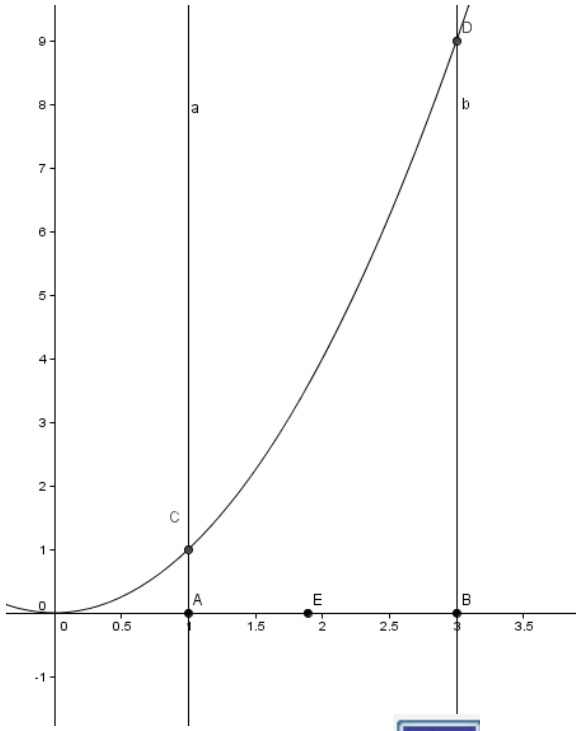
4. In the **Input Bar type a=Integral[f,x(A),x(B)].**
5. In the **Input Bar type b=Integral[f,x(C),x(B)]. Note**. The order of **A, B** and **C**.
6. In the **Input Bar type t=a+b** to get the **total area between the curve** and the **x axis**.

ACTIVITY 44: TO DEMONSTRATE THE AVERAGE VALUE OF A CURVE BETWEEN 2 POINTS

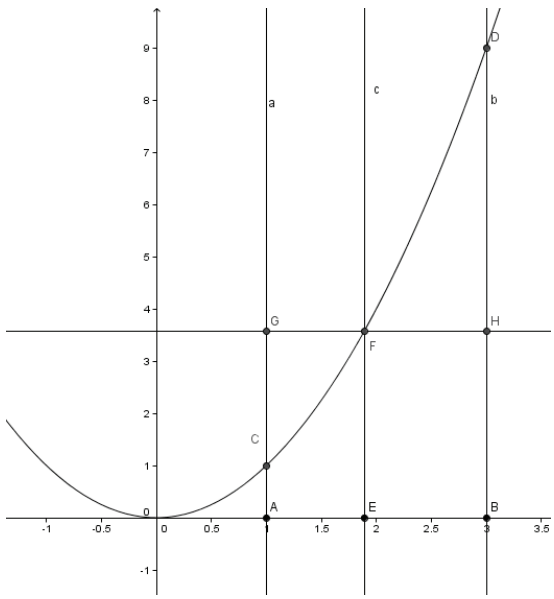


For example, f(x) = x^2 between x=1 and x = 3

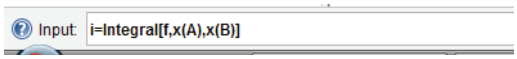
1. **Go** to **File** and **choose New Window**.
2. By typing **f(x)=x²** in the **Input Bar, draw** a **curve** for example **f(x) = x²**.
3. **Select** the **Move tool**  . **Click** on the **x axis** and **drag** to the **right** to **extend** the **x axis.**
4. **Create point A** at **(1,0)** and **point B** at **(3,0).**
5. **Select** the **Perpendicular Line tool**  **. Click** on **point A** and the **x axis** to **draw** a **line *a* perpendicular to** the **x axis** at **A**.
6. **Select** the **Perpendicular Line tool**  **. Click** on **point B** and the **x axis** to **draw** a **line *b* perpendicular to** the **x axis** at **B**.
7. **Select** the **Intersect Two tool**  **. Click** on the **line a** and the **function f** to **find** the **point of intersection C** of the **line a** and the **function f**.
8. **Select** the **Intersect Two tool**  **. Click** on the **line b** and the **function f** to **find** the **point of intersection D** of the **line b** and the **function f**.
9. **Select the New Point tool**  **. Click Create** on the **x axis between** the **points A** and **B to create** a **point E**.



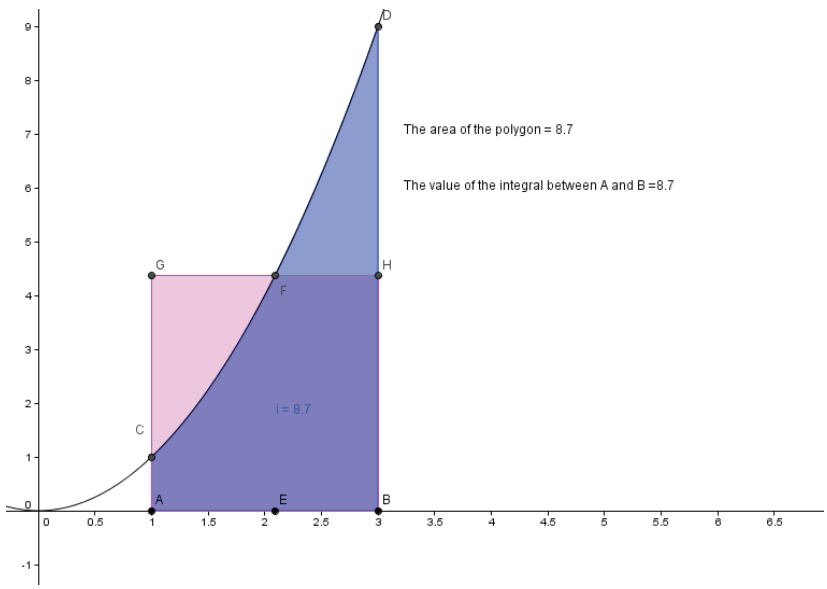
10. **Select the Perpendicular Line tool**  **. Click** on the **x axis** and the **point E** to **draw** a **line *c* perpendicular to** the **x axis** at the **point E**.
11. **Select the Intersect Two Object tool**  **. Click on the line c and the function f to find** the **point of intersection F** of **line c** and the **function f.**
12. **Select** the **Parallel Line tool**  . **Click** on the **point F** and the **x axis** to **draw a line d** through the **point F parallel to** the **x axis**.
13. **Select** the **Intersect Two Object tool**  **. Click on the line d** and **the line a** to **find** the **point of intersection G** of the **line d** and the **lines a**.
14. **Select** the **Intersect Two Object tool**  **. Click on the line d** and **the line b** to **find** the **point of intersection H** of the **line d** and the **lines b**.



15. **Right click** on the **lines a**, **b**, **c** and **d** and **deselect Show Object**.
16. **Select** the **Polygon tool**  .**Click** on the **points A, B, H, G and A to** draw the **polygon ABHG.**
17. **Right click** on the **polygon ABHG**, **choose Object Properties** and with the **Color tab open choose** a **bright pink colour** and with the **Style tab open choose** a **Filling** of **50**.
18. In the **Input Bar type i= Integral[f,x(A),x(B)].** This will return the **value of the area between the curve** and the **x axis** in the **interval x=1** to **x=3**.



19. **Right click** the **Integral** in the **Algebra View** and with the **Color tab open choose** a **bright blue**.
20. **Move** the **point E along** the **x axis** until the **area** of the **polygon ABHG** is equal to the **value** of the **Integral i**. At this point **the area of the pink section** of the **polygon will equal the area of the blue section on the diagram**. Hence the **y value** of **point F** is the **average value** of the **curve between A and B**.



21. **Checkboxes to Show / Hide Objects** and **Text boxes** may be added.

PEDAGOGICAL REFLECTION | EXPLORATIONS | TIPS

Take a moment in pairs to explore how you might use the materials in Module 3 with your students. Discuss how you might apply what you have learned in your classroom and share links to websites or web tools that you find useful.

Teaching ideas and suggestions:

Your Tutor will gather the group's ideas and suggestions and post them to the wiki **www.ncte.ie/ictmathswiki** where you will be able to share your teaching ideas with other Maths teachers.

Project Maths Tionscadal Mata Development Team

National Centre for Technology in Education
Ionad Náisiúnta don Teicneolaíocht san Oideachas

NCTE PROFESSIONAL DEVELOPMENT

ICT AND MATHS – PART 2

APPENDICES

APPENDICES

APPENDIX A: HOW TO DOWNLOAD GEOGEBRA

The GeoGebra software package is available free at http://www.geogebra.org/cms/. It is recommended that the **Download GeoGebra** version be used, rather than the GeoGebra Webstart version. The notes, screenshots and diagrams are based on Version 3.2.46.0.

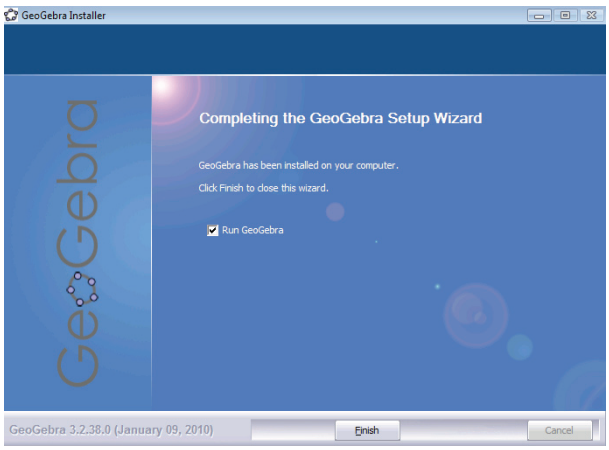
In order for GeoGebra to work on a computer, one also needs the latest version of a program called Java; this is available free at http://www.java.com/en. The current version of Java is version 6 and instructions on how to download Java are available in Appendix B.

INSTRUCTIONS FOR DOWNLOADING GEOGEBRA

Note: These instructions may alter if the layout of the GeoGebra website changes.
The version used in this manual is **3.2.46.0**. Go to http://www.geogebra.org/cms/.

1. Click the **Download** button and **select** the version suitable for your computer e.g. GeoGebra 3.2 for Windows (Server 2).
2. **Click Run** in the new window which appears. The installation process will start and this will continue for a few minutes depending on download speed.
3. When the following Security window appears **click Run** and follow any instructions that appear.

4. **Choose 'English'** as the language you'd like to use in the next dialogue box and then **click Next.**
5. **Click 'I agree'** when the **Licence Agreement** window appears and follow the wizard by clicking **Next** until '**Install**' appears. Click **Install**.
6. When this window appears click **Finish**.



GeoGebra is now installed on your computer.

HOW TO CHANGE THE LANGUAGE USED BY THE APPLICATION IF REQUIRED

Go to **Options** in the **Menu** and from the **drop down menu choose Language** and **English (UK)**.

The different versions of the English language use different words e.g. the  tool in **English (UK)** uses **Enlarge Object from a Point by Factor** but **English (US)** uses **Dilate Object from a Point by Factor**. If using English (US) you will need to use the function GCD instead of HCF.

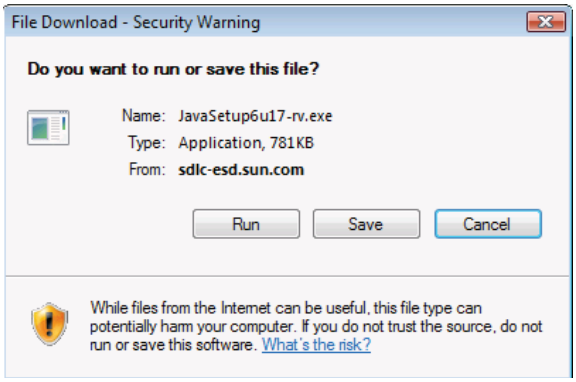
APPENDIX B: HOW TO DOWNLOAD JAVA

In order for GeoGebra to work on a computer, one also needs the latest version of a program called Java; this is available free at http://www.java.com/en. The current version of Java is version 6.

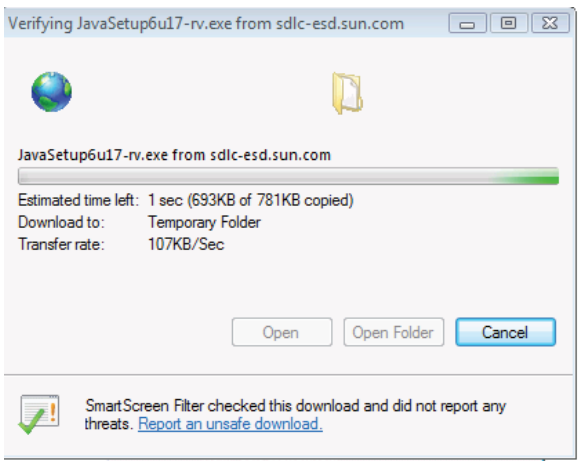
INSTRUCTIONS ON DOWNLOADING JAVA

Go to http://www.java.com/en/ and **click Free Java Download**.

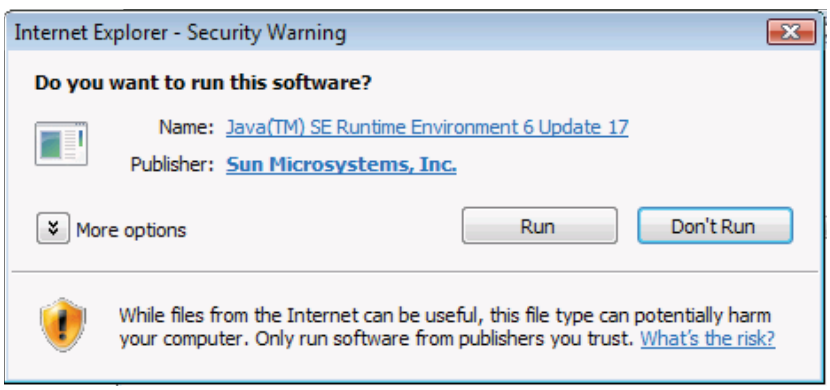
The following window appears. Click **Run**.



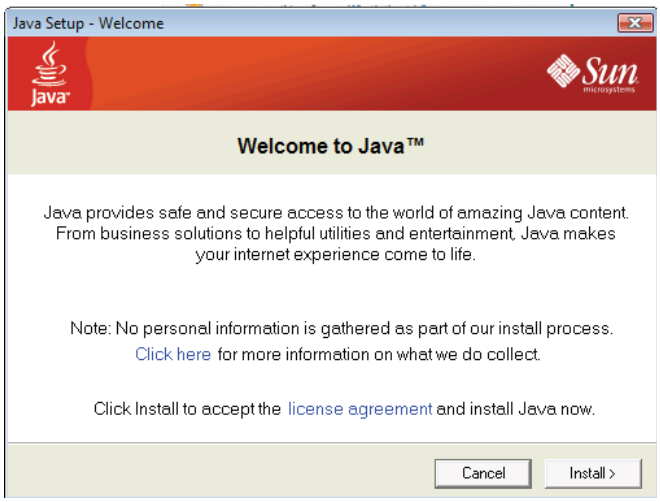
The Java Setup window will appear.



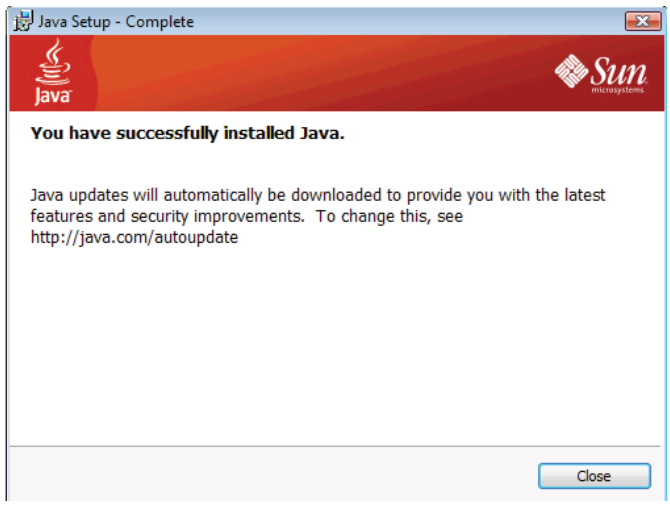
Eventually this Security window will appear. **Click Run**.



When the **Welcome** window appears **click Install** and **follow the wizard**.



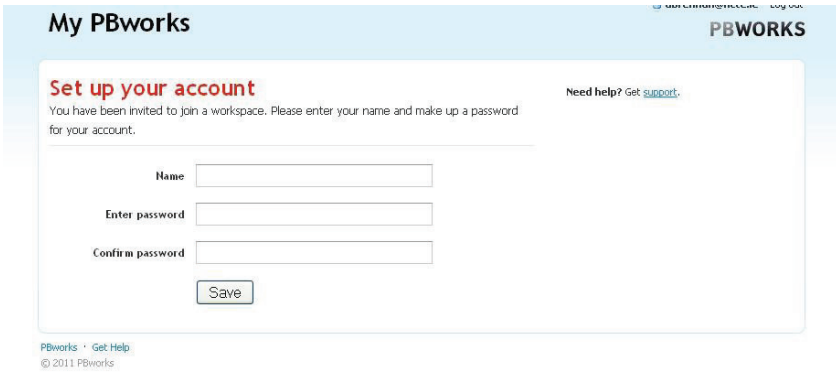
When the "**You have successfully installed Java**" window below appears **click Close.**



The latest version of Java should now be installed on your computer.

APPENDIX C: ACCESSING AND USING THE COURSE SUPPORT WIKI

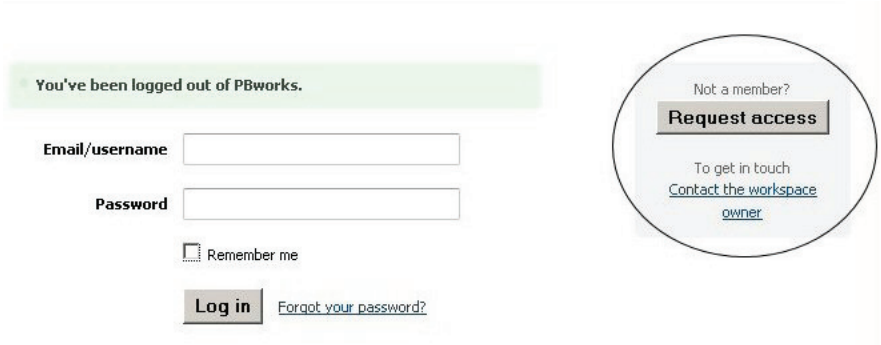
The accompanying wiki for the course can be found at: www.ncte.ie/ictmathswiki Where possible, the NCTE will send you an email invitation to join the wiki before you attend Module 1. Simply click on the Join the Workspace link in the invitation email to set up your wiki account.



Once you **Save** your new account details, the wiki will open. If you need any assistance, click the Get Help link.

Alternatively, at the beginning of Module 1 your tutor will help you to Request Access to the wiki:

1. Enter www.ncte.ie/ictmathswiki into your browser address bar and click the Request Access link on the right-hand side of the page.



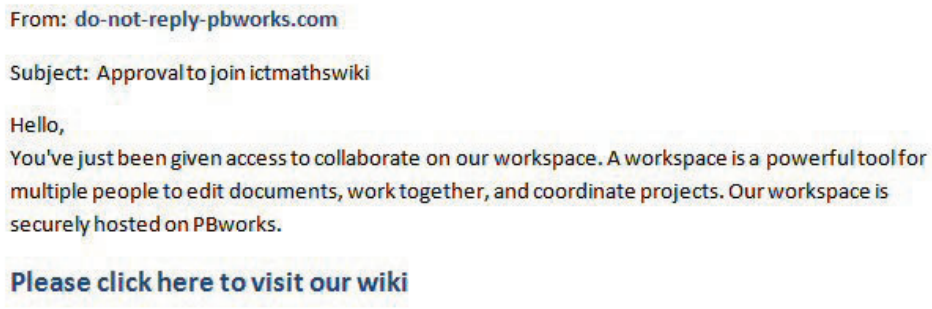
2. Using your own email address type the following into the request box:

   "Your Name, School Roll Number in *Tutor's Name* course group on the *Date* in *Education Centre venue* would like to join this wiki workspace."

   e.g. Seán Boyle (sboyle@hisownemailaddress.ie) writes:

   Seán Boyle, 12345A in John Brown's course group on the 29/03/2011 in Sligo Education Centre would like to join this wiki workspace.

3. The NCTE ICT and Maths wiki is hosted by PBworks and you will receive a confirmation email from PBworks.


From: do-not-reply-pbworks.com

Subject: Approval to join ictmathswiki

Hello,
You've just been given access to collaborate on our workspace. A workspace is a powerful tool for multiple people to edit documents, work together, and coordinate projects. Our workspace is securely hosted on PBworks.

Please click here to visit our wiki

Clicking on the Please click here link will bring you to the Set up your Account window as above.

USING THE COURSE WIKI

Each participant is encouraged to create and share teaching resources in the Teacher Uploads page for their group. There is an uploads folder for each course venue. All uploaded resources will be collated after the courses and a best practice folder will be created and it and the wiki will be shared online in Scoilnet.

Any work shared must be the original work of the participant uploading to the wiki. All participant uploads to the NCTE ICT and Maths wiki are subject to the conditions of the Creative Commons CC0 'No rights Reserved' license: http://wiki.creativecommons.org/CC0_FAQ. You may only upload files in the NCTE ICT and Maths wiki that are compatible with this license which allows free use, free distribution, derivative work by others and the waiving of all copyright.

By sharing work, participants agree to waive and relinquish copyright and agree to the work being shared by the NCTE without attribution.

To upload to your group's page and folder:

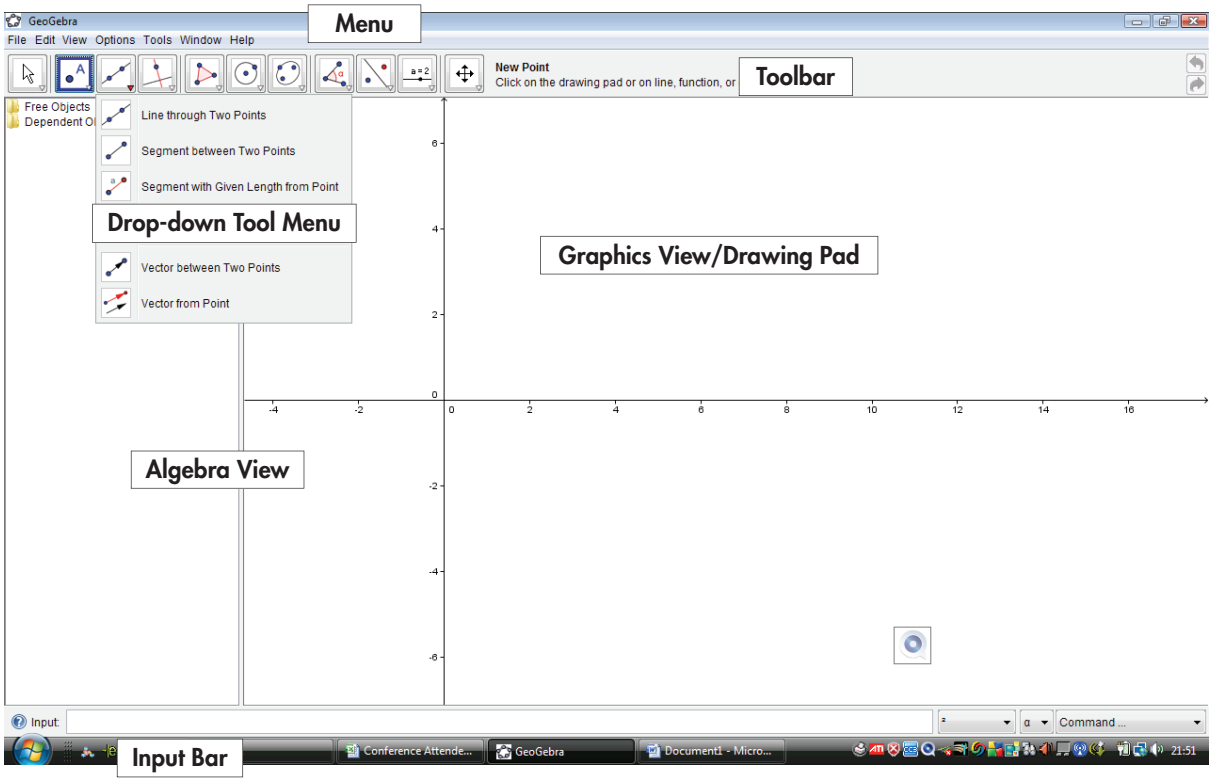
1. In www.ncte.ie/ictmathswiki click Teacher Uploads Page.
2. Select your group's page (Groups are arranged by Education Centre venues).
3. Open your uploads folder by clicking on the link marked 'here' and follow the instructions on the page.

APPENDIX D: GEOGEBRA INTERFACE, TOOLBAR, TOOL GUIDE, DROP-DOWN MENUS AND TOOLBAR SETTINGS

The GeoGebra software package is available free at http://www.geogebra.org/cms/ and it is recommended that the **Download GeoGebra** version be used, see Appendix A. These notes and screenshots are based on Version 3.2.46.0., language version English (UK).

THE GEOGEBRA INTERFACE

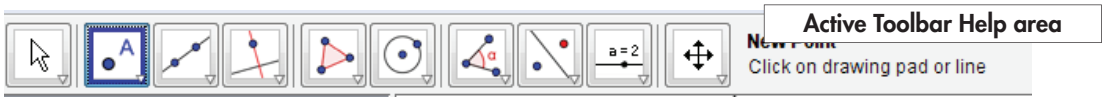
The following diagram demonstrates the **GeoGebra interface**.



Note: The **Graphics View** is known as the Drawing Pad in some versions of GeoGebra.

THE GEOGEBRA TOOLBAR

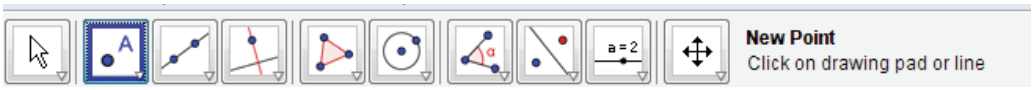
The **Active Toolbar Help area** shows the tool that is currently open and the instructions to be followed when using that tool are also displayed in this area.



Note: Once a tool has been used that tool remains as the visible one on the toolbar.

CONSTRUCTION TOOLS

The **Construction tools**, for example, the **New Point tool**  are found on the **Toolbar.**



ALGEBRA VIEW

To show or remove the **Algebra View**, go to **View** and **click Algebra View**.

INPUT BAR

This bar enables one to input formulas and commands for constructions. To show or remove the **Input Bar**, go to **View** and **click Input Bar.**

SELECTING ITEMS

In order to select anything in GeoGebra, **click** on the **Move tool**  and next, **click** on the item.

TO UNDO THE LAST ACTION

Go to **Edit** and **click Undo or click** the **Undo button**  at the top right hand side of the screen.
Note this can only be done until the last save.

TO ZOOM IN AND OUT OF A CONSTRUCTION

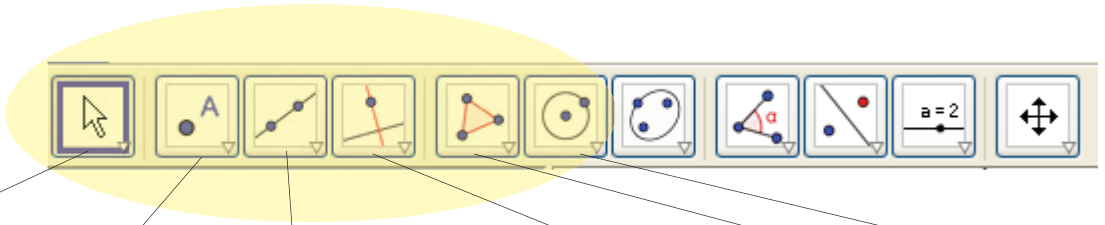
Use either the **Zoom In tool**  or the **Zoom Out tool**  .

TO CHANGE THE APPEARANCE OF AN OBJECT

Right click on the object for example a point, **choose Object Properties** and make the required changes using the various options and tabs available.

TOOL GROUPINGS DROP-DOWN MENUS: FIRST SIX DROP-DOWN MENUS FROM THE LEFT

By following the drop down arrow in each section of the toolbar, e.g. the drop-down arrow ▽ beside the **New Point tool**  alternative tools can be found in its **drop-down menu.**



Tool group first on the left

- Move
- Rotate around Point
- Record to Spreadshe

Tool group second from the left

- New Point
- Intersect Two Objects
- Midpoint or Center

Tool group third from the left

- Line through Two Points
- Segment between Two Points
- Segment with Given Length from Point
- Ray through Two Points
- Vector between Two Points
- Vector from Point

Tool group fourth from the left

- Perpendicular Line
- Parallel Line
- Perpendicular Bisector
- Angle Bisector
- Tangents
- Polar or Diameter Line
- Best Fit Line
- Locus

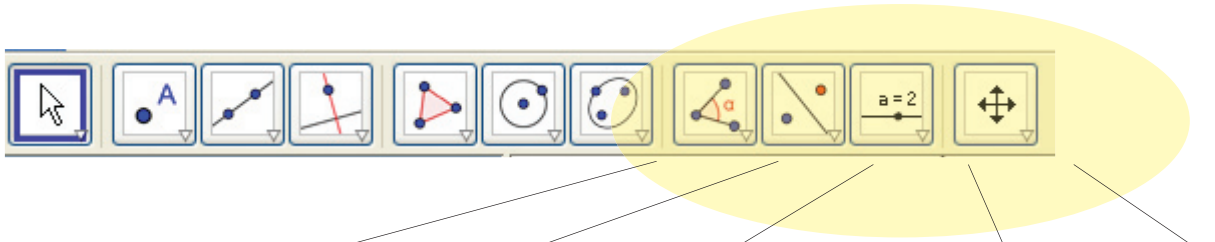
Tool group fifth from the left

- Polygon
- Regular Polygon

Tool group sixth from the left

- Circle with Center through Point
- Circle with Center and Radius
- Compass
- Circle through Three Points
- Semicircle through Two Points
- Circular Arc with Center between Two Points
- Circumcircular Arc through Three Points
- Circular Sector with Center between Two Points
- Circumcircular Sector through Three Points

TOOL GROUPINGS DROP-DOWN MENUS: THE FIVE DROP-DOWN MENUS FROM THE RIGHT



Tool group fifth from the right

- Ellipse
- Hyperbola
- Parabola
- Conic through Five Points

Tool group fourth from the right

- Angle
- Angle with Given Size
- Distance or Length
- Area
- Slope

Tool group third from the right

- Reflect Object about Line
- Reflect Object about Point
- Reflect Point about Circle
- Rotate Object around Point by Angle
- Translate Object by Vector
- Dilate Object from Point by Factor

Tool group second from the right

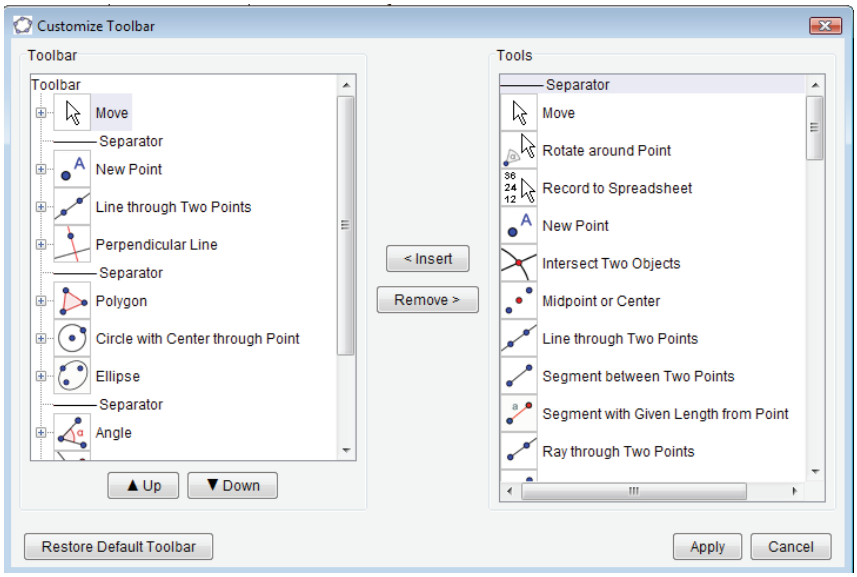
- Slider
- Check Box to Show / Hide Objects
- Insert Text
- Insert Image
- Relation between Two Objects

Tool group on the extreme right

- Move Drawing Pad
- Zoom In
- Zoom Out
- Show / Hide Object
- Show / Hide Label
- Copy Visual Style
- Delete Object

TO REMOVE ITEMS FROM TOOLBAR

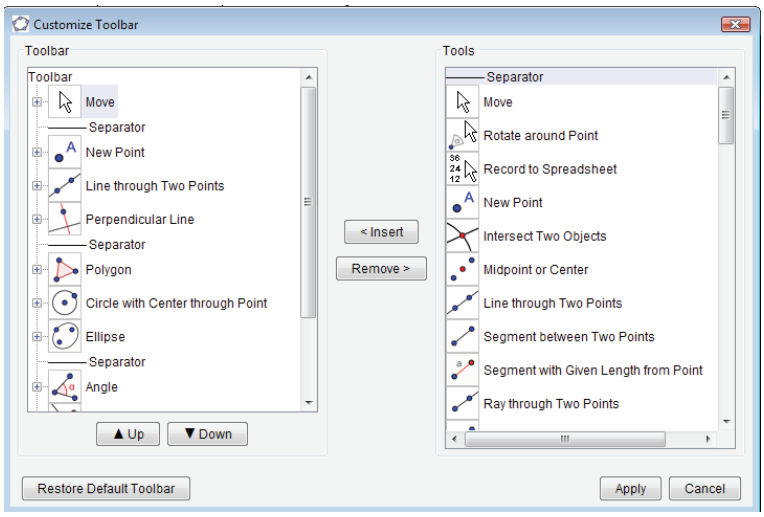
1. **Go** to **Tools** and **choose Customize Toolbar**. A **new dialogue box appears**.



2. **Click on** the **tool** that you **wish to remove** on the **left hand side** of this **dialogue box** and **click Remove**.
3. Continue for the **other tools** you **wish to remove**.
4. **Click Apply**.

TO ADD ITEMS THAT ARE NOT CURRENTLY ON YOUR TOOLBAR

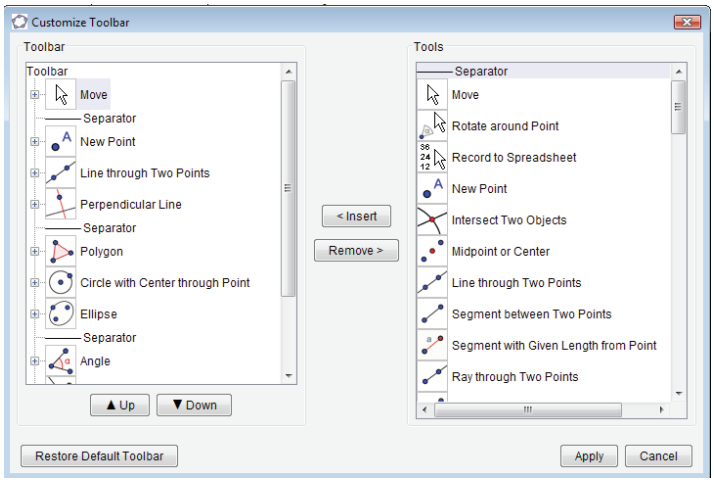
1. **Go** to **Tools** and **choose Customize Toolbar**. A new dialogue box appears.



2. **Click on** the **tool** that you **wish to tool** on the **right hand side** of this **dialogue box** and **click Insert**.
3. Continue for the **other tools** you wish to add.
4. **Click Apply**.

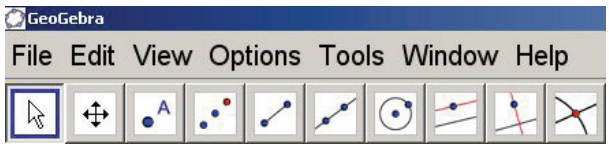
TO RESTORE THE DEFAULT TOOLBAR

1. **Go** to **Tools** and **choose Customize Toolbar**. A new dialogue box appears.



Click **Restore Default Toolbar** and **click Apply.**

GEOGEBRA HELP FILES



Clicking on the **Help menu** in GeoGebra will automatically launch your browser and open up the GeoGebra online help documentation. This can be searched by either going through the **Contents** section or by using the **Search** function and entering a keyword.

GeoGebra Online www.geogebra.org/cms/

Course Support Wiki: www.ncte.ie/ictmathswiki

APPENDIX E: SOME GEOGEBRA FUNCTIONS AND USEFUL TIPS

TO DRAW A VECTOR BETWEEN TWO POINTS

Create two points. Go to the Vector between Two Points tool  , click on the point you want the vector to start from and then click on the point you wish the vector to finish at.

TO CREATE A POLYGON SHAPE

Draw 3 or more points. Go to the **Polygon tool**  and **click** on the points that are to form the polygon, not forgetting to **re-click** the first point.

TO DEMONSTRATE A REFLECTION IN A LINE

Create a polygon and a line, if using a line other than the X or Y axis. Go to the **Mirror Object about Line tool**  and **click** on the polygon plus the line or the X or Y axis. Now **drag** the line and or the polygon to different locations and see the image change accordingly.

TO DEMONSTRATE A REFLECTION IN A POINT

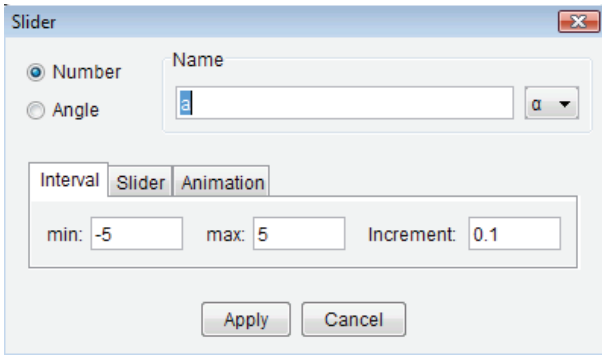
Create the polygon and the point in the usual way. **Click** on the **Mirror Object about Point tool**  and **click** on the polygon and the point. Now **drag** the point and the polygon to different locations etc. and see the image change accordingly.

TO DEMONSTRATE HOW TO USE A VECTOR TO TRANSLATE A POLYGON

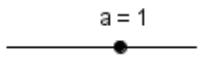
Create a polygon in the usual way and create the vector that you wish to use for the translation. Go to the **Translate Object by Vector tool**  and **click** on the polygon, followed by the vector. Note both the vector and the polygon can be changed and see how the image changes accordingly.

TO CREATE A SLIDER

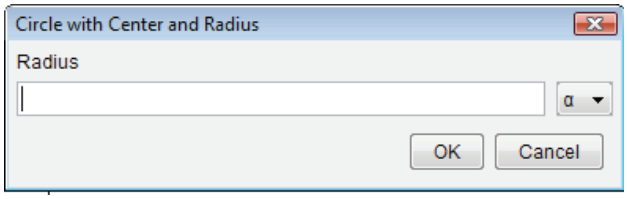
1. Go to the **Slider tool** and **click** on the screen, where you want your slider located. A new dialogue box appears.



2. Choose if you want the slider to be an angle or a number. Give it a name. Choose the min, max values and the increment you want it to go up in. **Click Apply**. The slider appears as follows on the screen.



3. For example if you want to draw a circle with a varying radius, go to the **Circle with Centre and Radius tool** and **click** on the screen where you want the centre of the circle to be. A new box appears asking you for the **Radius.**



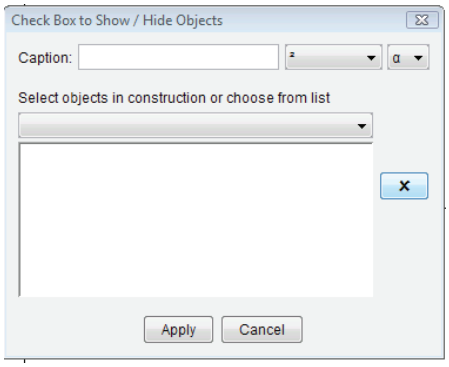
4. Type in the name of the created slider and **click OK**.
5. **Drag** the slider and see the size of the circle changing. Sliders created with angle values can be used to create angles with varying size.

TO INSERT AN IMAGE

Go to **Insert Image tool** and **click** at the location on the Drawing Pad where you want to place the image. A new box appears. **Select** your picture and **click Open**. Be careful as a lot of pictures are too big and will need to be edited to the size you require using alternative software.

TO USE THE CHECK BOX TO SHOW / HIDE OBJECTS

1. **Click** on the **Check Box to Show / Hide Objects**  and **click** on the Drawing pad at the location you require the check box to appear. A new dialogue box appears.

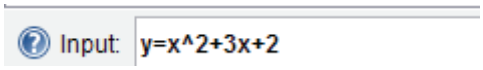


2. In the new dialogue box that appears, type in your caption for example "Click to hide or show the circle". Follow the arrow under '**Select objects in construction or choose from list**' in the dialogue box and in this case choose the circle. You can select more than one object here. **Click Apply**.

3. With the Selection arrow clicked, **click** the check box and the circle **disappears**.

TO DRAW A GRAPH

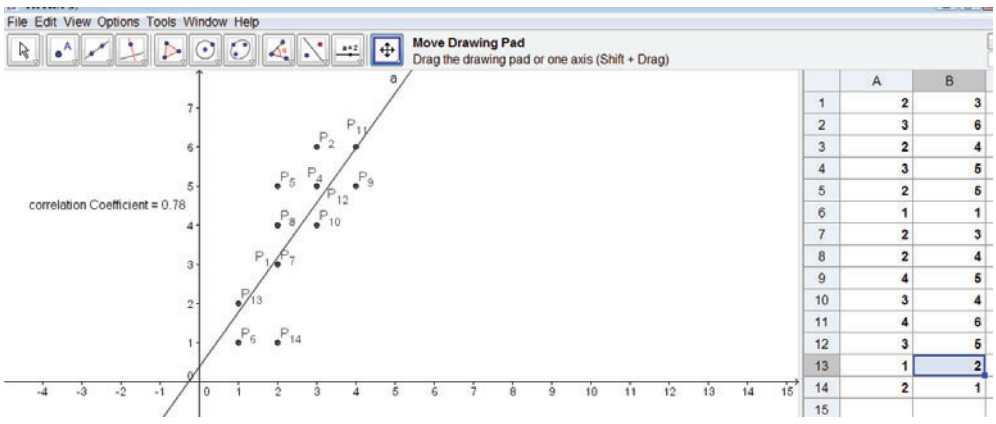
1. Go to where it says **Input** at the bottom of the screen, type in your equation eg. y=x^2+3x+2 and **press Enter**. Note x^2, means x^2.



TO CHANGE THE COLOUR, STYLE ETC. OF THE GRAPH

1. **Click** on the graph, **right click** and choose **Object Properties** and choose the **Colour, Style**, etc.

TO DRAW A SCATTER PLOT AND SHOW CORRELATION

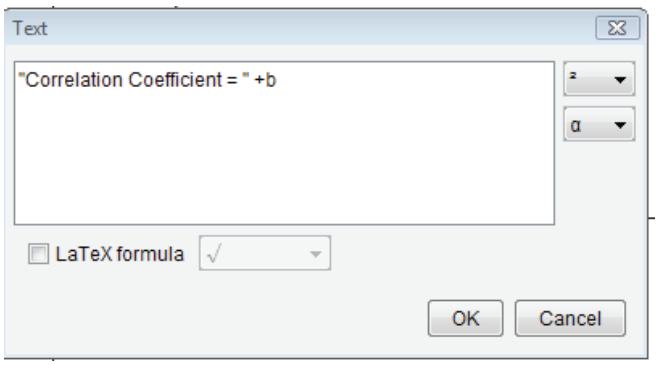


1. If the **Spreadsheet View** is not visible go to **View** and click **Spreadsheet View**.
2. Type the following table into the **Spreadsheet View**.

	A	B
1	2	3
2	3	6
3	2	4
4	3	5
5	2	5
6	1	1
7	2	3
8	2	4
9	4	5
10	3	4
11	4	6
12	3	5
13	1	2
14	2	1
15		

3. **Select** the cells **A2:B14**. **Right click** and **select Create List of Points**.
4. The name of the list of points, *list1*, or whatever name it has been allocated will now appear in the **Algebra View**.
5. To draw the line of Best Fit, go to the **Line of Best Fit Tool**  . **Drag** the cursor to create a rectangle over all the points in the **Drawing Pad.**
6. Calculate the correlation. (To calculate the correlation, go to the drop down menu at the far right hand side of the **Input Bar**). **Select Correlation Coefficient**.

7. Inside the square brackets after **Correlation Coefficient** type list1 or the name of your list of points. Press Enter. The value for the correlation coefficient will now appear in the Algebra View.
8. To show the correlation coefficient in a textbox, go to the **Insert Text tool**  and click on the **Drawing Pad** at the location you require the textbox to appear.



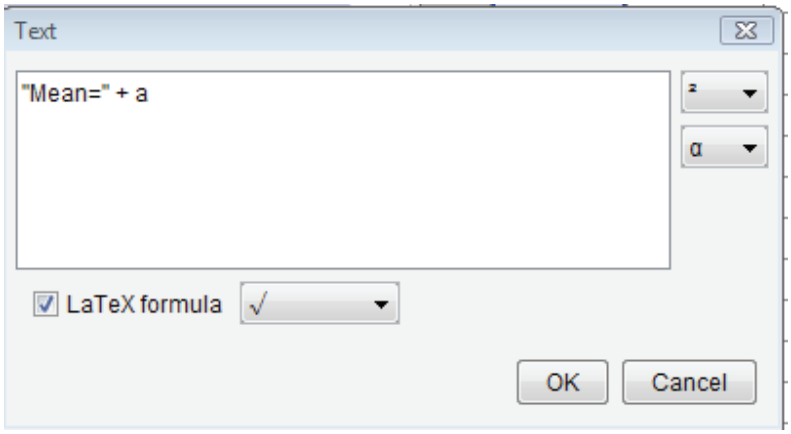
9. In the dialogue box that appeared type *"Correlation Coefficient = "+b* or replace the b by whatever your correlation coefficient is known as. With the **LaTeX formula** button in the dialogue box unclicked, **click OK**.
10. Change the values in the **Spreadsheet View** and see the **Scatter Plot**, **Line of Best Fit** and **Correlation change**.

TO FIND THE MEAN, MEDIAN AND MODE OF A DATA SET

	A
1	12
2	13
3	14
4	15
5	16
6	12
7	13
8	14
9	15
10	15

1. **Open** the **Spreadsheet View** and insert the data in **column A**.
2. **Highlight** the **data in column A**. **Right click** and select **Create List**.
3. As the list will automatically be called L_1 in the **Algebra View,** it is easier if one **right clicks** it in the **Algebra View** and selects **Rename** and give it the name L.
4. To calculate the mean, go to the drop down menu at the far right hand side of the **Input Bar** and **select Mean**.

5. Inside the square brackets after **Mean** type L or the name of your list of points. The value for the mean will now appear in the Algebra View.
6. Go to the **Insert Text Tool**  and a new dialogue box appears.



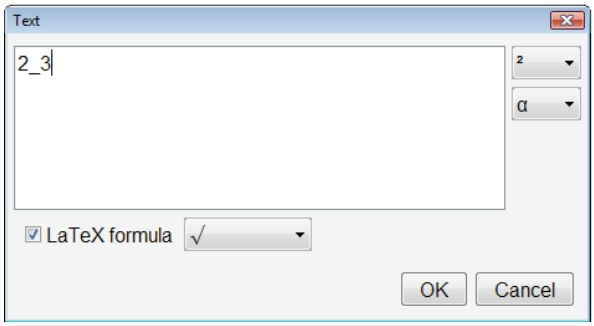
7. Type the text "Mean="+a in this dialogue box and with **LaTeX formula button** in the dialogue box unclicked **click OK**. The following text `Mean=13.9` should now appear on the **Drawing Pad**.

TO CALCULATE THE MEDIAN OR MODE OF A DATA SET

Replace **Mean** in the previous 7 instructions by **Median or Mode**, whichever is required.

USEFUL TIPS

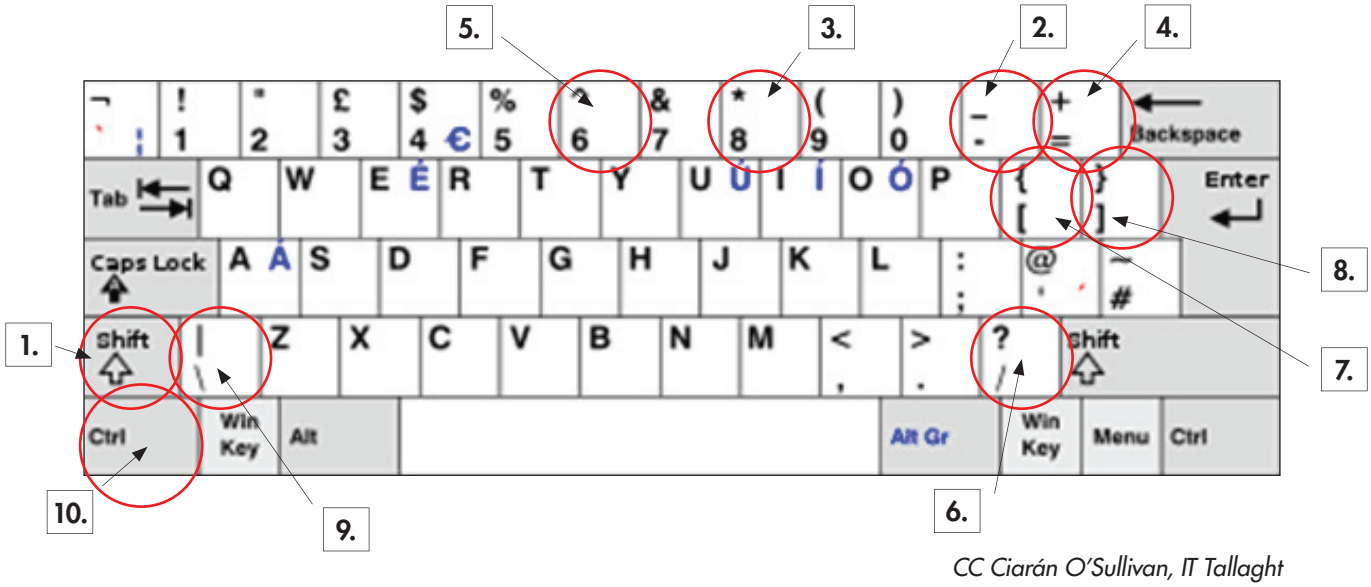
- **Clicking** the **dots** beside **the objects** in the **Algebra View** can **show/hide objects** quickly.
- When you have **object properties open** and you want to **change** the **properties** of a **lot of points/ lines/segments/functions** then **you can click on one object**, hold **down Shift key** and **use** the **arrow key** to **highlight lots of objects (in a row)** and then **change the properties** (e.g. colour or labelling) of **all of them at once**.
- If you **wanted to change the properties** of **objects** that **don't appear directly underneath one another** then **hold down Ctrl** and **click** on **each object** you want to **highlight** and then **change the properties** of **all** of them.
- **Press Ctrl+z** to **undo**.
- **Press Ctrl+y** to **redo.**
- **Press Ctrl+F** to **refresh** the **page** and clear any traces.
- **Press Ctrl+Shift+A** to **open** and **close** the **Algebra View.**
- **Press Ctrl+Shift+P to export** the **graphics view** as a **picture**.
- When using the **Insert text tool** with the **LaTeX tab** ticked and you **require spaces between words type\:** between each of the words.
- **To get subscript, type** in a **text box,** for example, **2_3, click** the **LaTeX formula box** and **click OK. This gives 2_3.**



APPENDIX F: HOW TO FIND SPECIAL KEYS ON THE KEYBOARD

Special keys used in constructions (highlighted 1 – 10 on the keyboard diagram below) can be found by clicking on the combination of keys listed in the grid.

Number on picture below	Operation needed	How to get
1	Shift key Shift	
2	_ , underscore - _	Holding down Shift press - _
3	* 8 multiplication *	Holding down Shift press * 8
4	= + =	+ = plus holding down Shift press
5	^ 6 power of	Holding down Shift press ^ 6
6	/ ? / Divide or back slash	Divide or back slash
7	{ [Left chain brackets	Holding down Shift press { [
8	}] Right chain brackets	Holding down Shift press }]
9	| \ the modulus line	Holding down Shift press | \
10	CTRL Ctrl	



CC Ciarán O'Sullivan, IT Tallaght

APPENDIX G: SAVING GEOGEBRA FILES

SAVING GEOGEBRA FILES

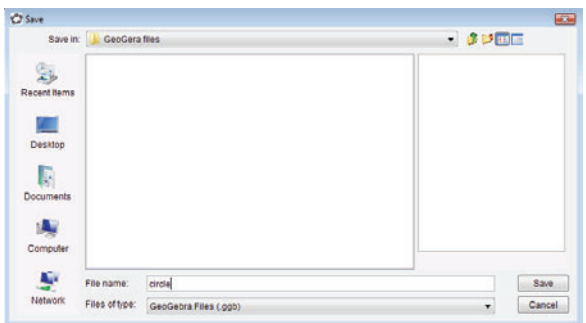
You will wish to save your work. All GeoGebra files are saved with the file extension **.ggb** which identifies the file as a **GeoGebra file.** Once saved a file can be opened again and adjustments made using the **GeoGebra application**.

USING SAVED GEOGEBRA FILES

To share your work with your students or to upload your work to the Support Wiki to share with other teachers you will need to save your GeoGebra file and then either save as a picture, copy it to the clipboard or export as a webpage. Each method is outlined below.

HOW TO SAVE A FILE AS A GEOGEBRA FILE

1. Go to the **File Menu** and choose **Save as**. A new dialogue box appears.

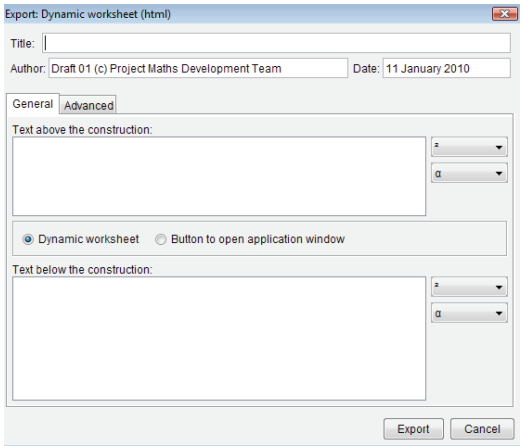


2. For **Save in, select** the folder that you wish the folder to be saved in.
3. For **File name** select the name you wish to give your file.
4. **Click Save**. A file with the **.ggb extension** is created. This extension identifies the file as a **GeoGebra file** and it can be opened again and adjustments made using the **GeoGebra application**.

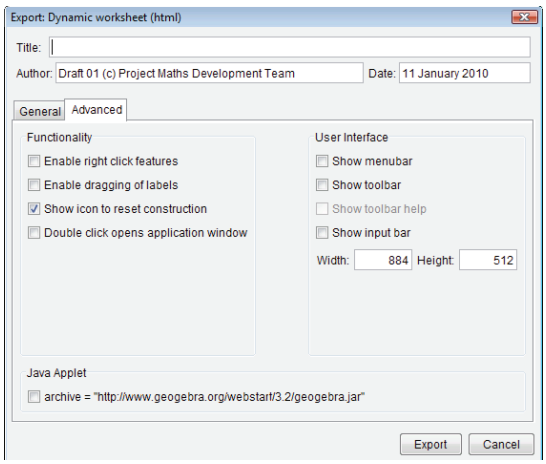
You can export a saved GeoGebra file as an interactive web page in order to share your construction with your students in a Java enabled web browser. If you also publish your web page online in a class blog or wiki, your students will be able to access it at home.

HOW TO SAVE A FILE AS AN INTERACTIVE WEB PAGE

1. First **save** your file as a **GeoGebra file**.
2. Go to **File**, **Export Dynamic Worksheet as Webpage (html)**. A new dialogue box appears.

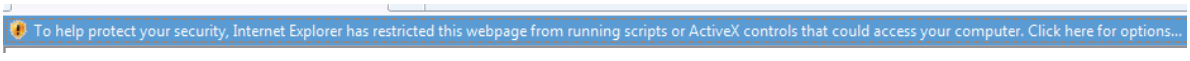


3. **Add** Title, Author, etc. **Click** on the **Advanced tab** and a new dialogue box appears.



It is recommended that one **clicks** the **Show Icon to reset construction button** and sets the width and height to appropriate values e.g. width 1100 and height 500.

4. **Click Export**.
5. **Navigate to the folder you want to save you file in.** Give it the name of your choice.
   Note: This file will have a **.html extension** and will be viewed using an **Internet browser** such as **Internet Explorer 8 or Firefox**)
6. **Click Save** and your **default Internet browser** will open**.**
7. When the webpage comes up the following message will normally appear at the top of the screen.

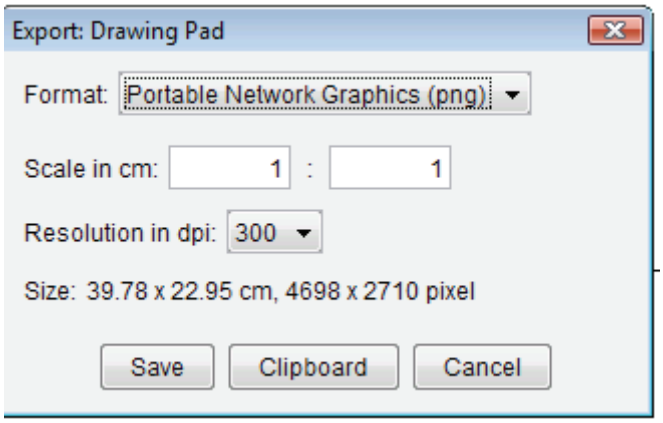


8. **Click** on **Click here for options** and **choose Allow Blocked Content...** and **click Yes.**

When creating worksheets for your students in a word processing document you may wish to add images or pictures of your GeoGebra files. Once you have saved your GeoGebra file it will be easy to insert it as a picture into your worksheet document.

HOW TO SAVE A FILE AS A PICTURE

1. First **save** your file as a **GeoGebra file**.
2. Go to **File**, **Export** and **Graphics View as Picture (png, eps).** A new dialogue box appears.



3. **Choose** the **Format**, **Scale in cm** and **Resolution**.
4. **Click Save**.
   Note: If you choose **Portable Network Graphics (png)** this file will have a **.png extension**. Other formats will give different extensions.
5. **Navigate** using **Save in** to the location you wish to save your file and fill in the **file name** at the **file name box.**
6. **Click Save**. This picture can now be used in other applications eg. Microsoft Word.

You may wish at times to add an image of one of your Geogebra files to a slideshow or work document. Using the clipboard will enable you to do so easily.

HOW TO EXPORT THE CURRENT GEOGEBRA VIEW (AS AN IMAGE) TO THE CLIPBOARD AND HENCE TO A WORD DOCUMENT OR A SLIDESHOW PRESENTATION FILE

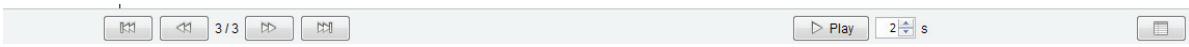
1. With your GeoGebra file open on screen **Go to File Menu**, Select **Export** and then Select **Graphics View to Clipboard**.
   Note: The current view has now been copied onto the Clipboard. You will be able to paste it to another application at the next step.

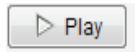
2. **Open any word processing application** such as Microsoft Word **or a slideshow file** such as PowerPoint.
3. **Place** the **cursor** at the l**ocation you require the drawing** to be **inserted**.
4. **Click Paste,** a **picture of the drawing that was visible** in **GeoGebra file** will **appear** in the word document or slideshow presentation file.
   Note: Placing the picture inside a textbox makes it easier to move and adjust. It could be useful in allowing you to squeeze more pictures onto the one page or position text beside the picture.

APPENDIX H: VIEWING THE CONSTRUCTION STEPS

TO VIEW THE CONSTRUCTION STEPS

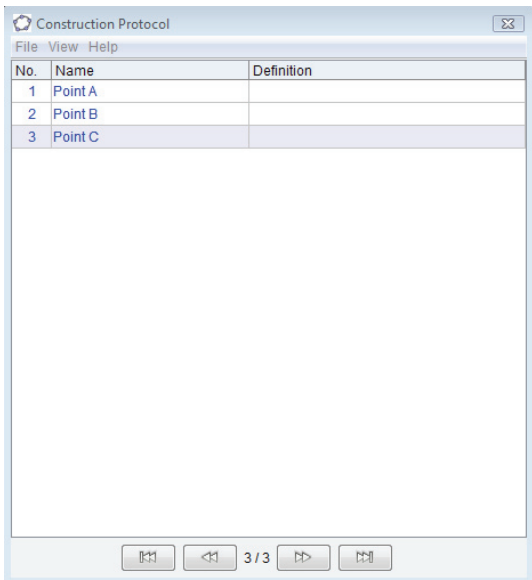
1. Go to **View**, and click **Navigation Bar for Construction Steps**

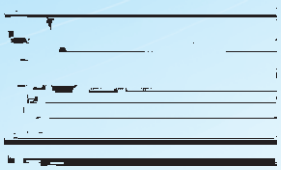


2. **Use** the **rewind**  and **fast forward**  **buttons** to click backwards and forwards in your construction.
3. **Use** the **play button**  to **show** the **construction being done step by step**.

TO VIEW A LIST OF THE STEPS INVOLVED IN THE CONSTRUCTION

1. **Go** to **View** and **choose Construction Protocol**. A new window appears showing a list of the steps involved in the construction.





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