

GeoGebra Quickstart

A quick reference guide for GeoGebra

GeoGebra is free educational mathematics software that joins dynamic geometry, algebra and calculus.

In the most simple manner, you can do constructions including points, vectors, segments, lines, and conic sections as well as functions, which can be altered dynamically by mouse afterwards. On the other hand, also the direct input in school-notation like

g: $3x + 4y = 7$ or c: $(x - 2)^2 + (y - 3)^2 = 25$ is possible, and a range of commands including differentiation and integration are at your disposal. The most remarkable feature of GeoGebra is the dual view of objects: every expression in the algebra window corresponds to an object in the geometry window and vice versa.

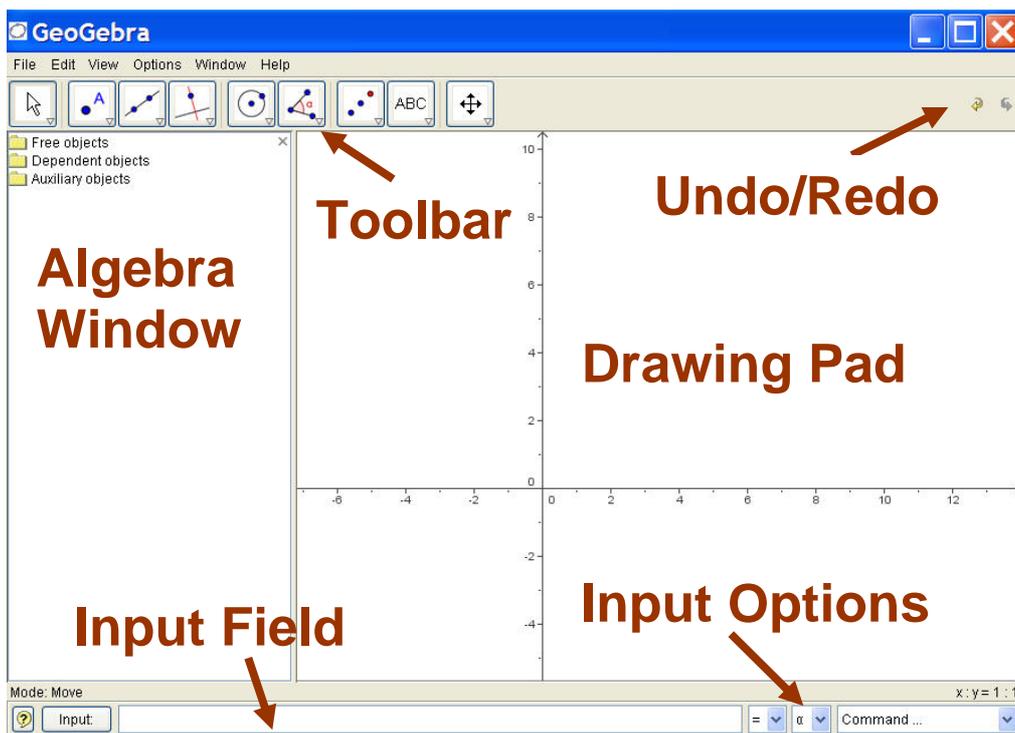
In the following, you will get acquainted to GeoGebra by examining three examples. You should work them out one after the other and not forget to try out the given tips, too.

Example 1: Circumcircle of a triangle

Example 2: Tangents to a circle

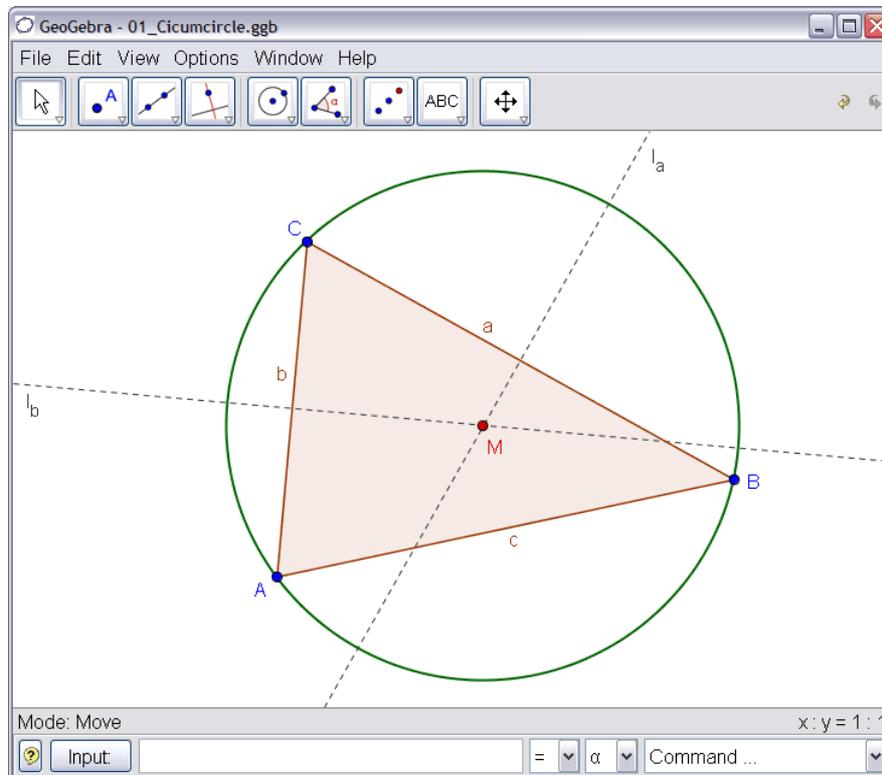
Example 3: Derivative and tangent of a function

After starting GeoGebra, the window depicted below appears. By means of the construction tools (modes) in the *toolbar* you can do constructions on the *drawing pad* by mouse. At the same time the corresponding coordinates and equations are displayed in the *algebra window*. The *input text field* is used to enter coordinates, equations, commands and functions directly; these are displayed at the drawing pad immediately after pressing the enter key. Geometry and algebra side by side:



Example 1: Circumcircle of a triangle

Task: Plot a triangle A, B, C and construct its circumcircle using GeoGebra.



Construction using the mouse

-  Choose the mode “Polygon” from the toolbar (click on the small arrow at the third icon from the left). Now click on the drawing pad three times to create the vertices $A, B,$ and C . Close the triangle by clicking on A again.
-  Next, choose the mode “Line bisector” and construct two line bisectors by clicking on two sides of the triangle.
-  In the mode “Intersect two objects” you can click on the intersection of both line bisectors to get the center of your triangle’s circumcircle. To name it “ M ”, click on it with the right mouse button (Mac OS: ctrl-click) and choose “Re-name” from the appearing menu.
-  To finish the construction, you have to choose the mode “Circle with center through point” and to click first at the center, then at any vertex of the triangle.
-  Now choose the mode “Move” and use the mouse to change the position of any of the vertices – you will experience the meaning of “dynamic geometry”.

Some tips

- Try the “Undo” button on the right side of the toolbar.
- To hide an object, right click on it (Mac OS: ctrl-click) and uncheck “Show object”.
- The appearance of objects (color, type of line, ...) can be changed easily: just use the right mouse button (Mac OS: ctrl-click) again to click on the object and choose “Properties” from the appearing context menu.
- In the menu “View” algebra window, axes, and grid can be hidden or shown.

- In order to change the position of the drawing pad, choose the mode “Move drawing pad”  and simply use the mouse to drag it.
- The menu “View – Construction Protocol” provides a table listing all the steps you took while doing your construction. This allows you to redo the construction step by step by the use of the arrow keys, and also to modify the order of various steps afterwards (see menu “Help” of the construction protocol). Moreover, you are able to use the menu “View” to hide or show unwanted columns.
- Further information on constructions by mouse can be found in menu “Help“, section “Geometric input”.

Construction using the input text field

We are now going to do the same construction as above using the input text field, so you will need a new drawing pad (menu “File – New”). Then, type the following commands into the input text field at the bottom of the screen and press the enter key after every line.

```
A = (2, 1)
B = (12, 5)
C = (8, 11)
Polygon[A, B, C]
l_a = LineBisector[a]
l_b = LineBisector[b]
M = Intersect[l_a, l_b]
Circle[M, A]
```

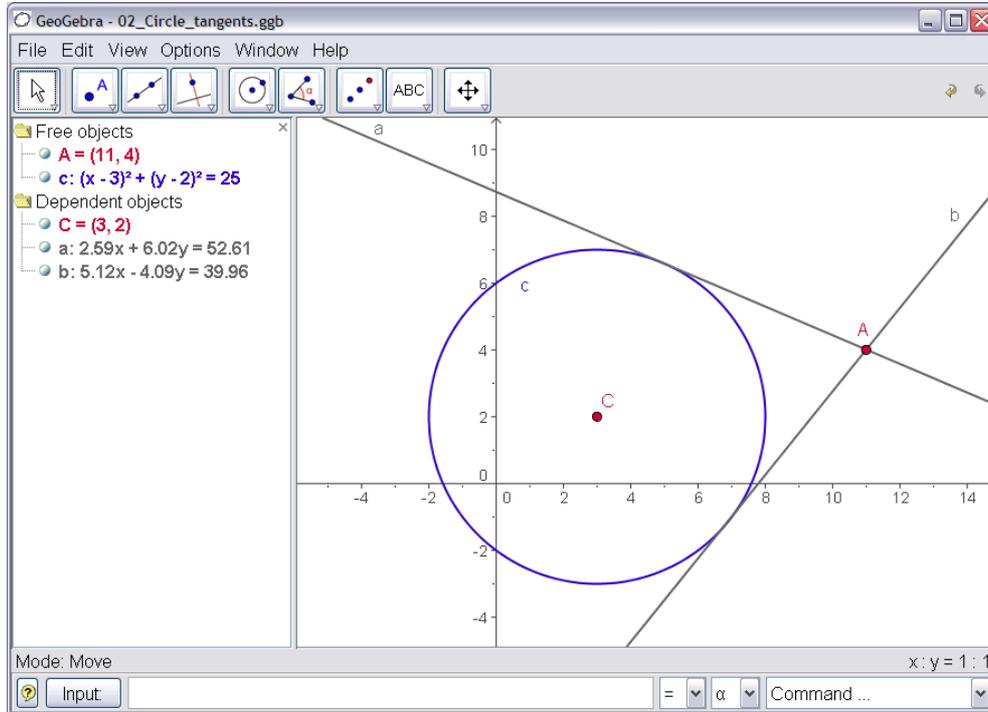
Some tips

- Automatic completion of commands: after entering the first two letters of a command, it will be displayed automatically. If you want to adopt the suggestion, press the enter key, otherwise just continue typing.
- It is not necessary to key in every command, you can also choose it from the list of commands that is found at the right next to the input text field.
- Clicking at the icon “Input“ (bottom left) activates the mode “Input field”. In this mode you can click on an object from the algebra window or drawing pad to copy its name into the input text field.
- For more tips concerning the input text field click on the question mark in the bottom left corner.

You will obtain especially good results from your work with GeoGebra by combining the advantages of both input forms, mouse and input text field.

Example 2: Tangents to a circle

Task: Using GeoGebra, construct the circle $c: (x - 3)^2 + (y - 2)^2 = 25$ and its tangents through the point $A = (11, 4)$.



Construction using input text field and mouse

Insert the equation of the circle $c: (x - 3)^2 + (y - 2)^2 = 25$ into the input text field and press the enter key (*tip: the exponent can be found in the list to the right of the input field.*)

Enter the command $C = \text{Center}[c]$ into the input text field.

Construct the point A by keying in $A = (11, 4)$.

Now choose the mode "Tangents" and click on the point A and the circle c .



After choosing the mode "Move", drag the point A with the mouse and observe the movement of the tangents.

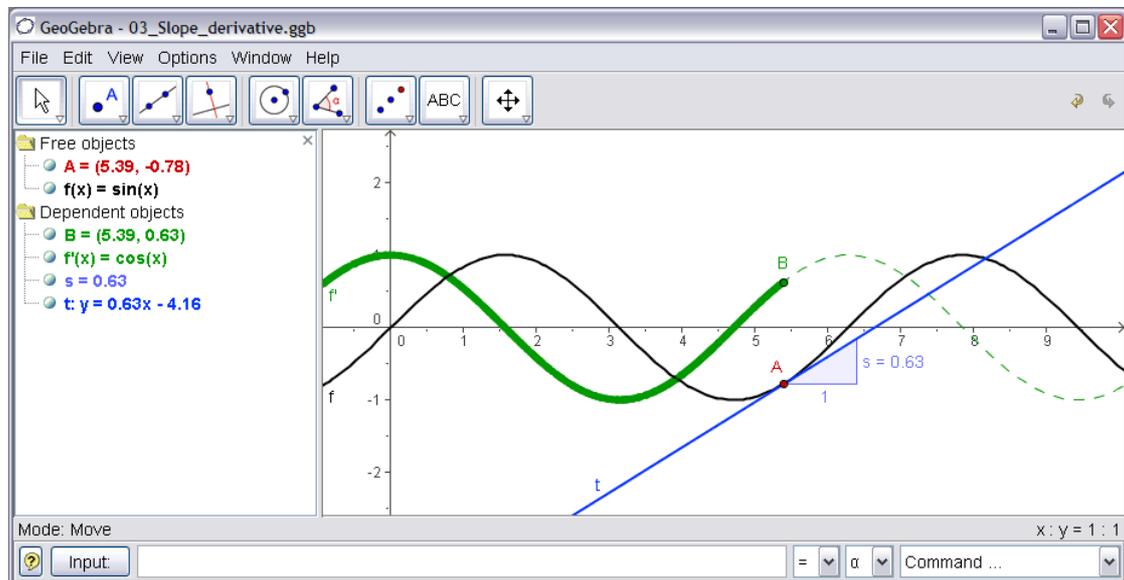
You should also try to drag the circle c and have a look at its equation in the algebra window.

Some tips

- Use the tools in the rightmost toolbar menu to zoom in or out. If you have a mouse wheel, try $\text{ctrl} + \text{mouse wheel}$ to zoom.
- It is possible to alter the equation of the circle directly in the algebra window by double-clicking on it.
- Further information on the possibilities of the input text field can be found in the menu "Help", section "Algebraic input".

Example 3: Derivative and tangent of a function

Task: Use GeoGebra to construct the function $f(x) = \sin(x)$, its derivative and its tangent to a point on f plus slope triangle.



Version 1: Point on function

-  Insert the function $f(x) = \sin(x)$ into the input text field and press the enter key.
-  Choose the mode "New Point" and click on the function f . This creates a point A on f .
-  Next choose the mode "Tangents" and click on the point A and the function f . Change the tangent's name to t (right mouse button (Mac OS: ctrl-click), "Rename").
- Type the command $s = \text{Slope}[t]$.
-  After choosing the "Move" mode, drag the point A with the mouse and observe the movement of the tangent.
- Type $B = (x(A), s)$ and switch on the *trace* of this point (click on B with the right mouse button (Mac OS: ctrl-click)). $x(A)$ gives you the x -coordinate of point A .
-  Choose the mode "Move" and drag A with the mouse – B will leave a trace.
- Type the command $\text{Derivative}[f]$.

Some tips

- Insert a different function, e. g. $f(x) = x^3 - 2x^2$ into the input text field; immediately, its derivative and tangent will be displayed.
- Choose the  "Move" mode and drag the function's graph with the mouse. Observe the changing equations of the function and its derivative.

Version 2: Point at $x = a$

We are now going to do another version of the last construction. Therefore, choose “File – New” first to get a new drawing pad. Next, type the following commands into the input text field and press the enter key after every line.

```
f(x) = sin(x)
a = 2
T = (a, f(a))
t = Tangent[a, f]
s = Slope[t]
B = (x(T), s)
Derivative[f]
```

Choose the  “Move” mode and click on the number a. You can change a by pressing the arrow keys. At the same time, the point T and the tangent will move along the function f.

Sliders: You are also able to change the number a by the use of a slider: right-click (Mac OS: ctrl-click) on a in the algebra window and choose “show object”.

Tip: sliders and also the arrow keys are very useful to examine parameters, for example p and q in the quadratic equation $y = x^2 + p x + q$.

Tangent without given command

GeoGebra is able to deal with vectors and also parametrical representations of lines. Therefore it is possible to construct a tangent t without the command *Tangent[]*. In order to try this out, remove the tangent from your construction first by clicking on it with the right mouse button (Mac OS: ctrl-click) and choosing “Delete”. Then, type the following commands:

```
v = (1, f'(a))
t: X = T + r v
```

v is the direction vector of the tangent t. Instead of r, you could also use any other letter as parameter.

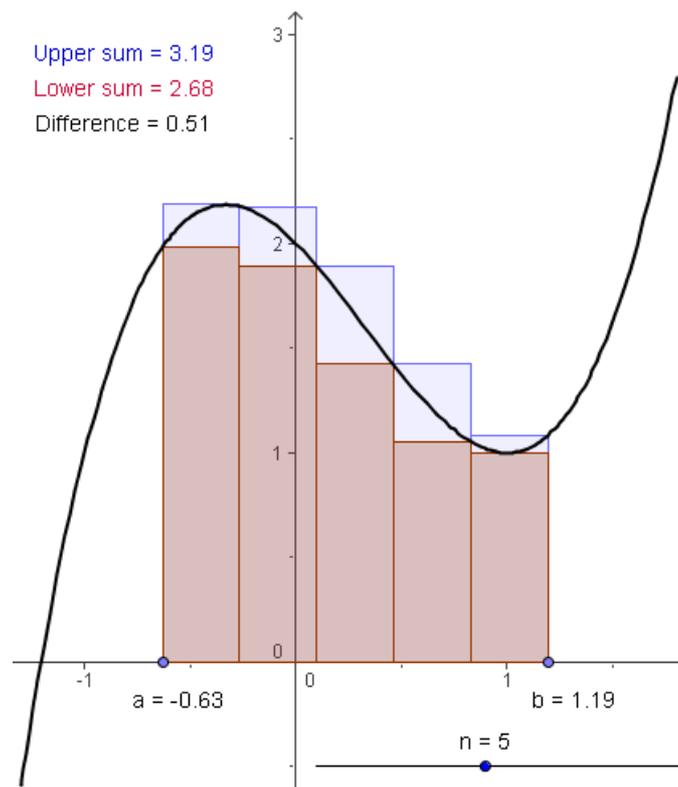
Some tips

- There is an additional possibility to construct the tangent with the help of the direction vector: $t = \text{Line}[T, v]$.
- Also try out the command *Integral[f]*
- Further tips concerning the commands of GeoGebra can be found in the menu “Help”, section “Algebraic input – commands”. *GeoGebra’s help* (pdf-file) is also available for download at www.geogebra.org.

Further information

You are invited to visit GeoGebra's homepage www.geogebra.org. There you will find further information as well as the most recent version of the free software.

GeoGebra also enables you to easily create dynamic worksheets that can be used with every internet browser (e.g. Firefox, Safari, or Internet Explorer). Examples and additional information can be found on GeoGebra's web page.



GeoGebra Homepage

www.geogebra.org

GeoGebra User Forum

www.geogebra.org/forum

GeoGebraWiki - pool of educational material

www.geogebra.org/en/wiki

If you have any suggestions or want to give feedback on GeoGebra or this paper, please feel free to write to Markus Hohenwarter (mhohen@gmail.com).