# HP Prime Advanced Graphing Calculator

HP Prime is the latest advanced graphing calculator from Hewlett-Packard. It incorporates a full-color, multi-touch screen and comes pre-loaded with 18 HP Apps. HP Prime also has a Home view, with a history of your numerical calculations, as well as a CAS view, with a history of your symbolic computations.

HP Prime has three design principles:

- Provide a high degree of mathematical fidelity across multiple mathematical representations
- Give students the interactive experiences with technology that they have come to expect
- Deliver a simple and seamless experience for mathematical exploration and problem-solving

HP Apps are designed to explore mathematical topics or solve problems. All HP Apps have a similar structure, with numeric, graphic and symbolic views to make them easy to learn and easy to use. Press **Apps Info** to see the App Library. Drag with your finger to browse the library, then tap the icon of the app you want to use.
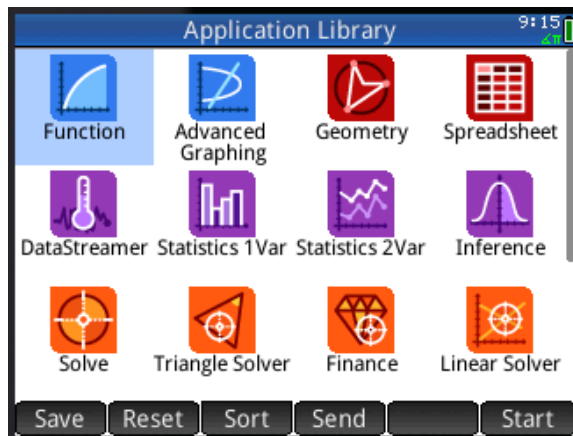
The HP Apps are color-coded for easy identification:

- 4 Solver Apps (orange) for solving specific types of problems (triangles, finance, linear systems) and a general solver for equations and non-linear systems
- 4 Statistics Apps (purple) for descriptive and inferential statistics and data collection
- 4 graphing apps (blue) to explore graphs and tables of values
- 3 Explorer Apps (green) for investigating the relationship between the parameters of a function and the shape of the function's graph

In addition to these apps, there are four more apps of particular interest:

- The **Advanced Graphing** App allows you to plot and explore the graphs of functions and relations in x and y, including implicit relations, inequalities, and conic sections
- The **Geometry** App gives you the features of a dynamic geometry application, but with a Symbolic view for defining geometric objects exactly using the CAS
- The **Spreadsheet** App gives you the features of a spreadsheet with the power of a CAS
- The **Data Streamer** app lets you collect data from sensors quickly and easily

In this brief introduction to HP Prime, we will examine these four apps, but first we will look at the Function App.

The Function App

The Function App gives you all the tools you need to explore the properties of functions, including plotting their graphs, creating tables of values, and finding roots, critical points, etc.

Tap on the Function App icon and it opens in the Symbolic view. Enter a function using the 2-D textbook format editor.

Choose a color for each of your graphs from the color picker.

Press ⌨ to see the graphs of your functions.

In the Plot view, tap **Fcn** and then tap an option. We will use the Signed Area function.

You can find the signed area between the two graphs. Just tap near the starting point and then use the arrow keys to get the exact point you want.

Now tap near the end point and again use the arrow keys to get the exact value. With the touch display, the experience is more responsive and interactive.

The color display shows you which regions have positive area and which have negative area.

You can use your finger to drag, which scrolls you through the window. You can also press ⌨ and ⌨ to zoom in and out on the cursor. No more going back and forth between the plot and the window settings!
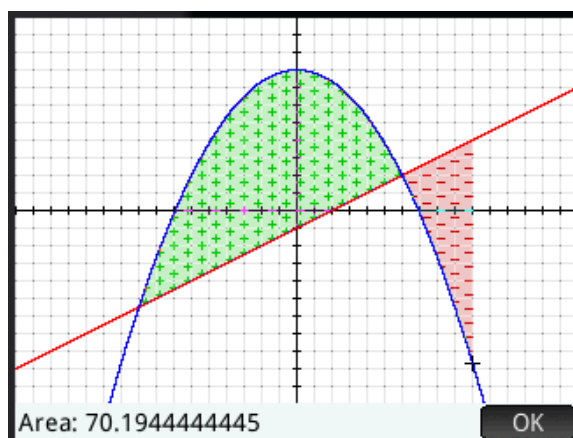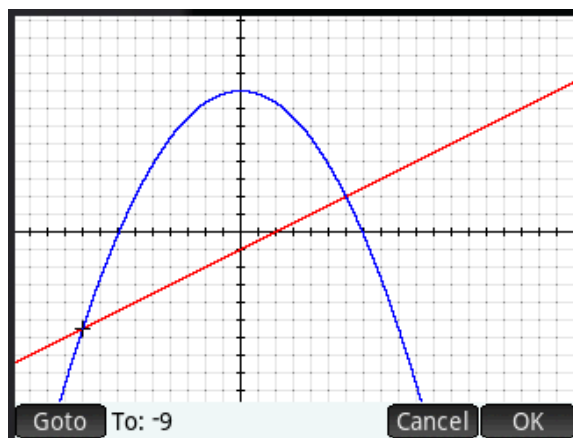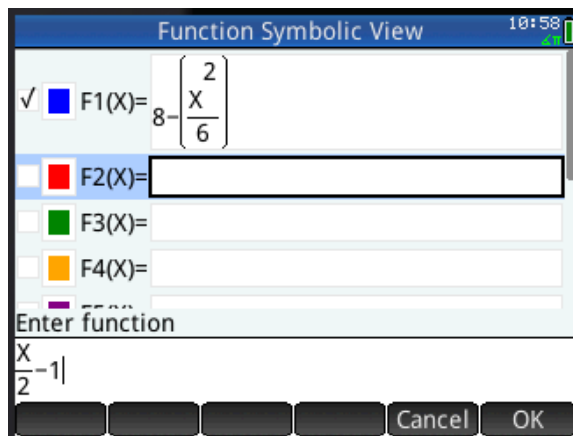
The Advanced Graphing App

The Advanced Graphing App is designed to plot the graphs of conic sections, polynomials, inequalities – virtually any mathematical open sentence in X and Y.

Tap the icon to see the Symbolic View and enter an open sentence in X and Y using the 2-D editor.

Here we enter a rotated conic in general form; in this case, an ellipse.

Use the color picker to choose a color for your graph.

Now press [Plot/Setup] to see the graph of this rotated conic section. Drag your finger to scroll the window, or use [Ans +] and [Base −] to zoom in and out. The touch interface makes it easy to adjust the graph without leaving the Plot view.

While in the Plot view, tap [Menu] and [Defn] to view and edit the equation-again without leaving the Plot view. Change the equal sign to < and then tap [OK] to see the new graph.
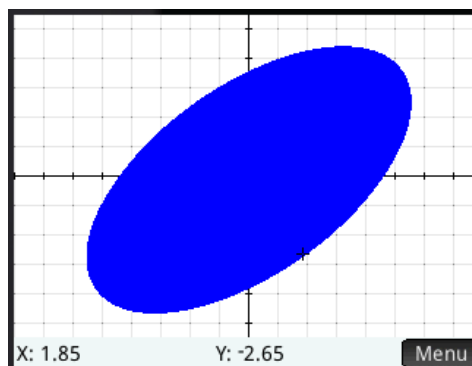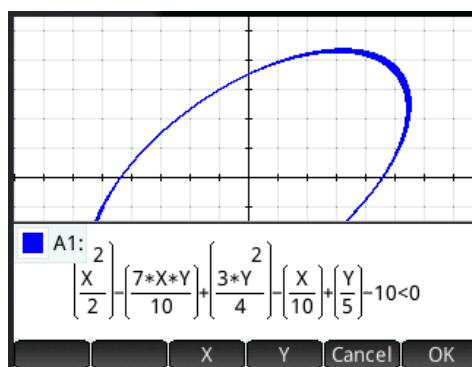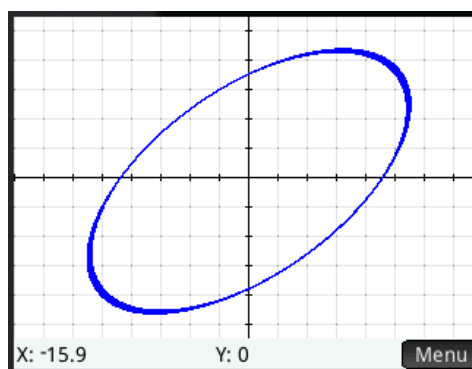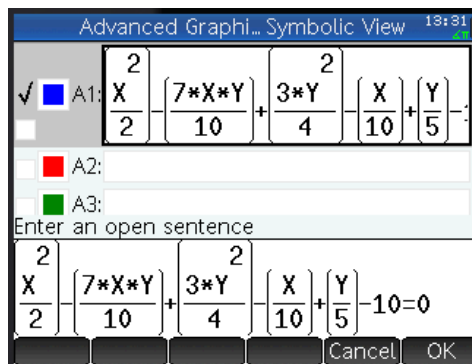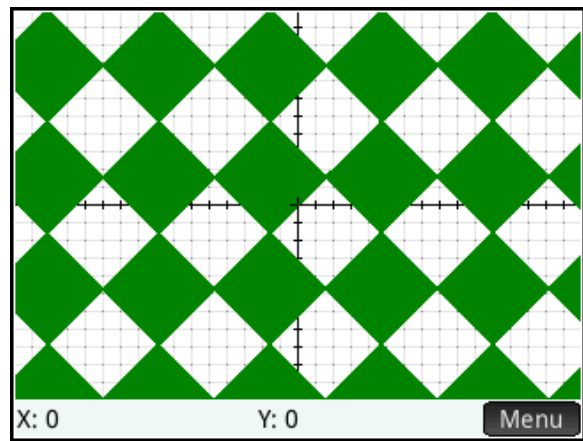
The Advanced Graphing App can handle all of the following with ease:

- Conic sections (rotated ones, too)
- Polynomials in standard or general form
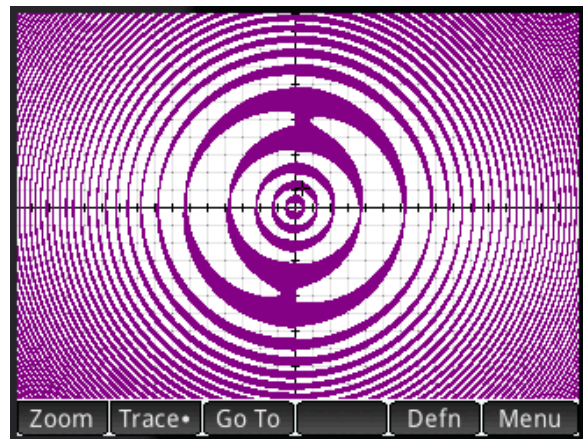- Inequalities (not just linear)
- Functions

In addition, it can handle graphs you have not thought about, like the figures to the right.

$Y \operatorname{Mod} X = 3$

$\operatorname{Sin}(X) < \operatorname{Sin}(Y)$
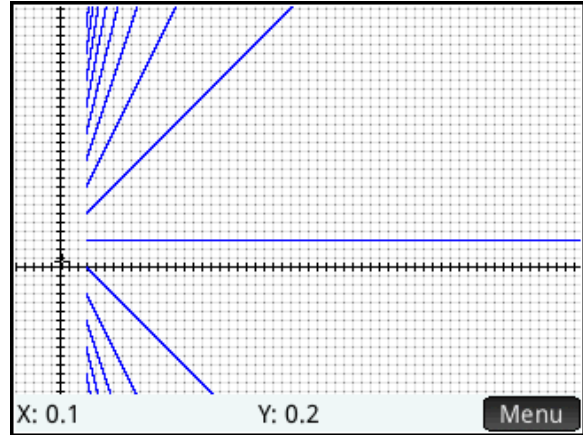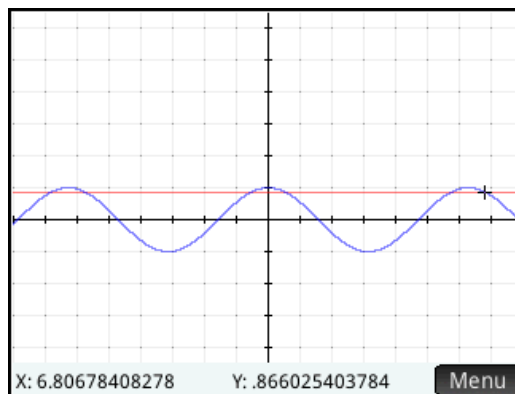

$$Sin\left(\left(\sqrt{x^2 + y^2} - 5\right)^2\right) > Sin\left(8 + Tan^{-1}\left(\frac{y}{x}\right)\right)$$

The Plot view tracer and the Numeric view have some useful innovations as well. The Plot view tracer can be set to only trace any one of the following:

- X-Intercepts
- Y-Intercepts
- Horizontal Extrema
- Vertical Extrema
- Inflection Points
- Intersections

The Numeric view has the same set of options, so you can build a table of just the points of interest you want.

In the Plot view to the right, you can see the graphs of $y = \cos(x)$ and $y = \dfrac{\sqrt{3}}{2}$. The tracer has been set to move between the intersection points. In the Numeric view shown, the table has been set to just show the intersection points that were visible in the Plot view.

With tools like this, students can focus on what is important, making conjectures and solving problems.

| X: 6.80678408278 | Y: .866025403784 | Menu |

X	Y
-6.80678408278	.866025403784
-5.75958653158	.866025403784
-.523598775598	.866025403784
.523598775598	.866025403784
5.75958653158	.866025403784
6.80678408278	.866025403784

(-6.80678408278,.866025403784)

| Trace• | Size | Defn |

The Geometry App

The Geometry App is a dynamic geometry application that allows you to create geometric constructions and explore their properties interactively.

In this construction, point B is the point of tangency for the red tangent line. The graph in black is a cubic function.
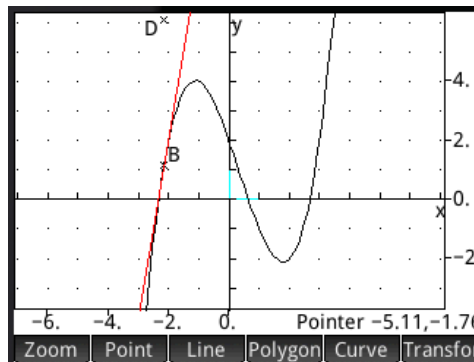
Point D has the same x-coordinate as point B but its y-coordinate is equal to the slope of the tangent line. As point B moves along the curve, point D traces out the derivative of the curve. This graphical representation is in the Plot view of the app.
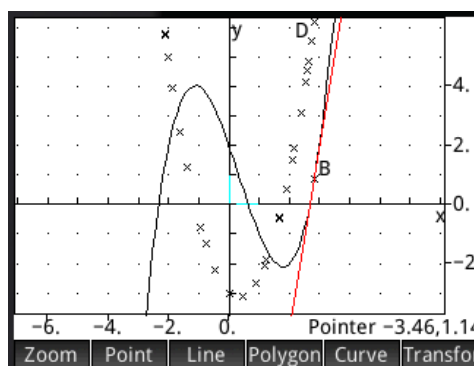
The Symbolic view of the app shows the definition of each object in the Plot view. With the Symbolic view, you can see exactly how the sketch was created. You can edit these definitions directly or create new objects in this view. Check the ones you want to show in the Plot view and uncheck the ones you want to hide. Change the graph being plotted in GA to y=3sin(x). Point D still traces out the derivative.

This one construction can now help your students visualize the derivative of <u>any</u> function!
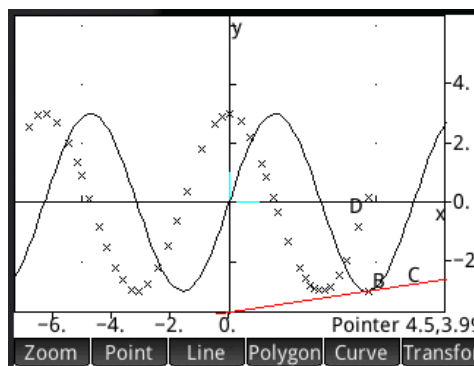
Save this construction with a name you'll remember and use the Geometry App to make other constructions.

In this construction, we have a blue ellipse defined by the focal points A and B, and a point C on the ellipse.

The red ellipse is the reflection of the blue one over the line y=x. They are inverses of each other. Note the equations of the two ellipses and how the roles of *x* and *y* are interchanged. Since the points A, B, and C were defined exactly in the Symbolic view, the equations are exact as well. Also, the y-coordinate of point J is shown to emphasize the exact nature of the result.
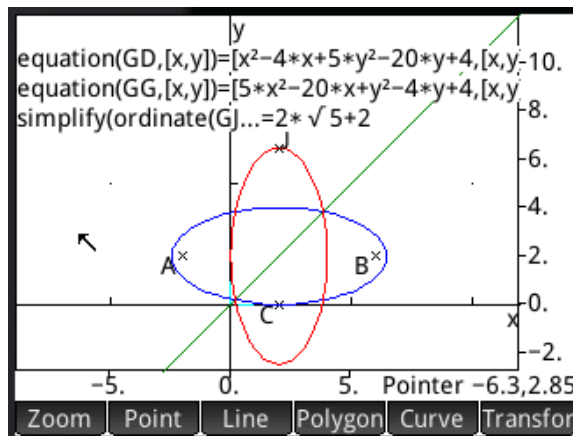
The Numeric view of the Geometry app is where you go to make measurements or create calculations based on measurements. Check the ones you want displayed in the Plot view.
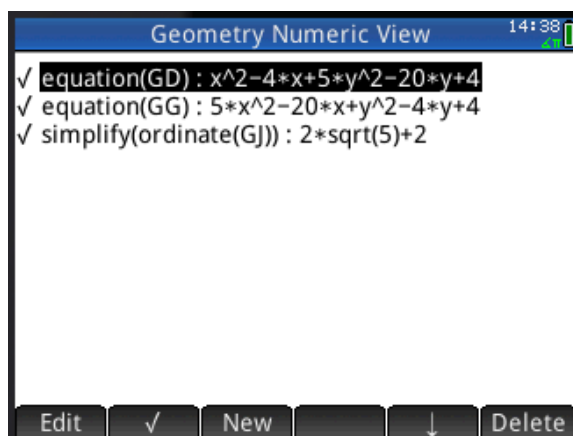
Here the CAS is used to retrieve the equation of the blue ellipse and put it into a more familiar form.

Note the length of the major semi-axis is $\sqrt{20} = 2\sqrt{5}$ and the center is at (2,2). So the point J on the reflected ellipse should have a y-coordinate of $2 + 2\sqrt{5}$, which it does exactly as shown in the figure above.
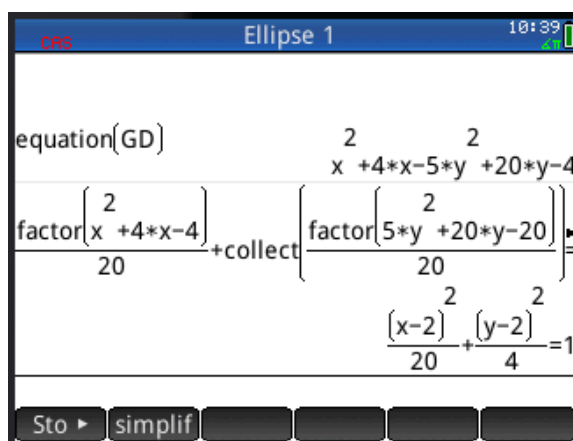
The integration of the CAS and dynamic geometry gives you an exact analytical geometry app that is dynamic as well.

The Spreadsheet App

The Spreadsheet App gives you the most common features you expect in a spreadsheet. But with HP Prime, you also get the power of a CAS integrated with the spreadsheet.

You can define the entire spreadsheet with a single command. Here we produced Pascal's Triangle using just the nCr command (COMB) and the Row and Col variables.

Or how about a handy reference table of the first thousand or so Pythagorean triplets? It's easy!

Here we used the CAS to define one column of the spreadsheet to expand the binomial $x+1$ to various integer powers. Note the expression editor shows a CAS button. When active, the CAS is used to evaluate the expression. When it is not active, expressions are evaluated to numerical results, as in the previous examples. Imagine all the patterns you and your students can explore in symbolic expressions!

The Spreadsheet App can also handle commands with multiple outputs, such as summary statistics. Here, the AMORT command was used to display an amortization table for a 30-year, $500,000 loan at 5% interest with monthly payments of $2684.11.

The Data Streamer App

The Data Streamer App works with the HP StreamSmart 410 and up to four Fourier® sensors to collect data in real time. The final data set is sent to one of the statistics apps for analysis.

Just plug the microphone sensor into the StreamSmart 410 and start the Data Streamer App. The microphone is automatically identified. Just tap Start to see your own voice in real time. Zoom in/out while data is still streaming.

Here, all the data you see was collected in 0.144 seconds-roughly 1/7 of a second!
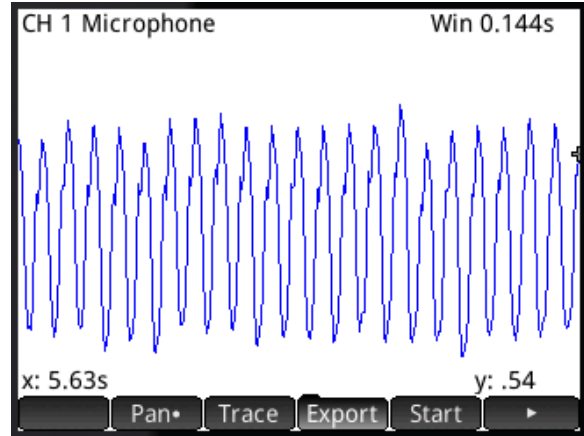
Tap Export to select a final data set. You can crop data from the left and right, as well as thin your data set to get just the data you want.

Once you have selected a final data set, send your data to one of the Statistics Apps for analysis.
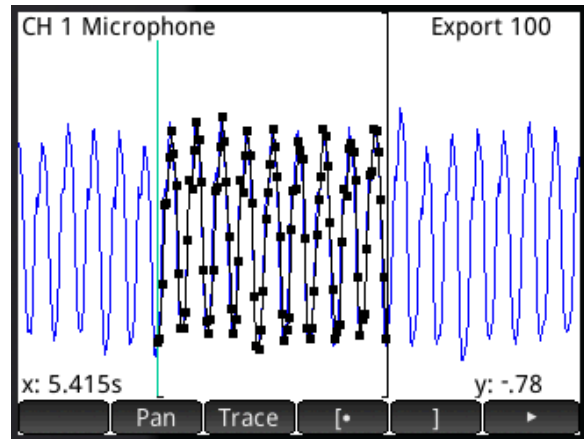
Here we see the same data numerically in the Numeric view of the Statistics 2Var App. From here, you can make a scatter plot of the data and create a trigonometric fit.

Examination Mode

HP Prime can be configured and locked for an examination. The machine will remain locked for the pre-set time period and secured with a password. LED lights at the top of the unit will flash to show that it is in examination mode.

Go to the Exam Mode interface, give your configuration a name, set a time period, and give it a password. You can also check a box to erase memory when examination mode starts, and check another box to make the LED lights blink while in examination mode.

Tap Config to select the features you want to disable.

Here we have disabled all saved apps, the whole CAS, and new notes and user programs.

You can block individual apps, all matrix operations, units, even the Help system.

In the Mathematics menu, you can disable commands by category or individually.

Create as many custom configurations as you like and save them with names you will remember. You can edit any saved configuration as well. Start the examination mode on the HP Prime or send it to another HP Prime via USB. Once examination mode has started, the LED lights will blink to show that the configuration is in effect.
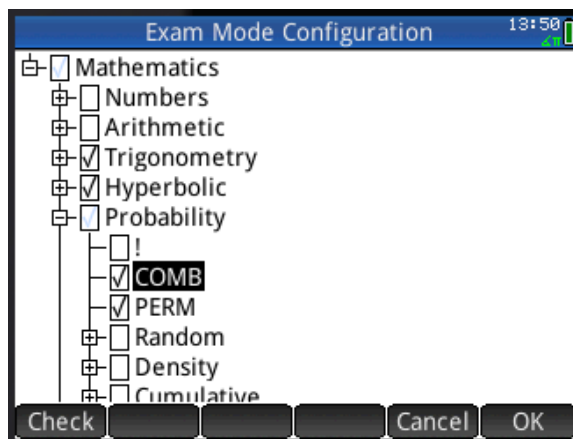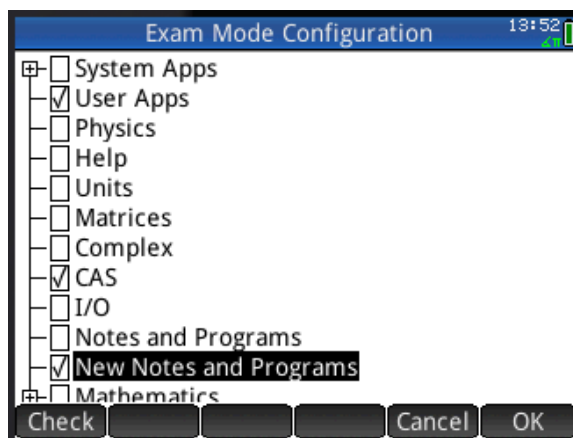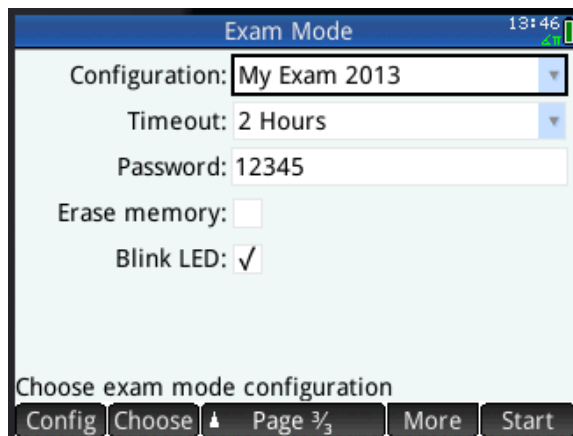
Getting Help

The HP Prime comes with a 60+ page *Quick Start Guide* in the box, and you can download the full 600+ page *User Guide* from the HP website. But most of the time, you will find the help you need right on your HP Prime by pressing [?Help User]! The help system of the HP Prime is context-sensitive; that is, when you press [?Help User], the help page(s) for your current view or selection is displayed.

Each view in HP Prime (including app views) has its own help page(s). In the figure to the right, [?Help User] was pressed while in the Geometry app Numeric view. The display shows the first of 3 pages of help for this view.

In the second figure, the Limit command has been selected from the Toolbox menus ([Mem B]). Pressing [?Help User] now displays the help page for that command. On the help page, you can tap:

- [Tree] to see the entire help system organized as a tree
- [Exampl] to select an example and paste it to the CAS or Home view to execute
- [Other] to see help on related commands
- [OK] to exit the help page

The last figure shows the example pasted to the CAS view and executed. Most commands have at least one help example.

So now you can learn about your HP Prime while you are using it!
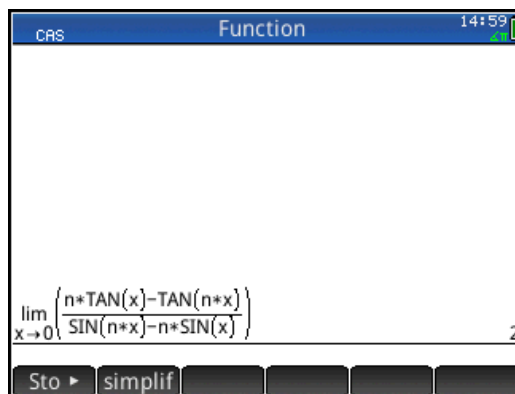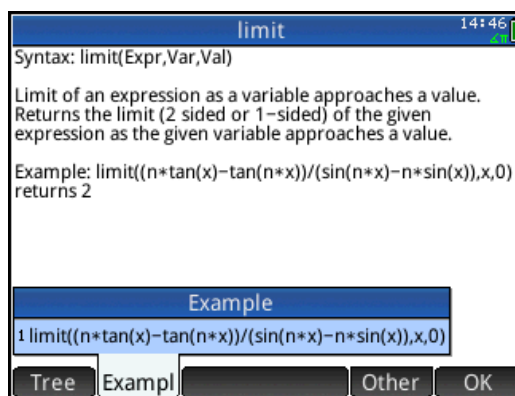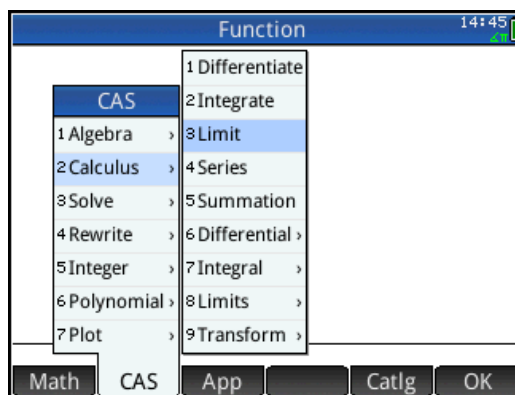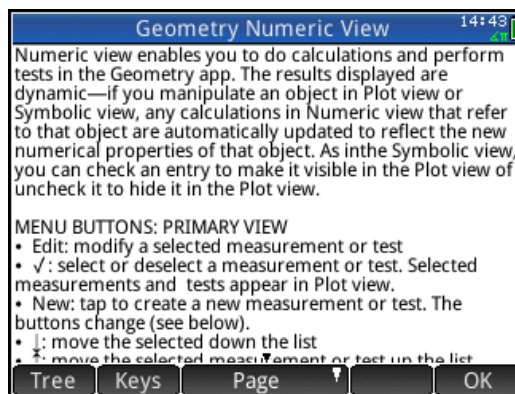
The HP Connectivity Kit and the HP Wireless Classroom Network

The HP Connectivity Kit comes in the box with your HP Prime. This software application lets you update your HP Prime, synchronize data with your PC, and lets you develop HP Prime content (apps, programs, notes, etc.) on your PC and then send it to your HP Prime.

With the optional wireless modules for HP Prime, the HP Connectivity Kit turns into a classroom instructional toolkit that you can use to monitor students, send and receive messages, perform formative assessment via polls and surveys, and broadcast apps and data to students. You can see all your student Primes at once, or select one to display to the rest of the class for discussion purposes.
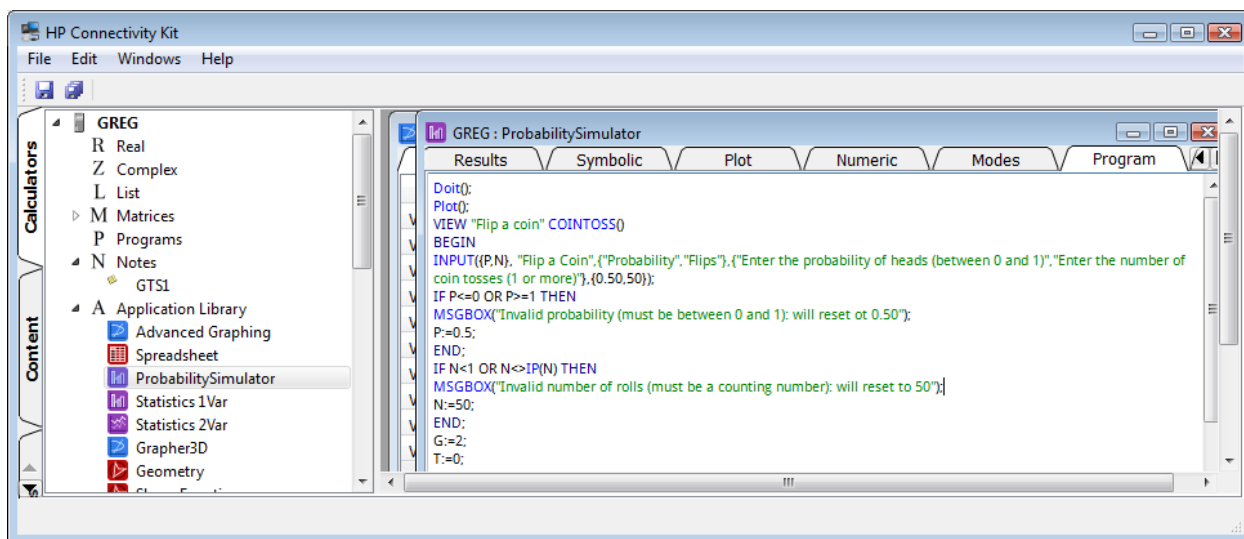
The HP Connectivity Kit lets you create content on your PC and send it to your HP Prime
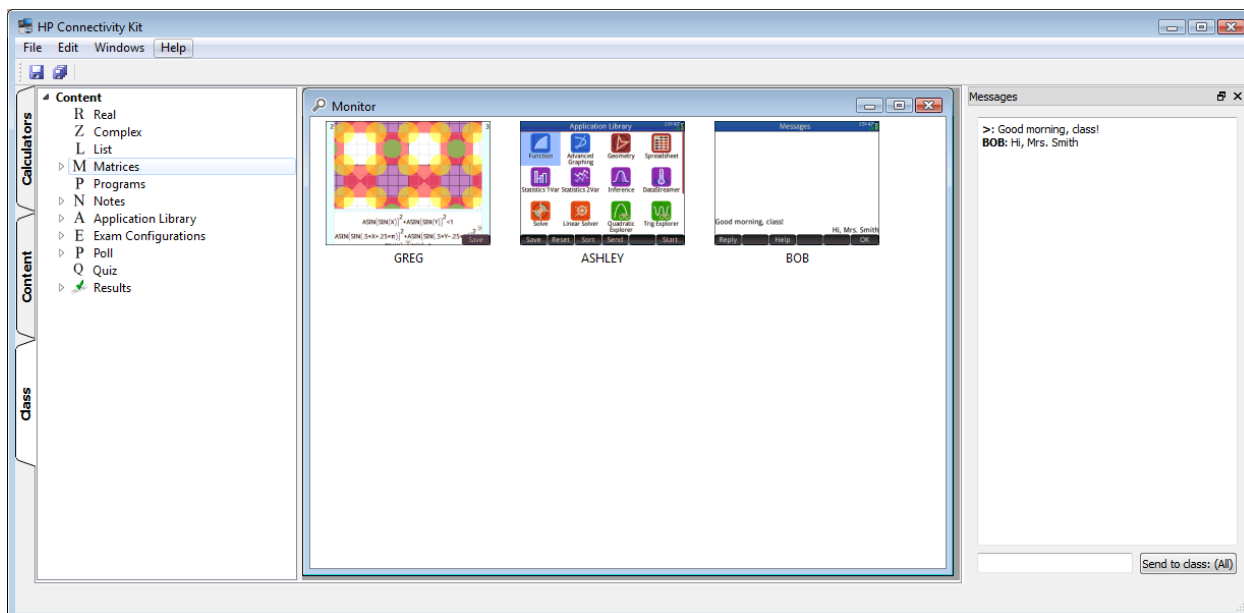
With the wireless module, the Kit becomes the center for the HP Prime classroom network

The HP Prime Virtual Calculator

The HP Prime Virtual Calculator is a software application that runs on your PC and emulates the behavior of your HP Prime. It, too, comes in the box with your HP Prime and is meant to be an instructional tool for classroom use. Besides emulating the behavior of your HP Prime, it:

- displays your HP Prime to the class for teaching purposes via a projector
- captures the display of your HP Prime for use as graphics in other documents
- uses your PC keyboard for easy data entry
- has a variety of skins to best fit your particular PC display
- has the User Guide and Quick Start Guide at hand via the Help menu