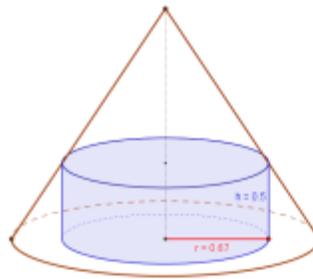
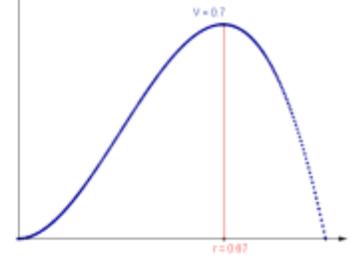


Cone
Height = 1.5
Diameter = 2



Cylinder - Volume
 $V = \pi r^2 h$



Algebra 1 and 2 with

GeoGebra

[Draft Version]

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Do not be concerned if your screen does not exactly look like the above. When we work our examples, you will be shown which tools must be used and how you can access them via the toolbar.

GeoGebra is a software with a wide variety of capabilities. This guide will focus primarily on how to work with functions and their properties using GeoGebra.

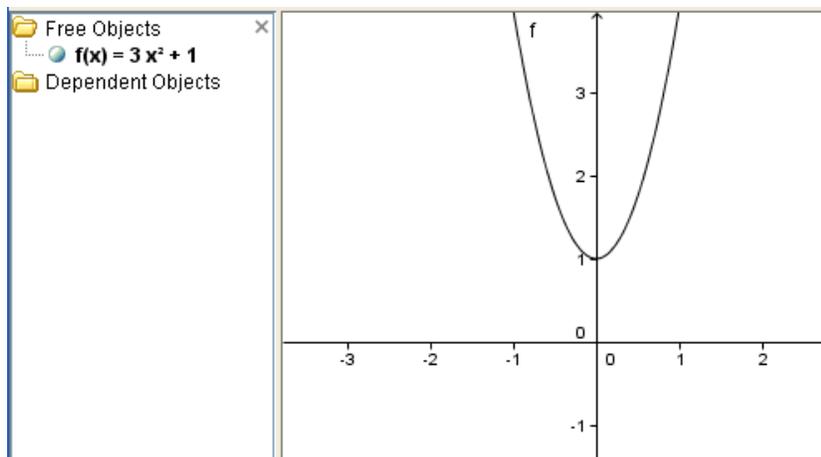
Graphing a function

The easiest way to see what GeoGebra is about is by graphing a function. Unlike most graphing software, GeoGebra allows you to **dynamically change** the graph with the mouse. That's what sets it apart.

Example 1 Graph the function $f(x) = 3x^2 + 1$

Solution

- 1 In input bar, type $f(x) = 3x^2 + 1$
- 2 Press <Enter> and you'll see the graph.



Moving the graph

GeoGebra is a dynamic geometry software. That is, the graph that's drawn is not static. It has various properties which can be examined individually. A simple property is to just move the graph. To do this, follow these steps.

- 1 Click on the **selection tool**. . This enables the drag option.
- 2 Point to the graph, then hold down the left mouse button, and move the graph with the mouse.
- 3 As you move the graph, note how the expression for $f(x)$ changes.

Changing line styles

To change the line color and/or styles in a plot, right click into the curve you want to change. Click on Properties, and set the options you wish.

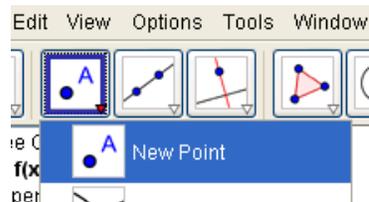
Points on the graph

Example 2 Use the graph of $f(x) = 3x^2 + 1$ to find various points on the curve and trace along the curve.

Solution

Steps to trace a point along a graph

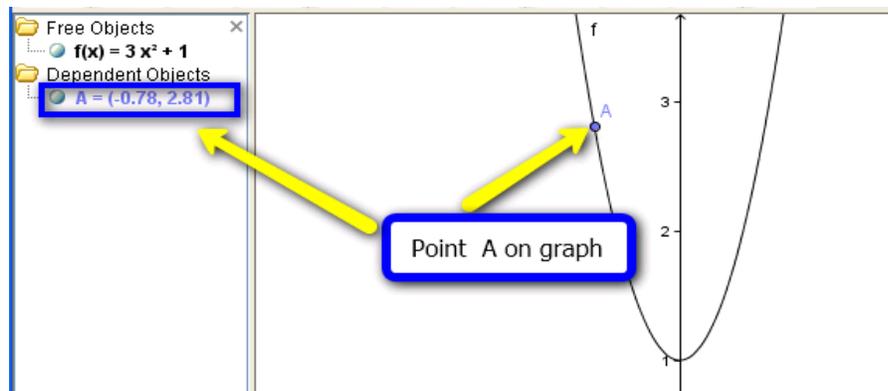
- 1 Click on the **point tool** and choose new point.



- 2 Now click on the **selection tool**.



- 3 Move mouse until you see the graph highlighted. Left click to place a point on the graph. Move mouse to the point A on the graph, hold down left mouse button and start moving your mouse. You should see the point A tracing along the curve. Your window should be similar to the following.

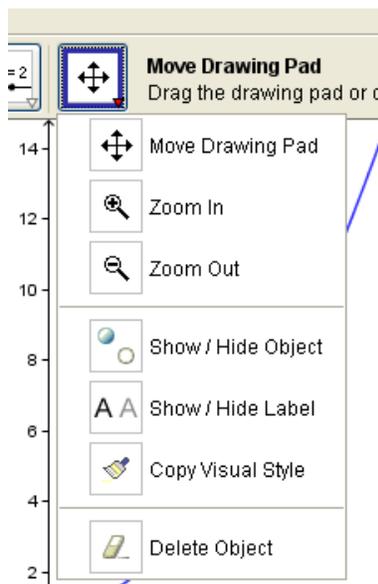


Note that the coordinates of the point A are displayed under **Dependent Objects**. That's because the point A *depends* on the function f .

Scaling the axes

You can change the scale on the axes by simply clicking on the **drawing pad tool** . Point the mouse to the axis you want to scale. By holding down your mouse button you can stretch or shrink the x or y axes.

You can also use the drop down menu from the drawing pad tool to zoom in or zoom out.



Saving GeoGebra files

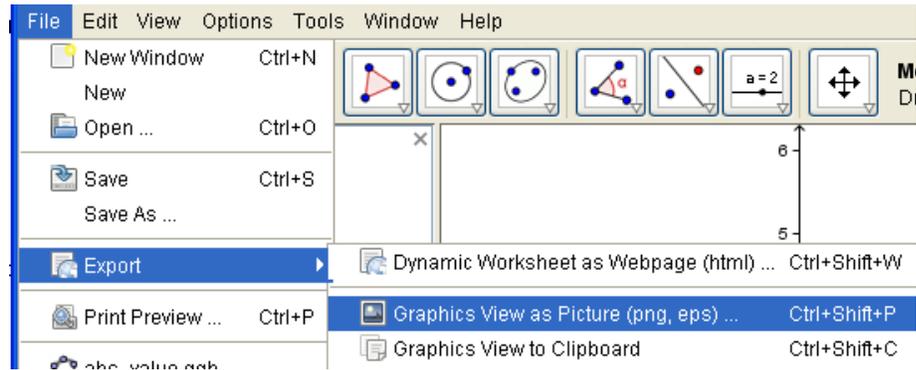
- 1 Open the File menu and select Save.
- 2 Select a folder where you want to store the file, or create a new folder.
- 3 Type in a name for your GeoGebra file.
- 4 Click Save in order to finish this process. A file with the extension '.ggb' is created. This extension identifies GeoGebra files and indicates that they can only be opened with GeoGebra.

Avoid using spaces or special symbols in a file name since they can cause unnecessary problems when transferred to other computers. Instead you can use underscores or upper case letters within the file name (e.g. First_Drawing.ggb).

Printing and exporting graphs

Once you've drawn a graph with GeoGebra, you may want to export the graph so that you can use it later for another purpose.

To do this, click on **File > Export > Graphics View...** Select the option you prefer. You can save as a graphics file (you will be prompted on the file type - png, pdf etc.) or save in the Clipboard to paste in a document..



Some Common Errors

- To move the graph around, you need to have the selection tool highlighted.

Chapter 2

Lines and Linear Equations

In this chapter

- Graph a line and find its equation given two points
- Explore the slope triangle
- Find distance between two points
- Parallel and perpendicular lines
- Creating dynamic graphs with sliders

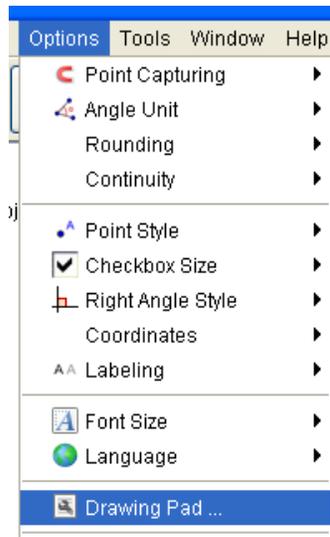
Graphing a line given two points

A simple way to explore the powerful features of GeoGebra is to plot two points, and draw a line. GeoGebra will automatically determine its equation

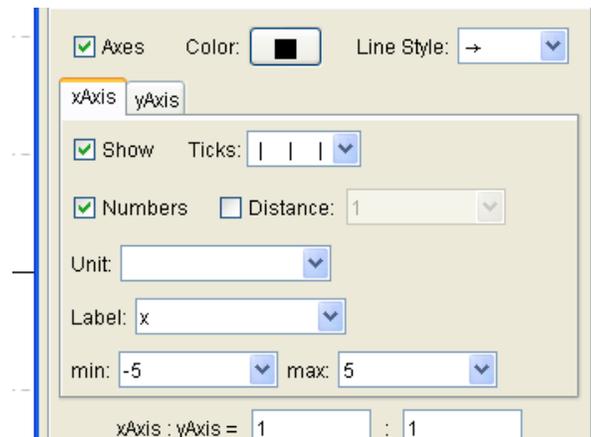
Example 1 Plot the points $(2,3)$ and $(-4,1)$ and draw a line through them.

Solution

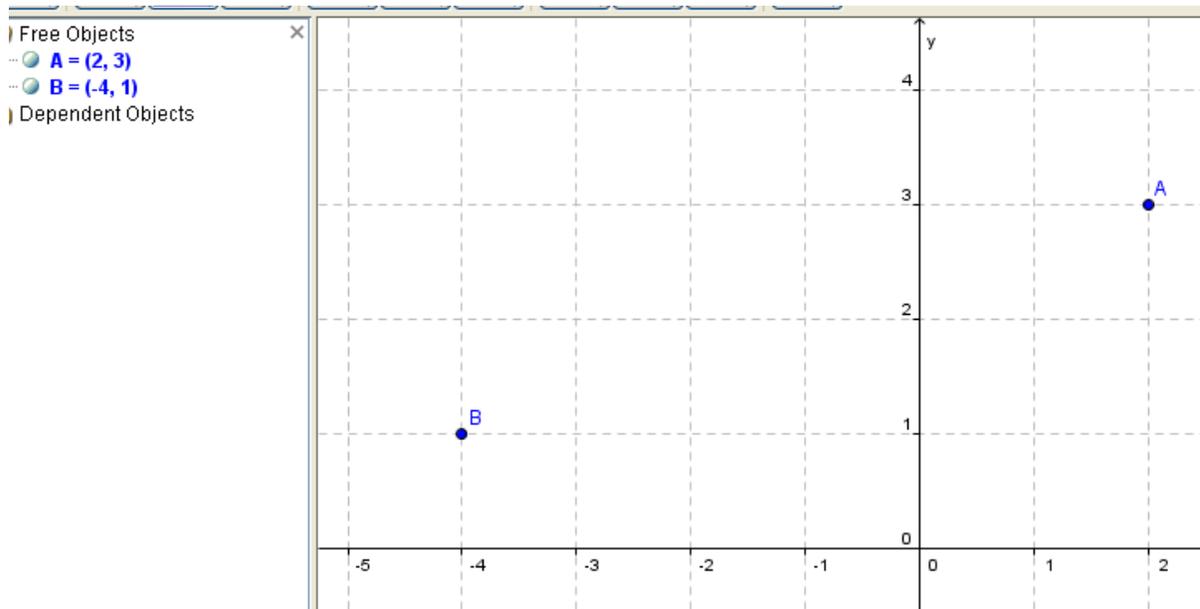
- 1 Click on **Options > Drawing Pad**.



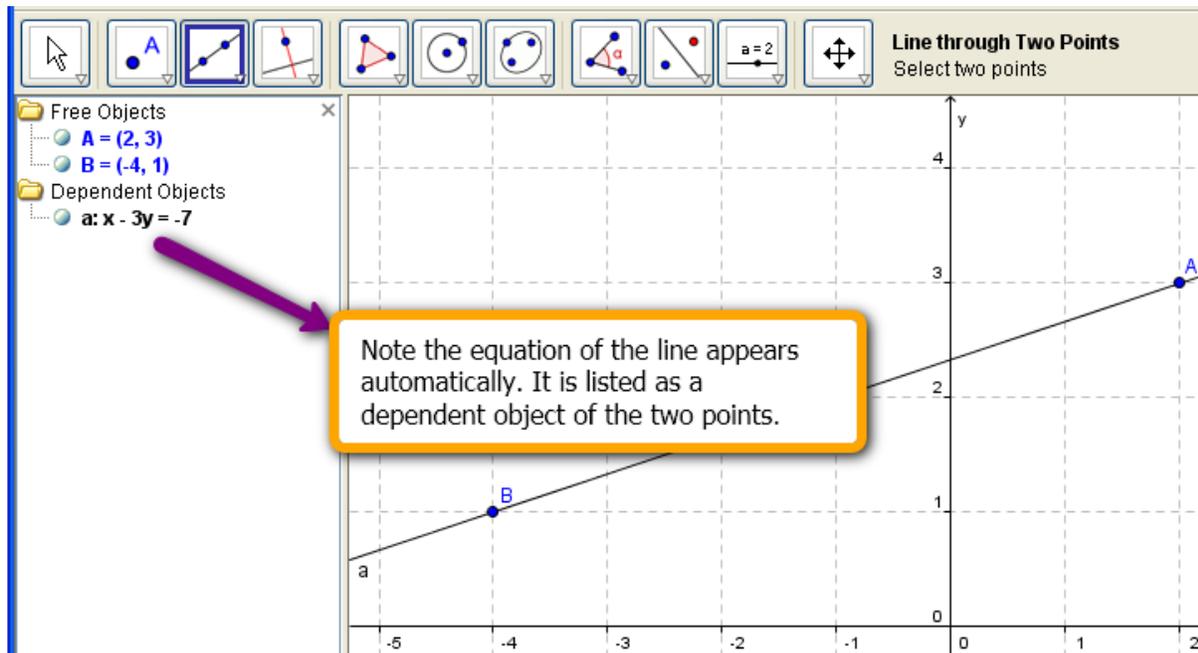
2 Use the options here to set up your drawing grid.



3 In the **Input** box, type $A = (2, 3)$. Press <ENTER>. Then type $B = (-4, 1)$. The two points will be plotted as follows.



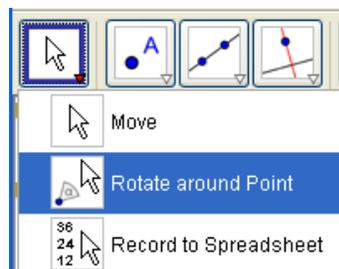
- 4 Now choose the line tool . Click on Point A. A line will appear. Guide the line to Point B and click. You should see a graph similar to the one below



- 5 Save the file as **line1.ggb**. We will use it later in this chapter.

Check it out

- Click on the selection tool and move the graph. You can translate the graph. See what happens to the points A and B and the equation.
- You can also rotate the line around a point. The drop down menu from the selection tool has an option for this.



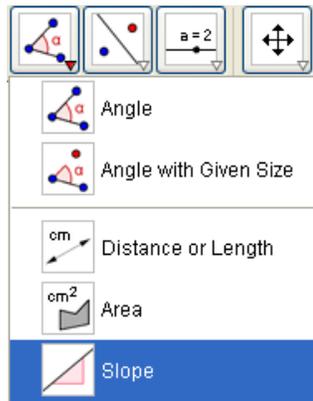
Using the slope triangle

Using GeoGebra, you can visually indicate the slope of the line that you graphed in Example 1. Furthermore, you can see how the slope changes as you move one or both of the points.

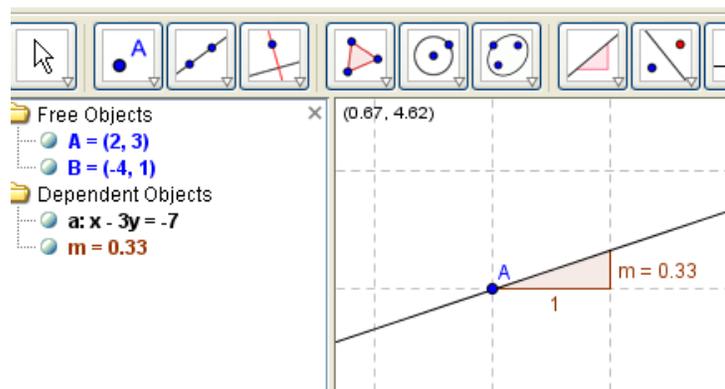
Example 2 Use GeoGebra to indicate the slope of the line in Example 1.

Solution

- 1 Open the file **line1.ggb**, created in Example 1. If you were moving the line around, the points A and B may have changed in the file. If so, in the algebra window, double click on B to (-4,1). You can now edit the coordinates of Point B. You can also do this for Point A(2,3).
- 2 Click at the bottom right of the **angle** button , and choose the slope button.



- 3 Move your mouse to highlight the line and click. The slope triangle and the value of the slope will appear on the graph. and in the algebra window.



- 4 You can also find the slope by typing **m=Slope[a]** in the **Input** box. Here, **a** is the name of the line that was created and **m** is the letter assigned to the slope.
- 5 You can display the equation of Line a in slope-intercept form by right clicking on its equation and selecting Equation $y=mx+b$
- 6 Save this file under the original name or to a different name.

Check it out

- Click on the selection tool, and move Point B. Keep Point A fixed. What do you notice about the slope?
- Calculate values of the slope for some different values of Point B and compare to the value given in GeoGebra.
- In the algebra window, double click on B. You can now edit the coordinates of Point B. You can also do this for Point A.

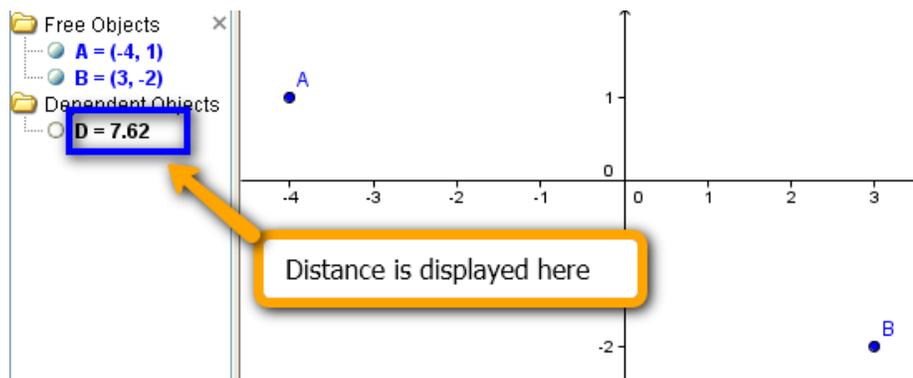
Finding distance between two points

You can use the **Distance** command in the **Input** box to calculate the distance between two points.

Example 2 Use GeoGebra to find the distance between A(-4,1) and B(3,-2).

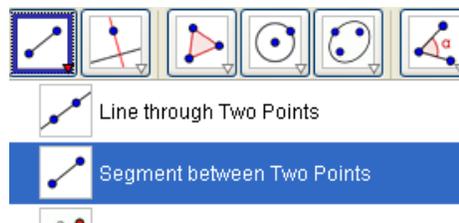
Solution

- 1 Start up GeoGebra or open a new GeoGebra workspace by choosing **File**> **New**.
- 2 In the **Input** box, type **A = (-4, 1)**. Press <ENTER> and then type **B = (3, -2)**.
- 3 In the **Input** box, type **d=Distance[A,B]**. Press <ENTER>. The value of the distance is displayed in the algebra window.



Check it out

- Use the distance formula $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ to verify that the distance given by GeoGebra is correct.
- Find the midpoint of points A and B by typing **C=Midpoint[A,B]** in the **Input** box
- A good use of the distance function is to help you find the perimeter of a polygon whose vertices are given by coordinates. Plot the points (1,2), (3,-1) and (-1,-2) in GeoGebra. Connect each pair of points with a line segment by clicking on the Line tool and choosing the segment option.. Find the perimeter of the resulting triangle.



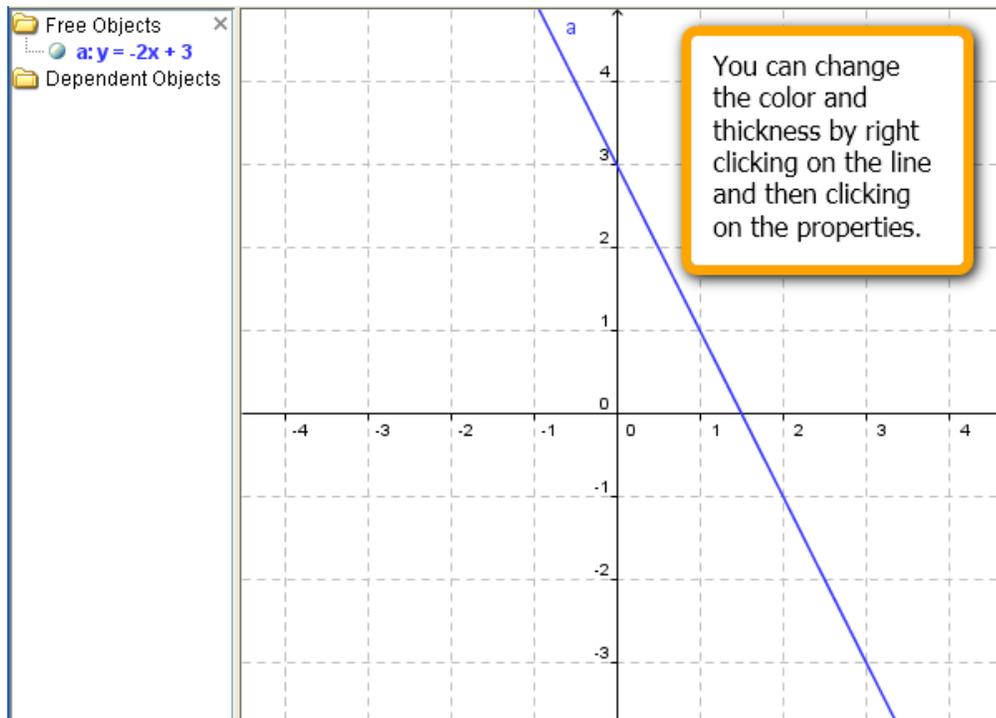
Parallel and perpendicular lines

Using GeoGebra, you can examine both the geometric and algebraic relationships between two parallel or two perpendicular lines.

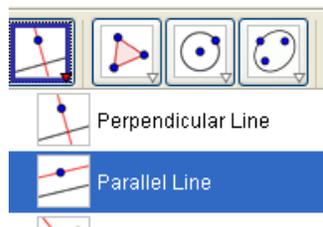
Example 4 Use Geogebra to sketch the line parallel to the line $y = -2x + 3$ and passing through $(-1,2)$.

Solution

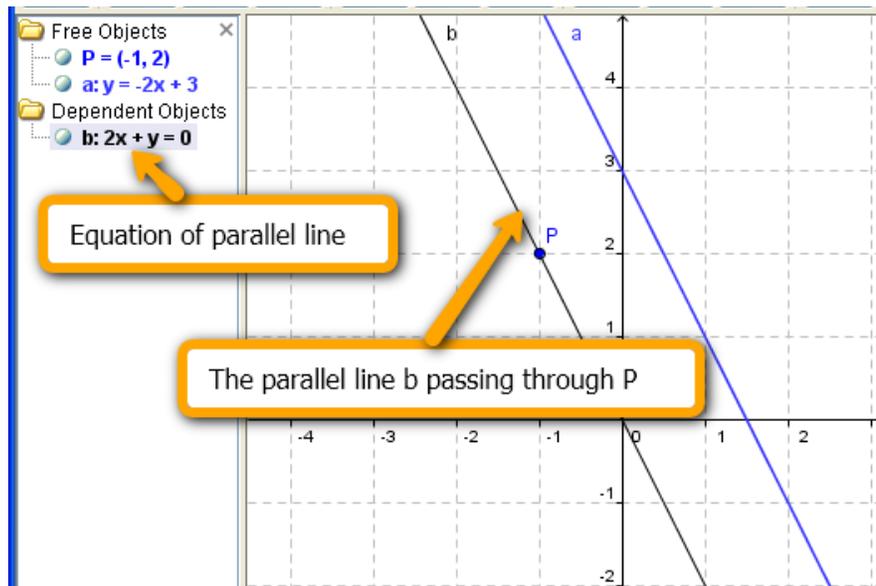
- 1 Start up GeoGebra or open a new GeoGebra workspace by choosing **File > New**. To see the grid, make sure the menu item **View > Grid** is checked.
- 2 In the **Input** box, type $y = -2x + 3$. Press **<ENTER>**. You'll see a line with label **a**. The name of the line is **a**. You can refer to this particular line as **a** in later commands in the **Input** box.



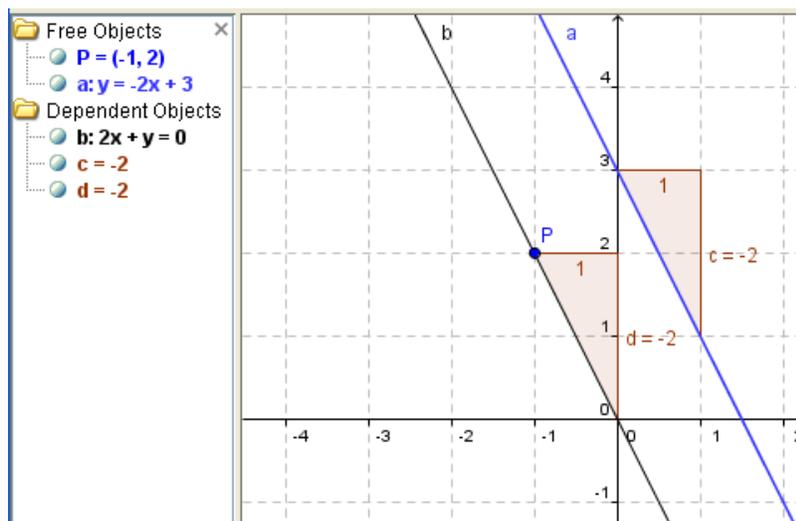
- 3 Now type $P = (-1, 2)$ in the **Input** box. Press **<ENTER>**. Click on the button with perpendicular lines and then click on the small red arrow. From the submenu, choose **Parallel Line**.



- 4 Now select the Point P and the line **a**. The parallel line passing through P is now drawn and its equation is given.



- 5 Use GeoGebra to find the slope of each line. Type **Slope[a]** in the **Input** box. Press <ENTER>. Then type **Slope[b]** in the **Input** box. Press <ENTER>. The slopes and the slope triangles are now given. Check these values by hand.



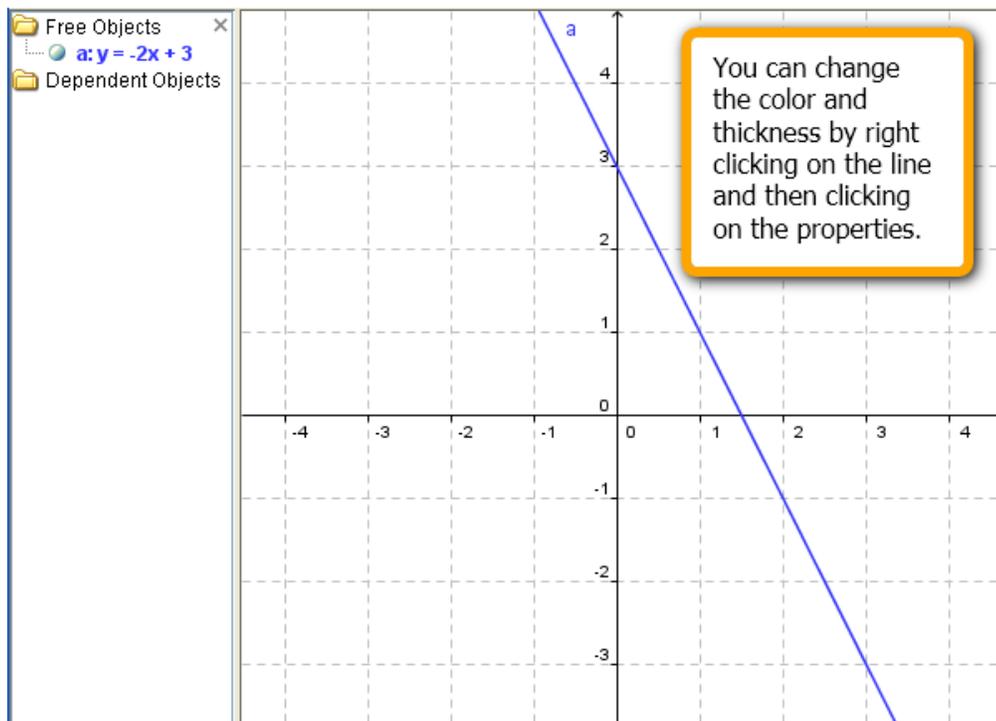
Check it out

- What do you observe about the slopes of parallel lines?
- Find the equation of the parallel line by hand, and check with the one from GeoGebra..

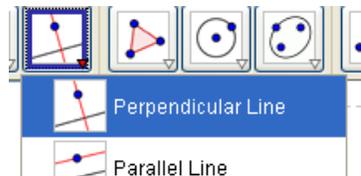
Example 5 Use Geogebra to sketch the line perpendicular to the line $y = -2x + 3$ and passing through $(-1, 2)$.

Solution

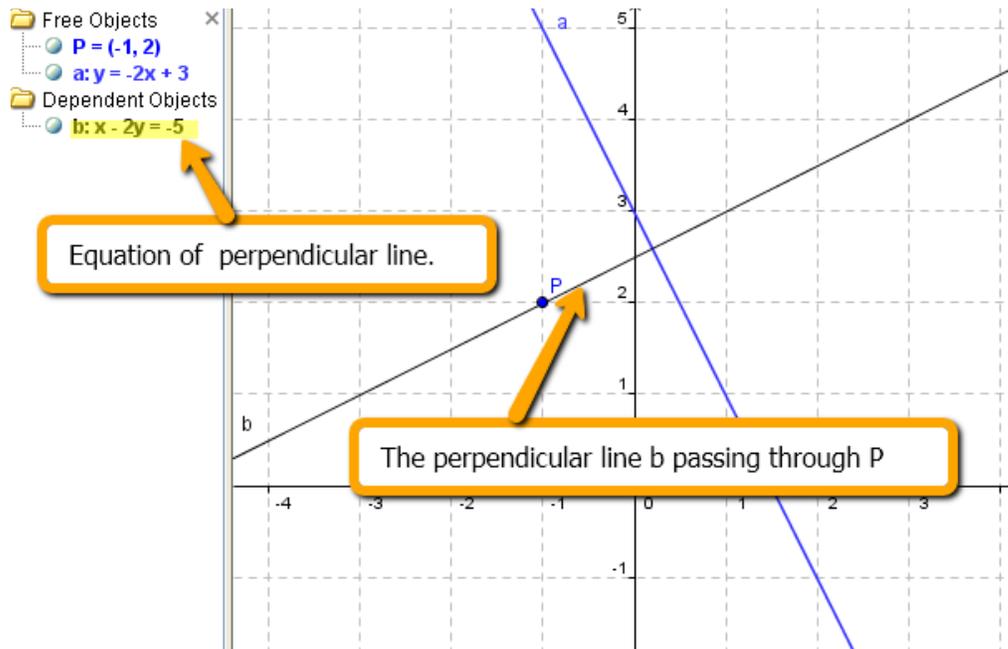
- 1 Start up GeoGebra or open a new GeoGebra workspace by choosing **File > New**. To see the grid, make sure the menu item **View > Grid** is checked.
- 2 To get a square grid, right-click in the graphing area. Select **Properties** and set **axis:axis** ratio to 1:1. Otherwise, perpendicular lines will not appear perpendicular!
- 3 In the **Input** box, type $y = -2x + 3$. Press <ENTER>. You'll see a line with label **a**. The name of the line is **a**. You can refer to this particular line as **a** in later commands in the **Input** box.



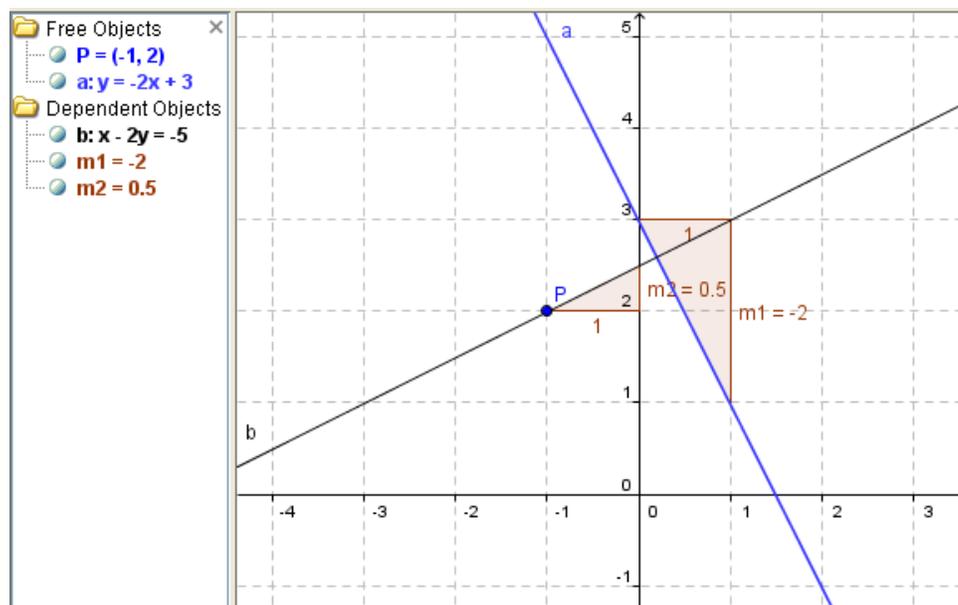
- 4 Now type $P = (-1, 2)$ in the **Input** box. Press <ENTER>. Click on the button with perpendicular lines .



- 5 Now select the Point P and the line **a**. The perpendicular line **b**, passing through P, is now drawn and its equation is given.



- 6 Use GeoGebra to find the slope of each line. Type $m1 = \text{Slope}[a]$ in the **Input** box. Press <ENTER>. Then type $m2 = \text{Slope}[b]$ in the **Input** box. Press <ENTER>. The slopes and the slope triangles are now given. Check these values by hand by examining the slope-intercept forms of the equations.



Check it out

- Do you observe about the slopes of perpendicular lines are negative reciprocals of each other?
- Find the equation of the perpendicular line by hand, and check with the one from GeoGebra.

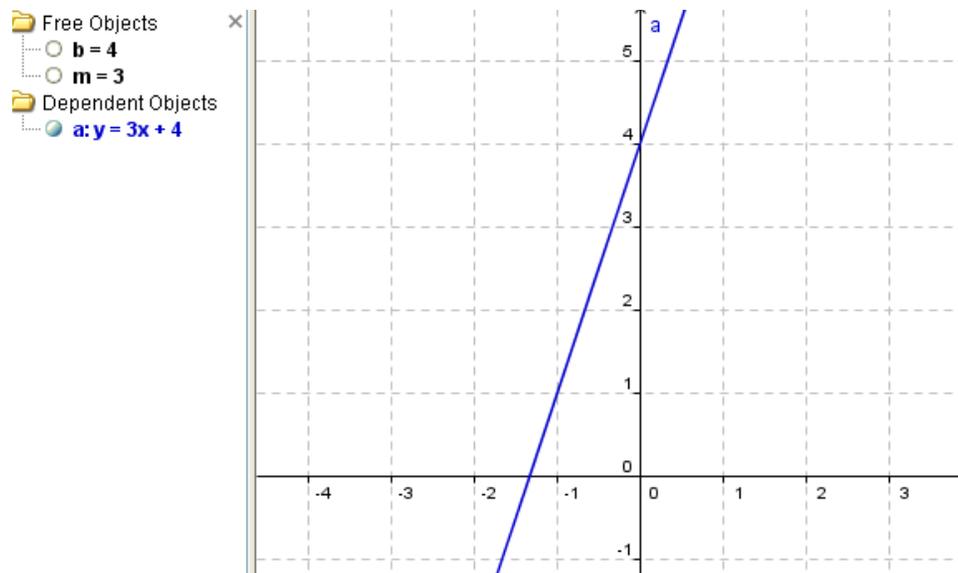
Creating dynamic graphs with sliders

In GeoGebra, you can introduce sliders to make your graph change when its parameters change. For example, the equation of a line is given by $y = mx + b$. You can set the slope, m , and the y-intercept, b , as parameters and then define the line. This allows GeoGebra to change m and b dynamically.

Example 6 Use Geogebra to sketch the line $y = mx + b$, with $m = 3$ and $b = 4$. Use a slider to vary m and b .

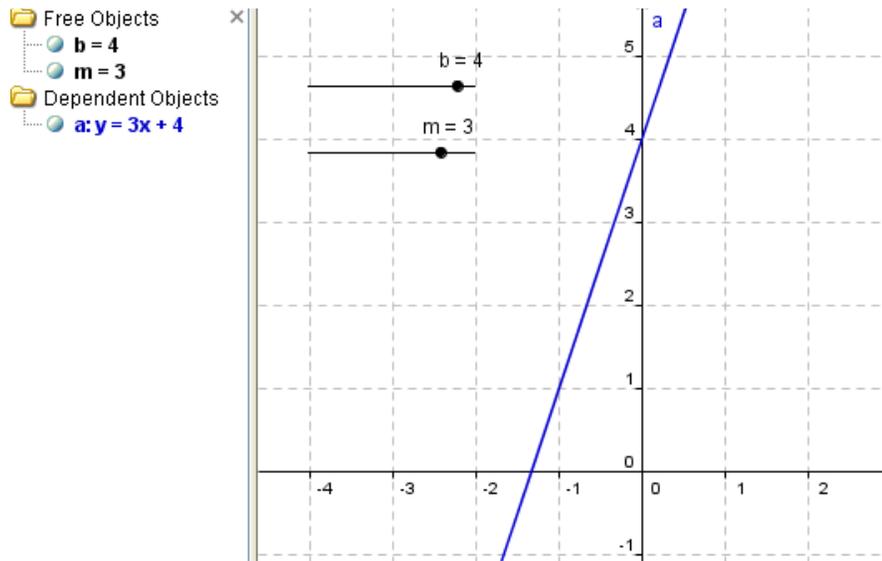
Solution

- 1 Start up GeoGebra or open a new GeoGebra workspace by choosing **File > New**. To see the grid, make sure the menu item **View > Grid** is checked.
- 2 In the **Input** box, type **m=3**. Press <ENTER>. Then type **b=4**. Press <ENTER>.
- 3 Now type **y=m*x+b** in the **Input** box.



- 4 If you look at the left panel, you will see that the line is dependent on the “objects” m and b . Click on the **b = 4** button in the left panel. You will see a slider appear in the graphing area. Do the same

for the $m = 3$ button. Your graph should resemble the following. Now move each slider with your mouse and see what happens to the graph.



Check it out

- As m varies from negative to zero to positive, what do you observe about the slant of the line?
- What do you observe about the line as b varies from negative to zero to positive?
- You can add a slope triangle to visualize the slope of the line. Refer to Example 2 for instructions.
- The default range for the sliders is from -5 to 5. You can change this by right-clicking on the slider and then modifying the range under the slider tab in the properties dialog box. You can also change its color and other properties. Try it!

NOTE: This guide is a work in progress. Chapters on different functions, including trig functions, and conic section will be added. Your comments are welcome. Please email comments to

reva@mymathspace.net

(Notes on new features to include:

http://www.geogebra.org/talks/2009/GeoGebra_WS9_Spreadsheet_Statistics.pdf

Idea: $mx+b$: parametrize m and b ; list view of points and “guess” at line of best fit)