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

Before we introduce calculus, let's look at a brief introduction to GGB.

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.

This is what you will see when you open GGB.
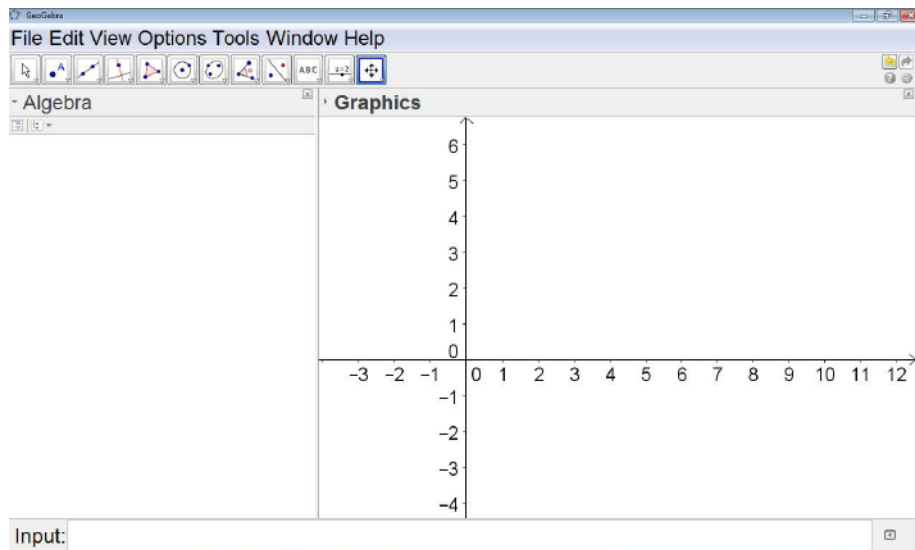


TO ADJUST FONT: Go to "Options," then click on "Font" and select the size that you'd like.

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 "Save Settings".

NEW WINDOW:  Control N or click on the File menu and select new.  *Try not to have too many different GGB windows open as it may make the program crash.*

You will enter functions or expressions using the input line.  Put the cursor in the input line and start typing.

Input:
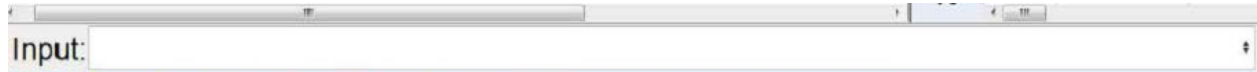
USE:

The caret key ("^") to raise a number or variable to a power.
The slash ("/") for division.
The asterisk ("*") for multiplication.
USE SQRT for the square root or USE CBRT for the cube root.
To enter a sixth root such as, $\sqrt[6]{2}$ , type:  2^(1/6)---Make sure the exponent is parenthesis!!

If you make a mistake in entering an expression, look at the end of the input line and click on the up/down arrow icon.  Your entry or entries will come up and select the desired one to correct.

Input:
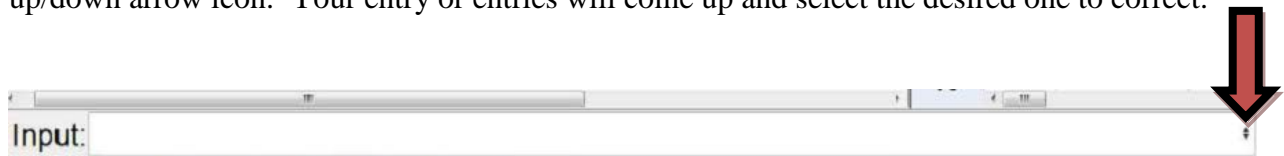
Example 1:  Use GGB to compute:
a.  $\sqrt{5}+\sqrt[3]{7}-\sqrt[6]{10}$        Command:                              Answer:

b.  $\dfrac{1+3e^3}{452^2-\frac{1}{2}}$           Command:                              Answer:

Example 2:  The path of a small rocket is modeled by the function $h(t) = -16t^2 + 128t + 12$
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.

*Begin by entering the function in the input line...*

Command:

Command for a:                                        Answer:
Command for b:                                        Answer:
Command for c:                                        Answer:
Command for d:                                        Answer:

## Graphing

Example 3:  Graph the functions $f(x) = \dfrac{x+1}{x^2 + 3x}$ and $g(x) = \dfrac{1}{2}x$, and find an appropriate

viewing window.



TO MOVE GRID:  Make sure that  is selected then put the cursor anywhere on the grid, and move it.
TO ADJUST X- Y- AXES:  Put the cursor on the respective axis and move up, down, right or left.
TO VIEW ONE FUNCTION AT A TIME IN THE GRAPHICS WINDOW:  Check or uncheck the blue circle to the left of the function in the Algebra window.

**Finding Some Features of a Graphed Function**

You can find the zeros (also called roots or x intercepts) of a function using GGB.  The command will depend on if the function is a polynomial or not.

| Function | GGB Command |
|---|---|
| Polynomial | Root[<polynomial>] |
| Not a polynomial | Roots[<function>,<start value>,<end value>] |

Example 4:  Suppose $g(x) = -5x^3 + 8x^2 - 3x + 2$.  Find the zeros of the polynomial function.

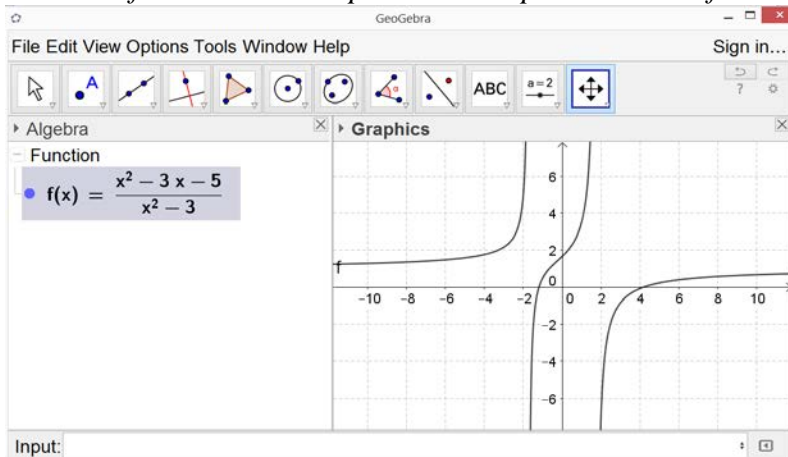*Enter the function in the input line.  Graph and resize if needed.*
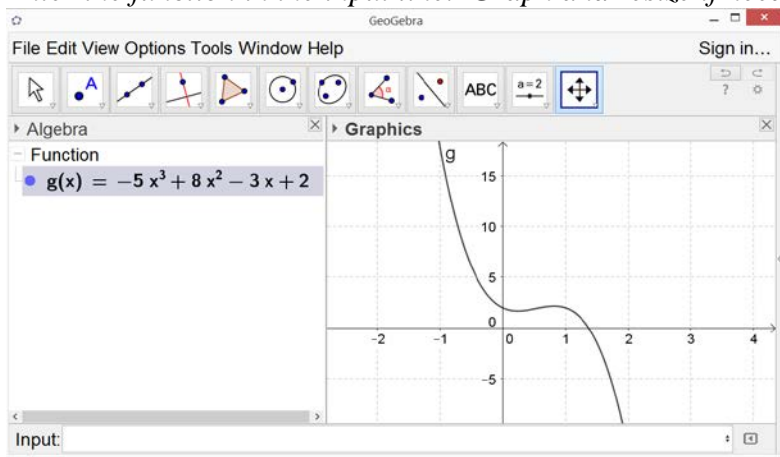


Command:

Answer:

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

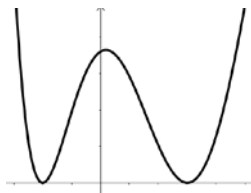*Enter the function in the input line.  Graph and resize if needed.*



Command:

Answer:

Example 6: The path of a small rocket is modeled by the function $h(t) = -16t^2 + 128t + 12$
The model gives the height of the rocket in feet, $t$ seconds after launch. When will the rocket reach the ground?
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 can find these points.



| Function | GGB Command |
|---|---|
| Polynomial | Extremum[<polynomial>] |
| Not a polynomial | Extremum[<Function>,<Start x-Value>,<End x-Value>] |

Example 7: Suppose $g(x) = -x^4 + 4x^3 - 5x + 1$. Find any relative extrema.

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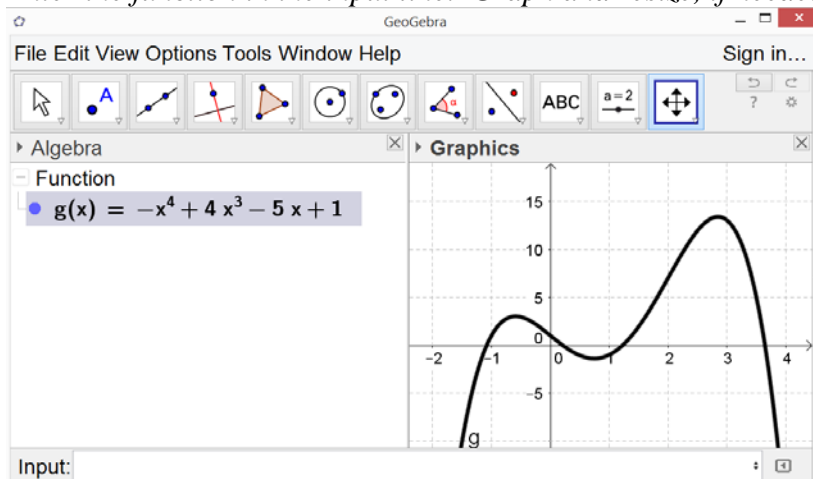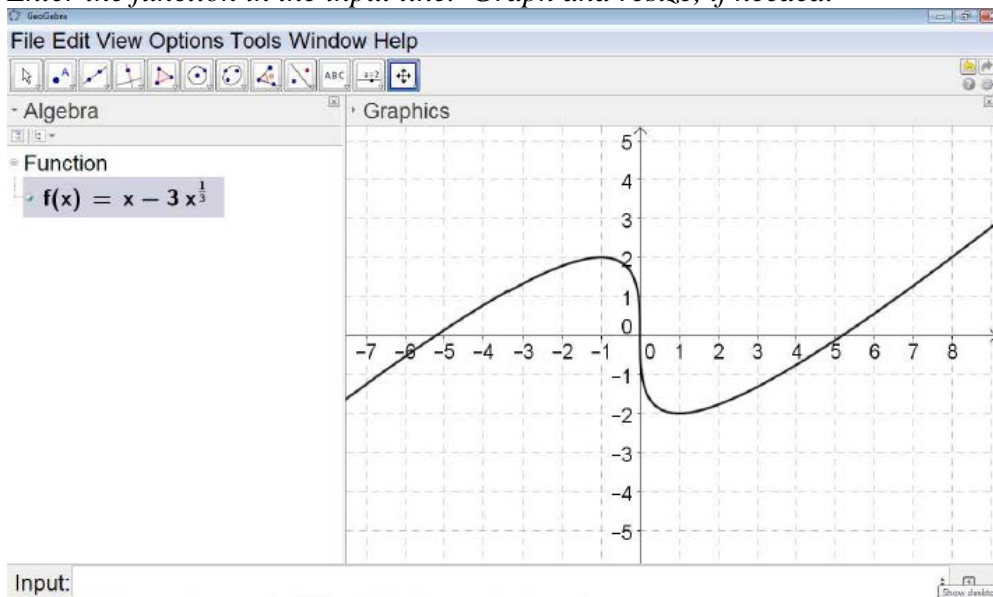


Command:

Relative Max:                                               Relative Min:

Example 8: Suppose $f(x) = x - 3x^{\frac{1}{3}}$ . Find any relative extrema.

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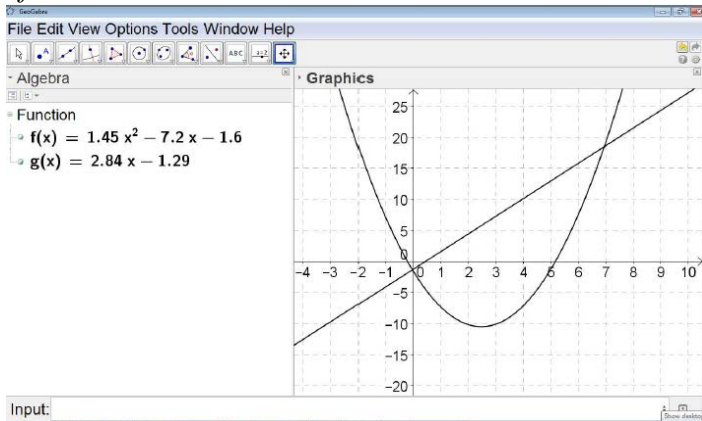


Command:

Relative Max:                                                    Relative Min:

**Intersection of Two Functions**

| Function | GGB Command |
|---|---|
| Polynomial | Intersect[<Object>, <Object>] |
| Not a polynomial | Intersect[<Function>,<Function>,<Start x-Value>,<End x-Value>] |

Example 9: Find any points where $f(x) = 1.45x^2 - 7.2x - 1.6$ and $g(x) = 2.84x - 1.29$ intersect.

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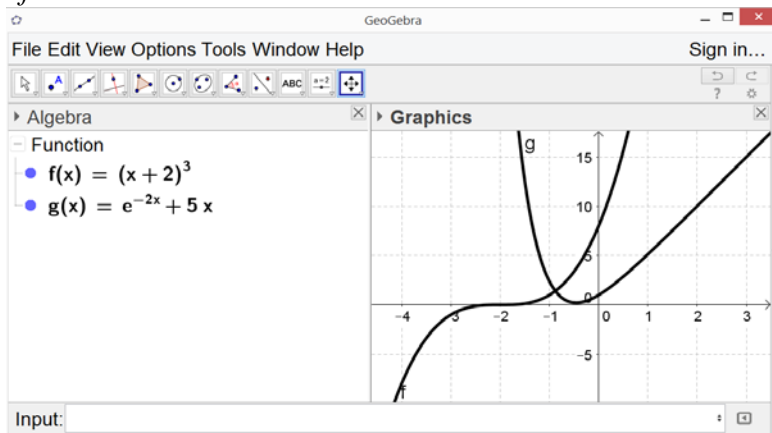


Command:

Answer:

Example 10: Find any points where $f(x) = (x+2)^3$ and $g(x) = e^{-2x} + 5x$ intersect.

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



Command:

Answer: