Math 1314
Lesson 2: An Introduction to Geogebra (GGB)

Course Overview

What is calculus?

Calculus is the study of change, particularly, how things change over time. It gives us a framework for measuring change using some fairly simple models.

The formal body of information that makes up a calculus course was developed in the 17th century by two mathematicians, each working separately: Isaac Newton and Gottfried Wilheim Leibniz. Newton' method of "fluxions" studied how things change. Leibniz did similar work at about the same time, and contributed additionally some of the notation we use to this day.

We will address two basic questions in this course.

1. How can we find the slope of a line that is tangent to an arbitrary curve at a given point?
The graph below shows a cubic function and the line tangent to the function at the point where
$x = -1$
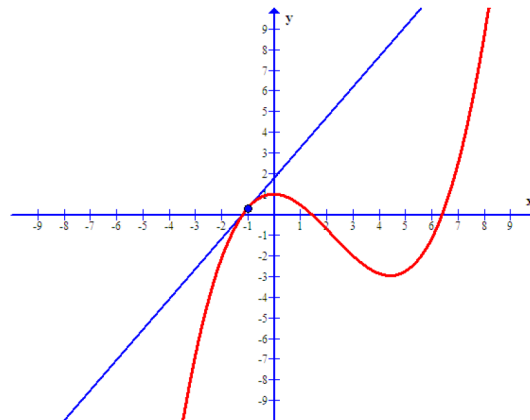
We are interested in finding the slope of this line, because it gives the rate at which the y value of the function is changing. You already have some experience working with slope. You have found the slope of a line in earlier coursework using a formula, $m = \dfrac{y_2 - y_1}{x_2 - x_1}$. This gives a rate of change: it gives the change in y over the change in x. It tells us how much y changes for a computed change in x. We will use this idea when we learn how to find the slope of a tangent line. *Differential calculus* treats problems of this type.

2. How can we find the area of a region such as the one pictured below?
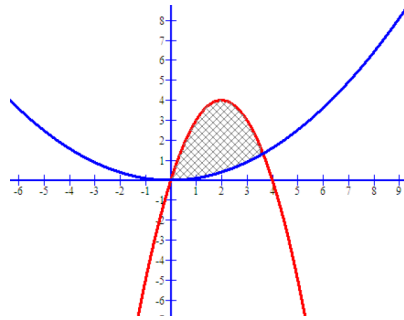
The shape of this region does not conform to the formulas we know, such as for a triangle, rectangle or circle, so we will need another method for finding this area. We will use *integral calculus* to solve problems of this type.

Both of these areas of inquiry rely on the concept of a *limit*. We will begin our study of calculus by looking at limits. Then we will investigate the types of problems we can solve using differential calculus and integral calculus.

A major focus of this course will be the use of technology in the teaching and learning of calculus. We will be less concerned with paper and pencil computations in this course, and more interested in solving problems. Our main tool will be GeoGebra, a free software, that you will need to download and use on a daily basis in this course.

An Introduction to GeoGebra

GeoGebra (GGB) is a free software package that we will use throughout the semester. The program can be used as a simple calculator, and it can also be used to perform some fairly sophisticated calculus operations. In this lesson, you will learn your way around the GGB display, and you will also learn to do some basic graphing.

You will need to download GGB onto your computer. Go to **www.geogebra.org** and follow the instructions for downloading the program. If you are using a computer where you cannot download the program, choose the Applet option on the download page.

This is what you will see when you open GGB.
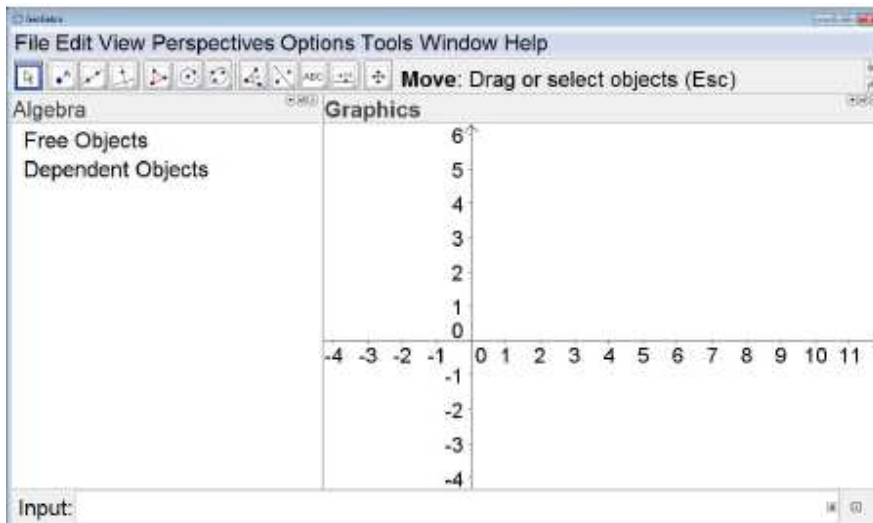
The GGB display consists of four parts:
AT TOP: the menus/icons   ON LEFT: algebra window
ON RIGHT: graphics window   AT BOTTOM: input line

TO ADJUST FONT: Go to "Options," then click on "Font" and select the size that you'd like.

TO RESIZE ALGEBRA AND GRAPHICS WINDOWS: Put cursor on the vertical line between algebra and graphics windows until you see a double-headed arrow. Then drag the line to the left or the right depending on which part you wish to enlarge.

TO SHOW GRID: Put cursor on graphics window. Right-click and choose "Grid". To undo follow the same steps.

TO ADJUST DECIMAL PLACES: Go to "Options," then click on "Rounding" and select "4 Decimal Places". Occasionally, we'll need to change this setting.

TO SAVE CHANGES TO SETTINGS: Go to "Options," then click on "Settings". In the pop-up window, at the bottom, choose "Save Settings".
You will enter functions or expressions using the input line. Put the cursor in the input line and start typing.

USE THE CARET KEY ("^") to raise a number or variable to a power.
USE SQRT for the square root
To enter a cube root such as, $\sqrt[3]{2}$, type: 2^(1/3)

Example 1: Use GGB to compute $-3^2 + (-2)^3 - \sqrt[3]{8}$

Command: Answer:

Example 2: Use GGB to compute $\sqrt{5e^2 - 3(-2)}$

Command:

Answer:

Example 3: Use GGB to evaluate $\dfrac{x-1}{y+2}$ if $x = -2$ and $y = 10$.
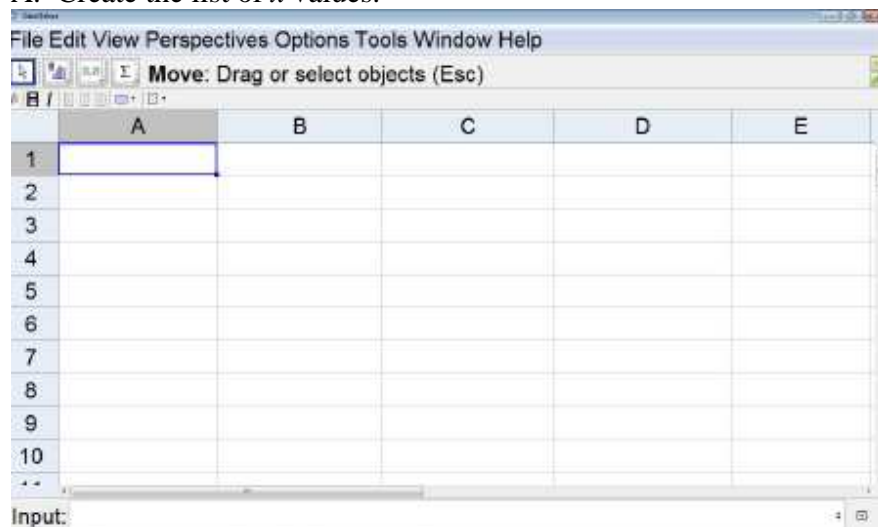
Command:

Answer:

Tables

You can make a table, similar to a table in Excel.
TO VIEW SPREADSHEET VIEW: Click on "View" and enable "Spreadsheet."

Example 4: Suppose $f(x) = -1.875x^2 + 12.3x - 7.164$. Use GGB to create a table of values that starts at $x = 1.63$ and has an increment of 0.26.
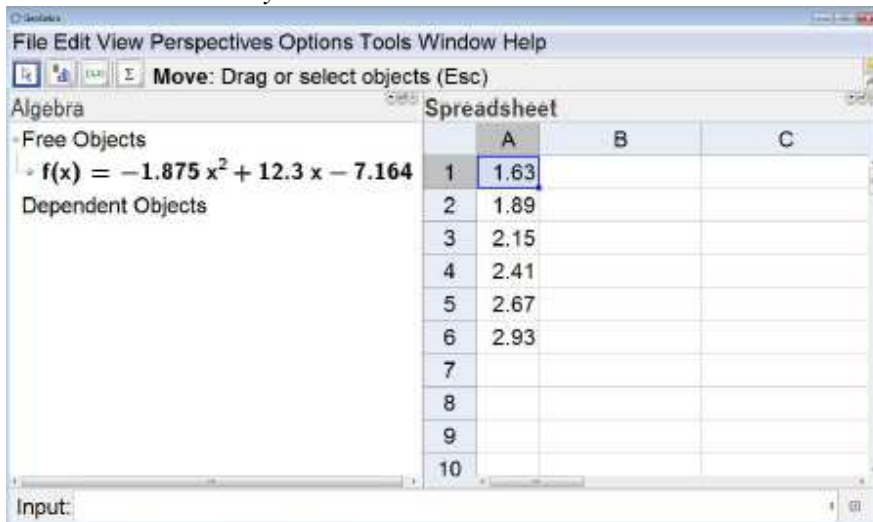
A. Create the list of x values.

File Edit View Perspectives Options Tools Window Help

Move: Drag or select objects (Esc)

	A	B	C	D	E
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Input:

Result:

A
1.63
1.89
2.15
2.41
2.67
2.93

B. Enter the function in the input line. If you make an error in entering the function, in the algebra window, double click on the function and make any corrections.
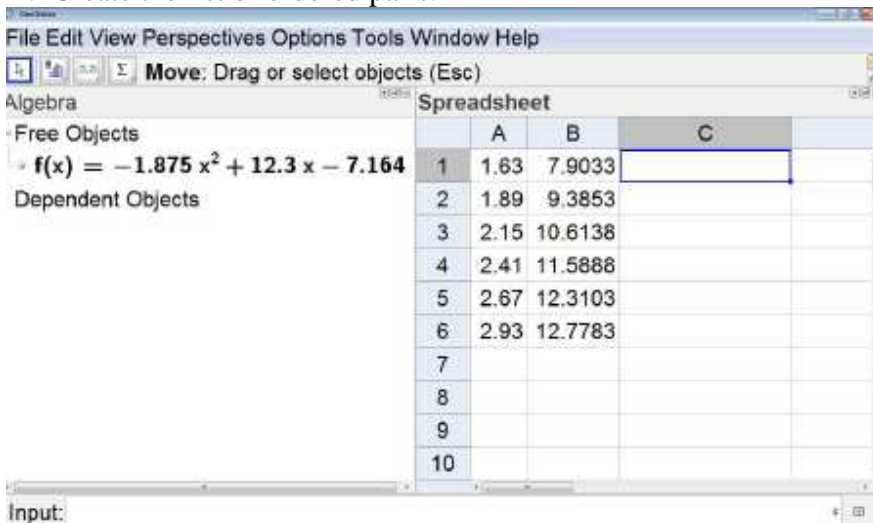
Command:

C. Create the list of *y* values.

Result:

B
7.9033
9.3853
10.6138
11.5888
12.3103
12.7783

D. Create the list of ordered pairs.

Result:

C
(1.63, 7.9033)
(1.89, 9.3853)
(2.15, 10.6138)
(2.41, 11.5888)
(2.67, 12.3103)
(2.93, 12.7783)

Once the ordered pairs are formed AND highlighted, find the icon {1,2} at the top left area of the GGB window and click it.
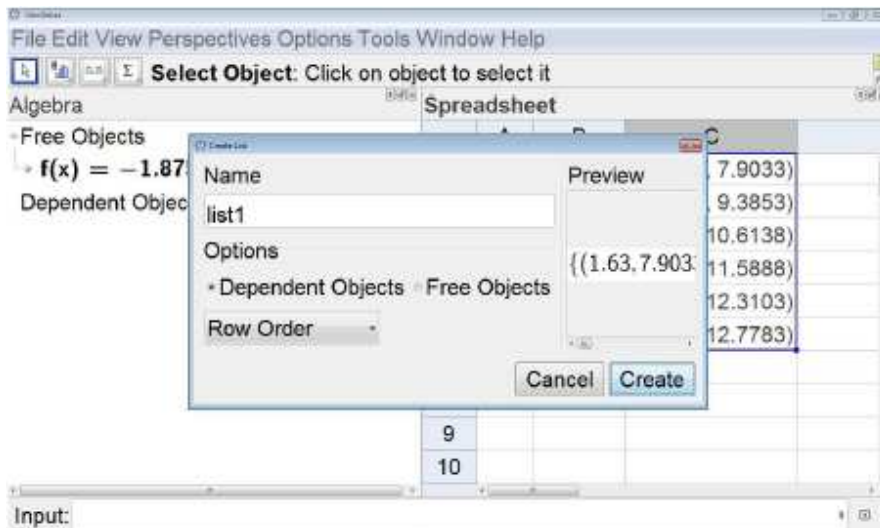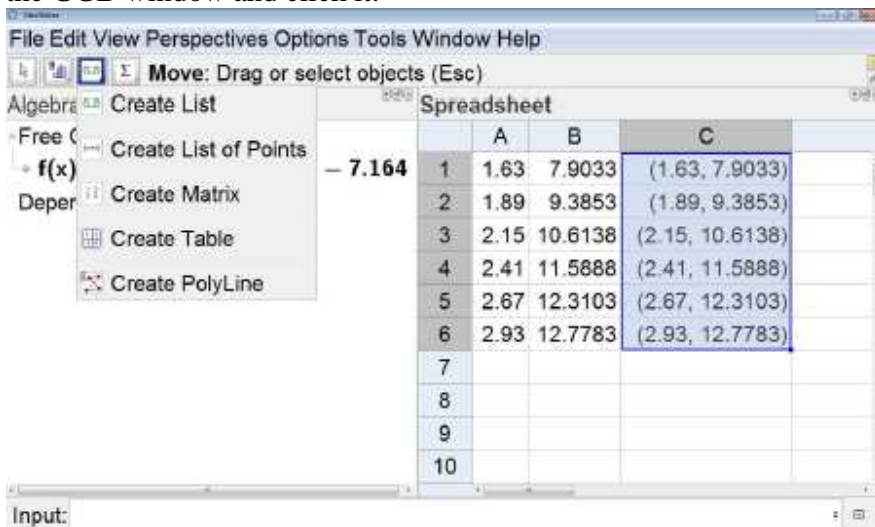
Result:
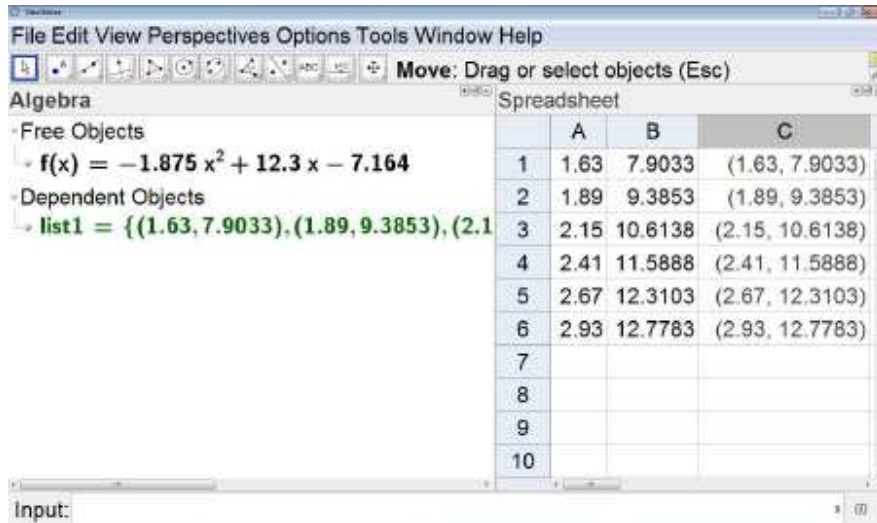
Good things to know when working with GGB:
NEW WINDOW: Control N or click on the File menu and select new.

DEACTIVATE OR ACTIVATE EQUATION OR VALUE: In the Algebra Window, click on the circle to the left of the item.

Example 5: The path of a small rocket is modeled by the function $h(t) = -16t^2 + 128t + 12$ where initial velocity is 128 feet per second and initial height is 12 feet. The model gives the height of the rocket in feet, t seconds after launch. Find the height of the rocket:
A. 2 seconds after launch.
B. 4 seconds after launch.
C. 5 seconds after launch.
D. 8 seconds after launch.

Enter the function in the input line. Command:

Evaluate the function at each t value given above.

Command for A: Answer:

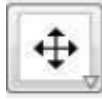Command for B: Answer:

Command for C: Answer:
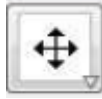
Command for D: Answer:

Graphing

Example 6: Use GGB to graph the function $f(x) = -2x - 3$.

Enter the function in the input line. Resize the graphics window, if needed, to get a good view of the function.
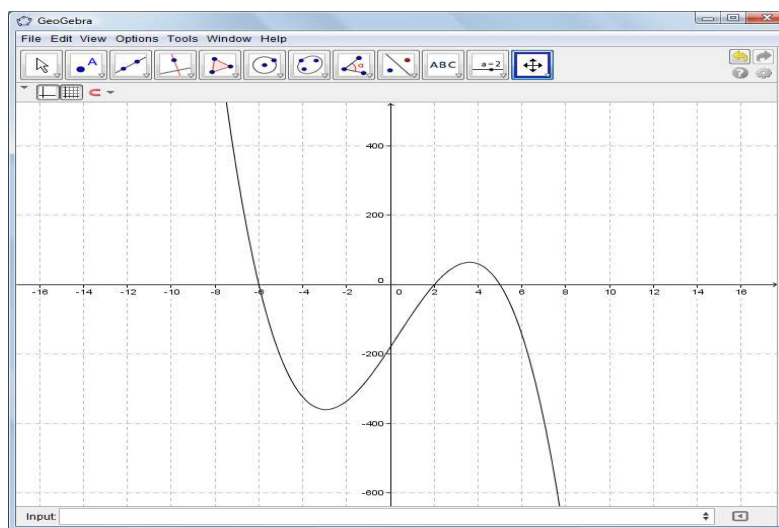
TO MOVE GRID: Make sure that is selected then put the cursor anywhere on the grid, and move it.

TO VIEW STANDARD VIEW: Ctrl+M or right-click on the grid and select "Standard View".
TO ADJUST X- Y- AXES: Put the cursor on the respective axis and move up, down, right or left.
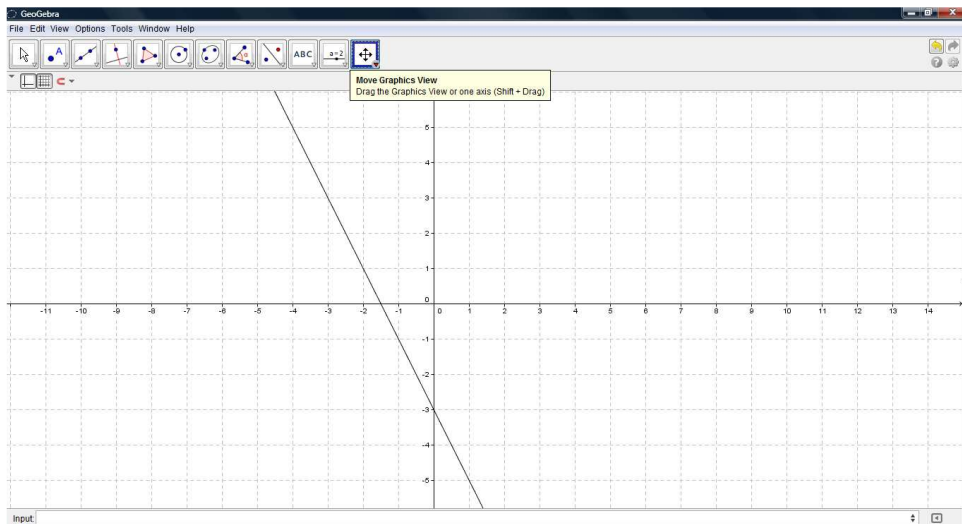
Example 7: Graph the function $h(x) = -3x^3 + 3x^2 + 96x - 180$ and find an appropriate viewing window.
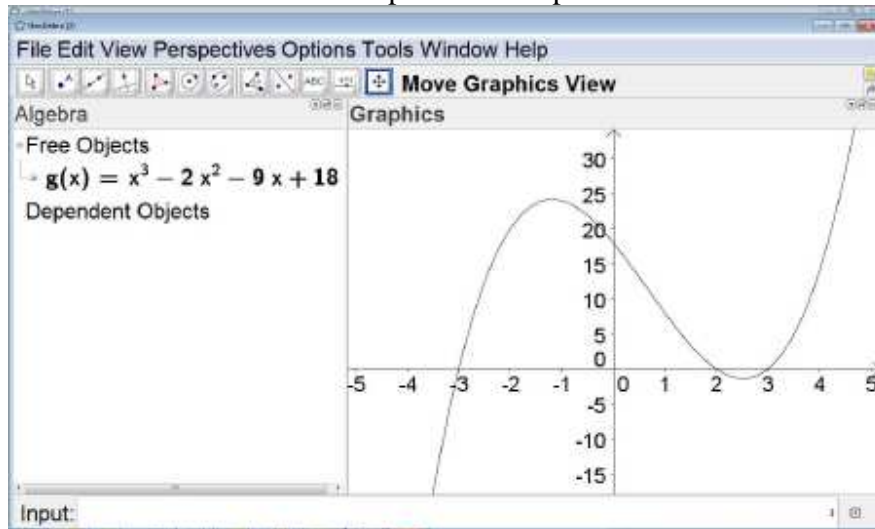
Finding Some Features of a Graphed Function

You can find the zeros (also called roots or x intercepts) of a function using GGB.

Example 8: Suppose $g(x) = x^3 - 2x^2 - 9x + 18$. Find the zeros of the polynomial function.
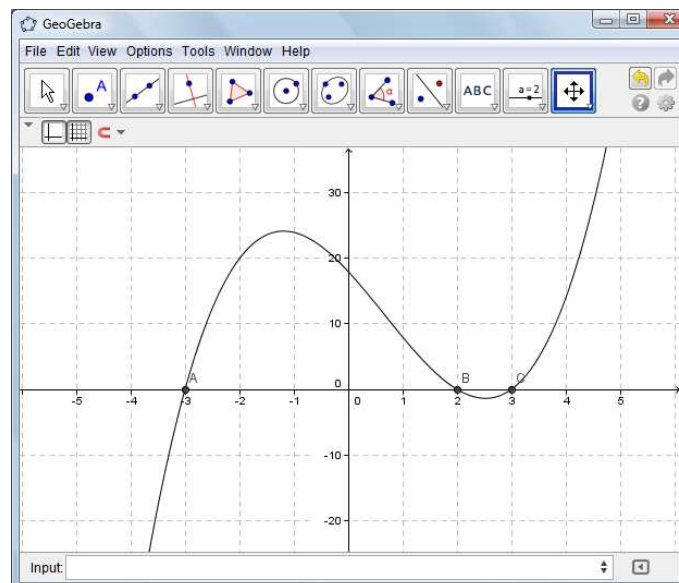
A. Enter the function in the input line. Graph and resize if needed.

B. Find the zeros of the polynomial function. (*When you begin to enter the command, a list will appear.*)
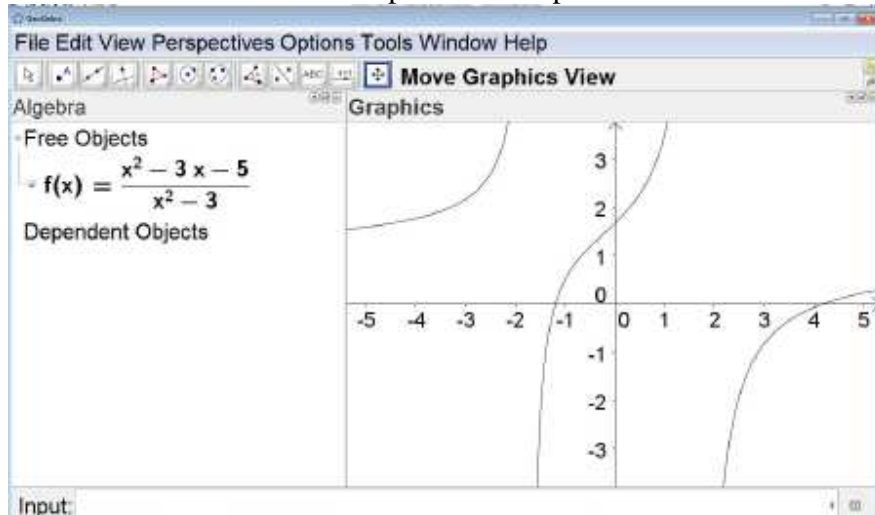
Command:

Answer:

Example 9: Suppose $f(x) = \dfrac{x^2 - 3x - 5}{x^2 - 3}$. Find the zeros of the function.

A. Enter the function in the input line. Graph and resize if needed.


B. Find the zeros of the function. The command in the input line will be the same as in Part B of the previous example; however, this function is not a polynomial so we'll need to choose the command: Roots[<function>,<start value>,<end value>] **Make sure to choose the command "ROOTS" *NOT* "ROOT".**
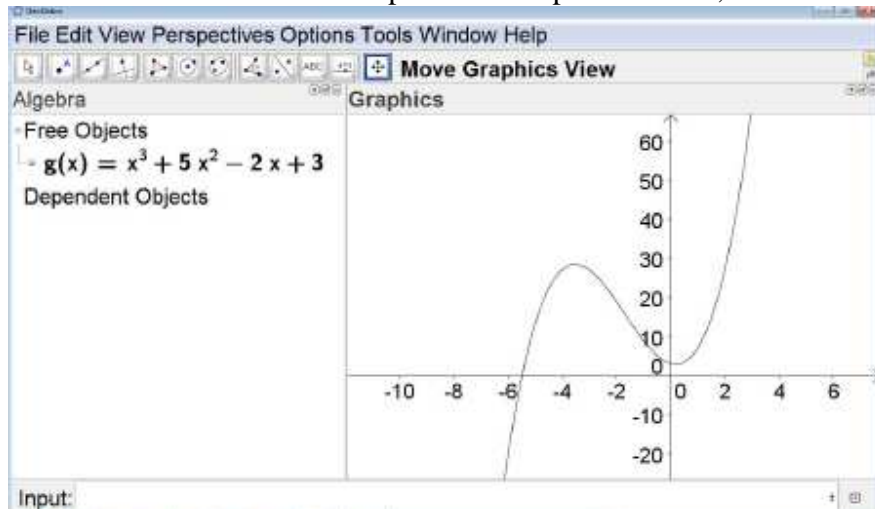
Command:

Answer:

The **relative extrema** of a function are the high points and low points of the graph of a function, when compared to other points that are close to the relative extremum.   A **relative maximum** will be higher than the points near it, and a **relative minimum** will be lower than the points near it.
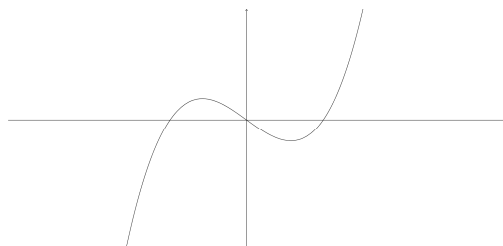
GGB will help you find these points.

Example 10: Suppose $g(x) = x^3 + 5x^2 - 2x + 3$. Find any relative extrema.

A. Enter the function in the input line. Graph and resize, if needed.
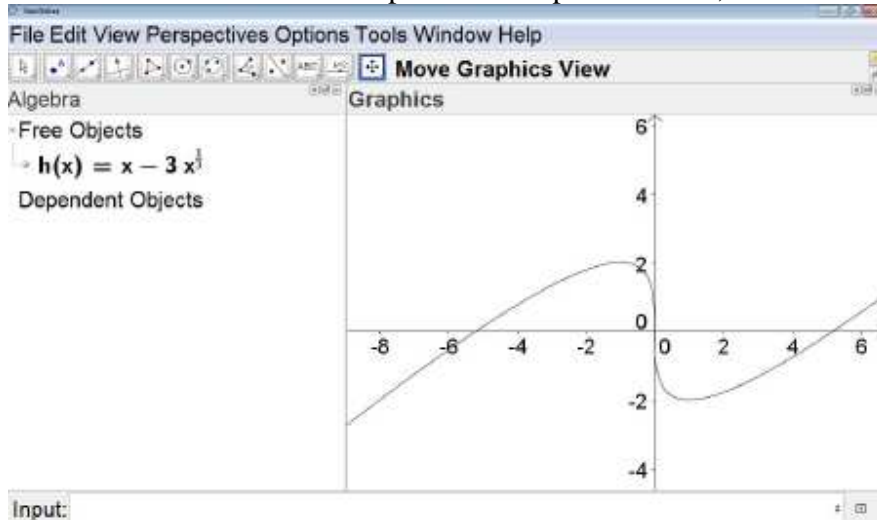

B. Find the relative extrema.

Command:

Relative Max:

Relative Min:

Example 11: Suppose $h(x) = x - 3x^{\frac{1}{3}}$. Find any relative extrema.

A. Enter the function in the input line. Graph and resize, if needed.

B. Find the relative extrema. Since the function is not a polynomial, the command is:
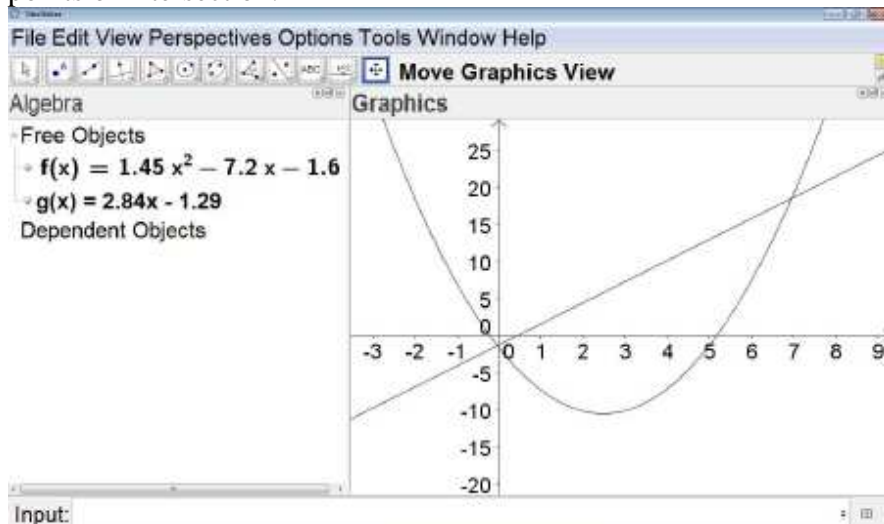Extremum[<Function>,<Start x-Value>,<End x-Value>]

Command:

Relative Max:

Relative Min:

Intersection of Two Functions

Example 12:   Find any points where $f(x) = 1.45x^2 - 7.2x - 1.6$ and $g(x) = 2.84x - 1.29$ intersect.

A. Enter the functions one by one in the input line. Graph and resize if necessary to view all points of intersection.
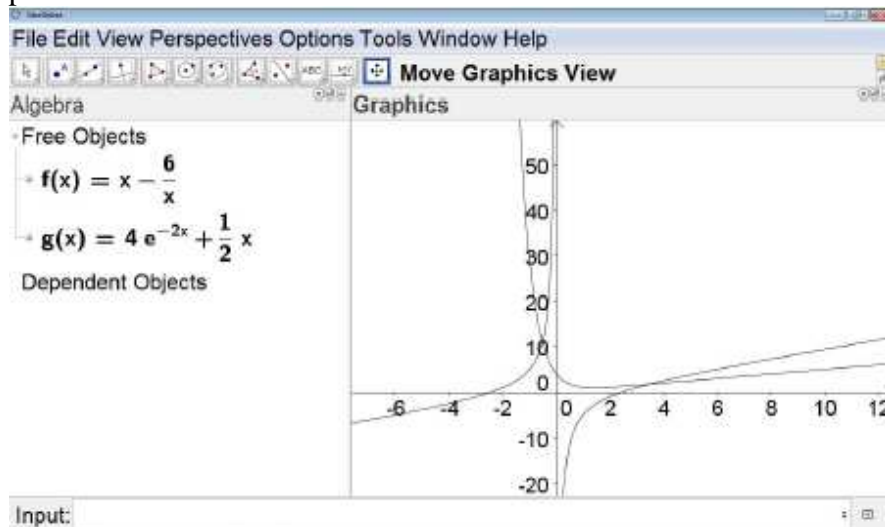

B. Find intersection points.

Command:

Answer:

Example 13: Find any points where $f(x) = x - \dfrac{6}{x}$ and $g(x) = 4e^{-2x} + \dfrac{1}{2}x$ intersect.

A. Enter the functions one by one in the input line. Graph and resize if necessary to view all points of intersection.

B. Find intersection points. Since the function is not a polynomial, the command is:
Intersect[<Function>,<Function>,<Start x-Value>,<End x-Value>]

Command:

Answer: