

Third Edition

Be Prepared
for the

AP

Calculus
Exam

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Appendix: Calculator Skills
(HP Prime)

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Appendix: Calculator Skills (HP Prime)

The Test Development Committee has defined four calculator operations that are sufficient to answer all AP exam questions:

1. produce a graph of a function within an arbitrary viewing window;
2. find the zeros of a function (i.e., solve an equation numerically);
3. calculate the derivative of a function at a given value;
4. calculate the value of a definite integral.

You should practice these skills prior to the AP Exam. A few examples follow, with calculator-assisted solutions for the HP Prime. The [TI-83 / TI-84](#), [TI-89](#), and [TI-Nspire](#) models are described in separate documents. There are other acceptable calculator methods to solve these problems. If your calculator model does not match one of the models presented, consult your user's manual to solve the examples.

A.1. Graphing a Function

This is the simplest calculator skill required on the exam. Usually, the hardest part is making sure you enter the function correctly on your calculator, and that you choose a suitable viewing window. Be sure to check that the parentheses that enclose function arguments (as in $\sin(X)$) are properly matched.

Be sure that your calculator is set to the [Radian](#) mode when you take the exam. (To set the mode, go to the [Home Settings](#) menu.)

You will see several graphing examples in the following sections.

A.2. Solving an Equation

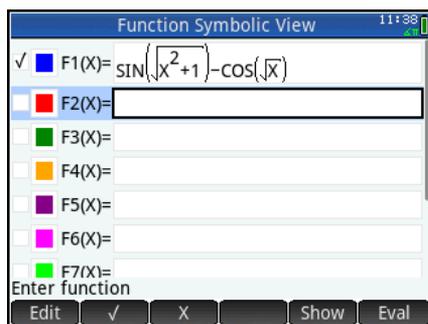
Graphing calculators offer several methods for solving an equation.

Example 1

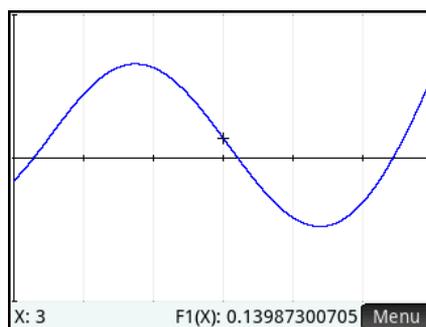
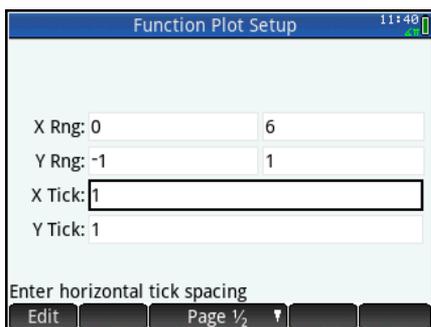
The derivative of a function f is given by $f'(x) = \sin(\sqrt{x^2 + 1}) - \cos(\sqrt{x})$. Find all the values of x in the open interval $(0, 6)$ where f has a local minimum.

Solution

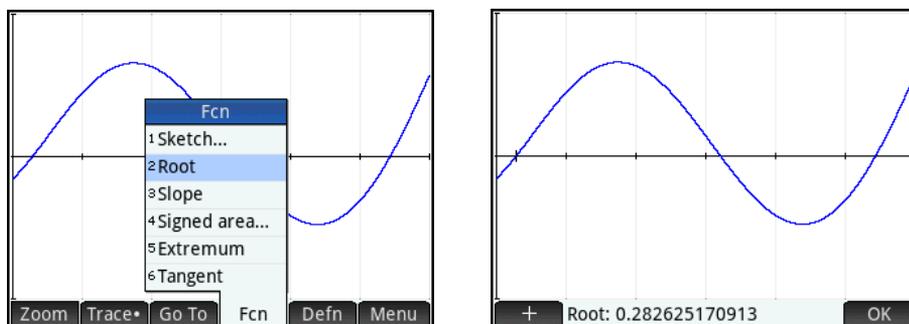
Use the **Function** app on the HP Prime to find the zero. If necessary, press **!** and start the **Function** app. Enter $f'(x)$ as **F1(X)**:



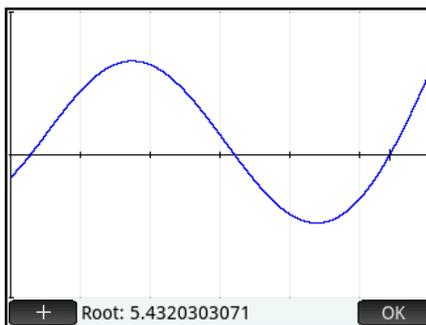
Press **Plot Setup**, **Shift** **Plot Setup**, and set the viewing window. Then press **Plot** to see the graph:



Finding the zero on HP Prime is easy. Touch the graph screen close to one of the points where the derivative changes sign from negative to positive. This moves the trace to the point where you tap. Then touch the **Menu** key, touch **Fcn**, and select **2 Root**. The zero closest to the trace is found:



To find the other root, touch the screen close to that root, touch **Fcn**, and select **2 Root** again:



The value of the zero is stored in the variable **X**.

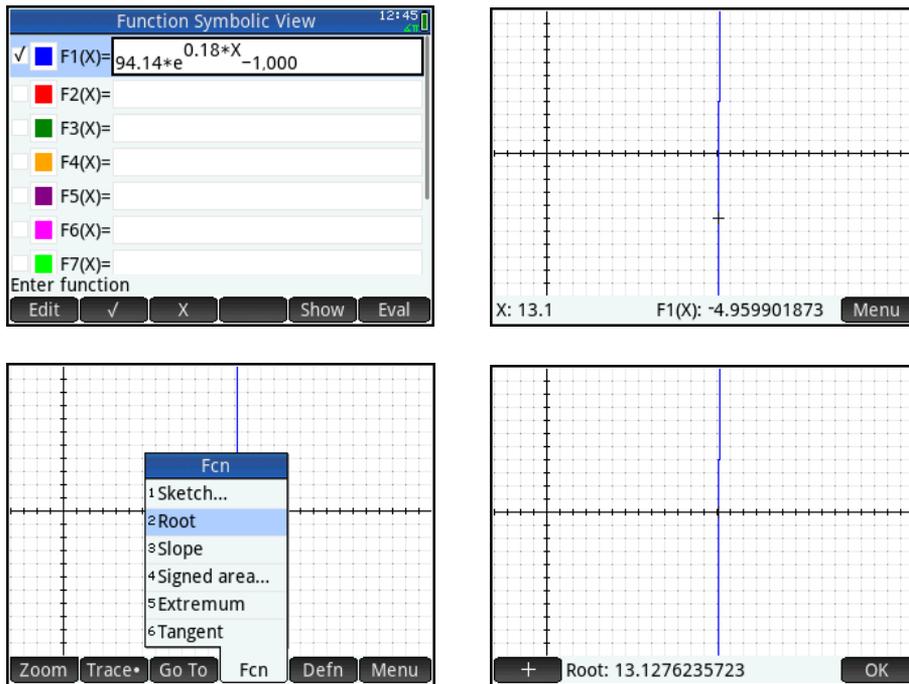
Example 2

The number of bees in a colony is given by $B(t) = 523e^{0.18t}$, where t is the number of days since the colony was established. The derivative of $B(t)$ is given by $B'(t) = 94.14e^{0.18t}$. On what day is the number of bees in the colony increasing at the rate of 1000 bees per day?

Solution

With HP Prime, it is easy to adjust the plot setup using touch gestures. Consequently, the graph is the simplest environment to use to solve an equation with that calculator. You can pan with your finger on the graph, or pinch to zoom in or out. Enter $94.14e^{0.18X} - 1000$ as **F1(X)** in the **Function** app. (We have to change the name of the independent variable from t to X .) Press **Plot** to see the graph. Use your finger

to pan if necessary until you can see the graph cross the x -axis. Tap near the x -intercept, and touch the **Menu** key, touch **Fcn**, and select **2 Root**:

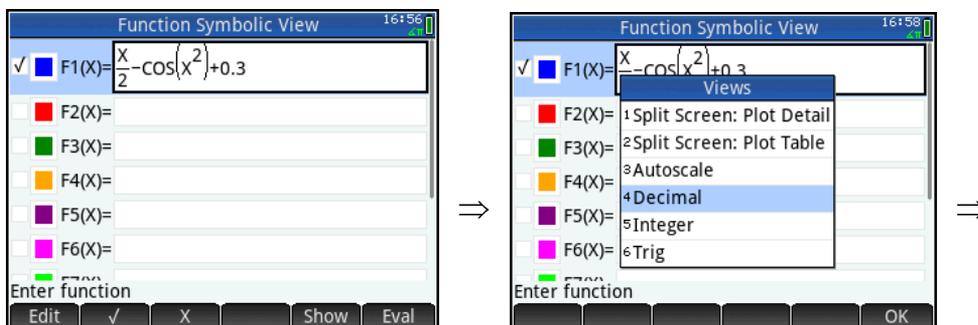


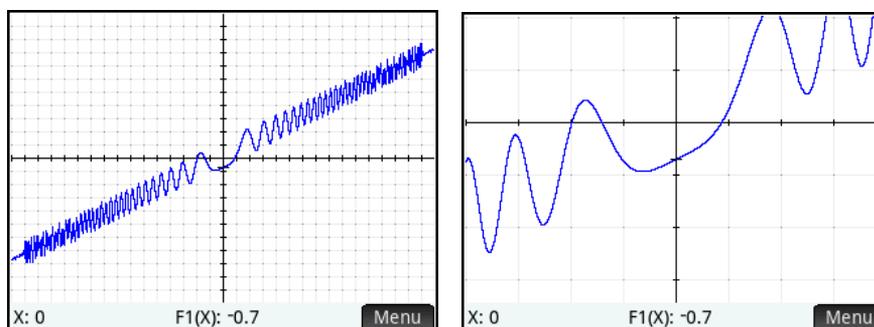
Example 3

The derivative of a function g is given by $g'(x) = \frac{x}{2} - \cos(x^2) + 0.3$. What is the x -coordinate of a local maximum point on the graph of g ?

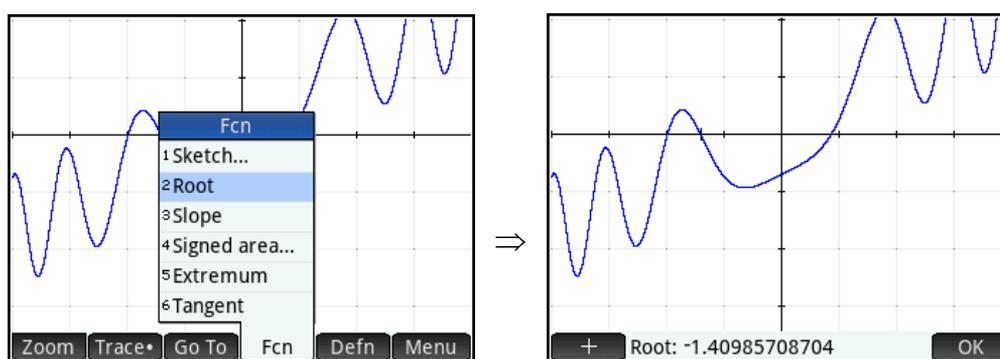
Solution

Enter $g'(x)$ as **F1(X)** in the **Function** app, and graph it in the **Decimal** view. Pinch to zoom in a bit so you can see the zero you are looking for:





We need to find a zero where $g'(x)$ changes sign from positive to negative. From the graph, this zero appears to be near $x = -1$. Simply touch the graph near this x -intercept to move the trace there. Then touch the **Menu** key, touch **Fcn**, and select **2 Root**. The zero closest to the trace is found:



The local maximum occurs at the point where $x \approx -1.410$.

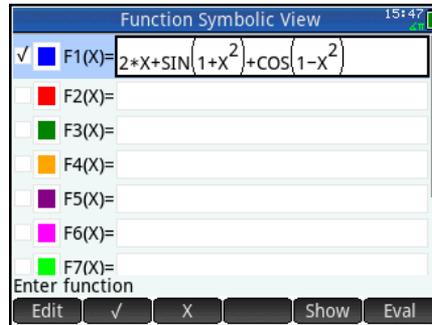
A.3. Evaluating a Derivative at a Point

Example 4

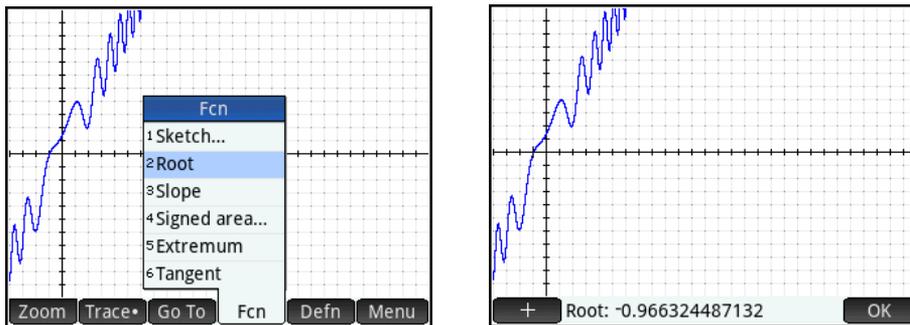
Find the slope of the line tangent to the graph of $y = 2x + \sin(1 + x^2) + \cos(1 - x^2)$ at the point where the graph crosses the x -axis.

Solution

Enter the function into **F1(X)** :

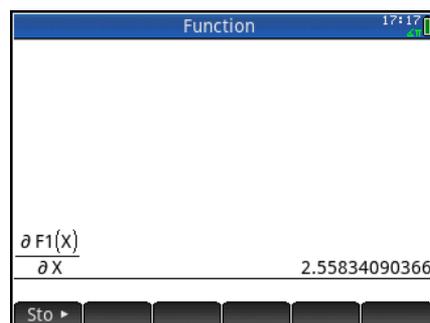


Use the procedure from the previous section to find the root of a function:



Once the root command has completed, immediately tap **OK**, tap **Fcn**, and select **3 Slope**. As long as you don't navigate on the graph, the current value of **X** used in the slope calculation will be exactly the root found previously.

If you prefer, you can evaluate a derivative directly on the **HOME** screen with HP Prime. Immediately after finding the root in the previous example, navigate to the **HOME** screen. Press the templates key, , and tap the derivative template. Enter the arguments as shown. The derivative is evaluated at the number that is currently stored in the independent variable **X**:



A.4. Evaluating an Integral Numerically

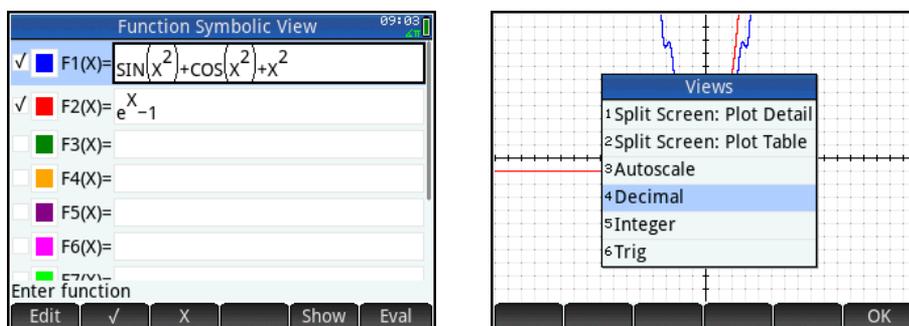
On the open-calculator free-response part of the AP exam (Section II, Part A), always use your calculator when you need to evaluate a definite integral. You don't get "extra credit" for evaluating an integral by first finding an antiderivative.

Example 5

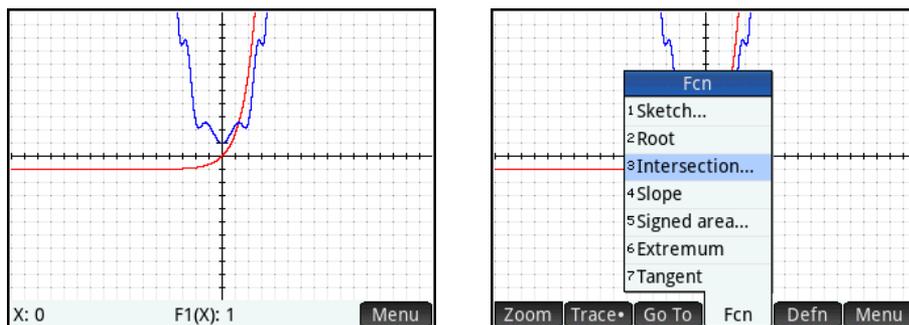
Find the area of the region in the first quadrant bounded by the graphs of $f(x) = \sin(x^2) + \cos(x^2) + x^2$, $g(x) = e^x - 1$, and the y -axis.

Solution

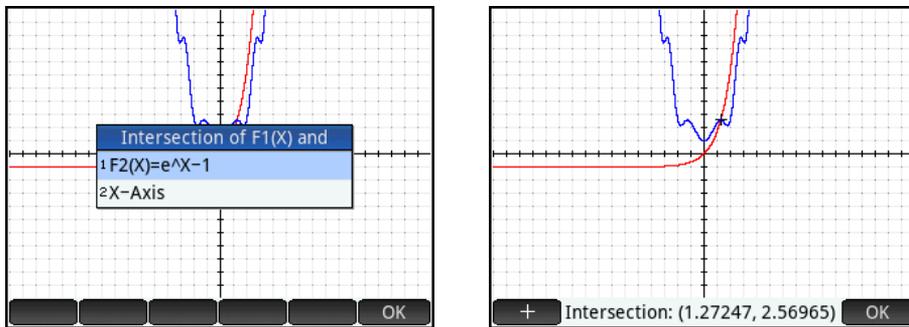
Use the **Function** app to define the curves and draw the graphs in the decimal view:



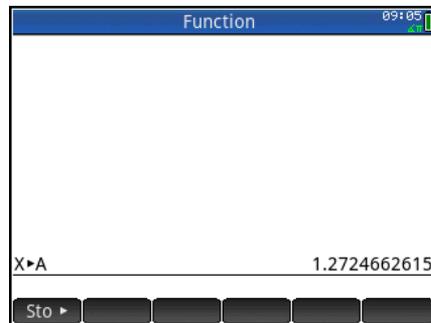
On the **Plot** screen, touch the **Menu** and **Fcn** keys, and select **3 Intersection**:



Tap **OK** to find the intersection of **F1 (X)** and **F2 (X)** :

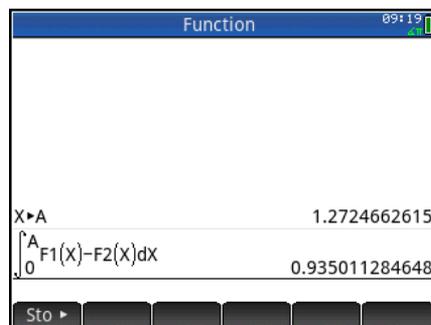


Press  and store the current value of x , which is the point of intersection, into the variable A :



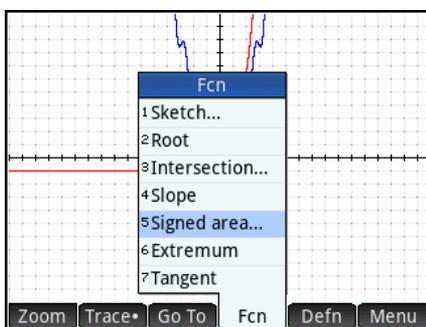
From here, you could calculate the integral right on the [HOME](#) screen in one step.

Press the templates key, .

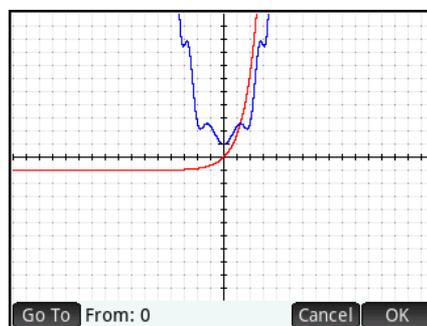
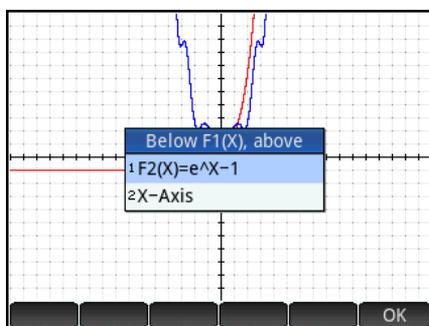


Use the [ALPHA](#) shift to type the letters A and F , and touch in the proper positions of the integral or use the arrow keys template to navigate.

An alternative is to calculate the integral on the graph screen. There is no issue with the accuracy of the integral results on the graph screen with HP Prime. Return to the graph and select [5 Signed Area](#) from the [Fcn](#) menu.



Touch OK to find the area below $F1(X)$ and above $F2(X)$. Enter 0 for the lower limit of integration, and touch OK or press ENTER:



Enter A from the ALPHA keypad to integrate up to A . Press OK and the value of the area is displayed:

