

Function applet

About the Function applet

The Function applet is perhaps the most commonly used applet. It enables you to explore up to 10 real valued, rectangular functions y in terms of x . For example $y = 2x + 3$.

Once you have defined a function you can:

- create graphs to find roots, intercepts, slope, signed area, and extremum of functions
- create tables to evaluate functions at particular values.


This chapter demonstrates the basic tools of the Function applet by stepping you through an example. See “Applet views” on page 2-37 for further information about the functionality of the Symbolic, Numeric, and Plot views.

Getting started with the Function applet

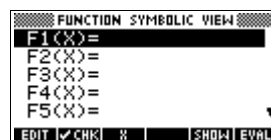
The following example involves two functions: a linear function $y = 1 - x$ and a quadratic equation $y = (x + 3)^2 - 2$.

Open the Function applet

1. Open the Function applet.



 Select Function
START

The Function applet starts in the Symbolic view.

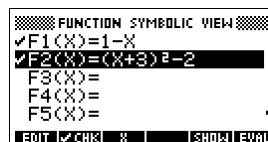


The Symbolic view is the *defining view* for Function, Parametric, Polar, and Sequence applets. The other views are derived from the symbolic expression.

Define the expressions

2. Highlight the function definition field you want to use, and enter an expression. (You can press  to delete an existing line, or  *CLEAR* to clear all lines.)

1 $\boxed{-}$ $\boxed{X,T,0}$ $\boxed{\text{ENTER}}$
 $\boxed{(}$ $\boxed{X,T,0}$ $\boxed{+}$ $\boxed{3}$ $\boxed{)}$ $\boxed{X^2}$
 $\boxed{-}$ $\boxed{2}$ $\boxed{\text{ENTER}}$



Ensure the functions are checked. If the function is not checked, highlight it and press **CHK**. You can select multiple functions to explore.

Set up the plot

You can change the scales of the x and y axes, graph resolution, and spacing of axis ticks. *Note: If your settings do not match this example, press $\boxed{\text{SHIFT}}$ $\boxed{\text{DEL}}$ to restore the default values.*

3. Display plot settings.

$\boxed{\text{SHIFT}}$ $\boxed{\text{SETUP-PLOT}}$



Note: For our example, you can leave the plot settings at the default values since we will be using the Auto Scale feature to choose an appropriate y axis for our x axis settings

4. Specify a grid for the graph.

PAGE

$\boxed{\blacktriangleright}$ $\boxed{\blacktriangledown}$ $\boxed{\blacktriangledown}$ **CHK**



Plot the expressions


5. Specify the scale for the x and y axes using the Auto Scale option.

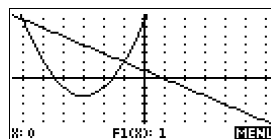
$\boxed{\text{VIEWS}}$ *Select Auto*
Scale
OK



Trace the graph

- Trace the linear function.

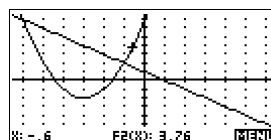
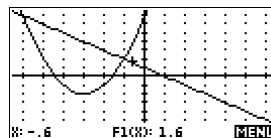
 6 times



Note: By default, the tracer is active.

- Jump from the linear function to the quadratic function.

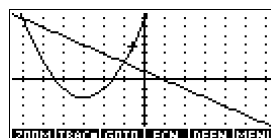




Analyse graph with FCN tools

- Access the Plot view display options.





MENU



From the Plot view, you can use the operations on the FCN menu to find roots, intersections, slopes, and areas for a function defined in the Function applet (and any Function-based applets). The FCN operations act on the currently selected graph. See “FCN operations” on page 3-66 for further information.

To find the greater of the two roots of the quadratic function

- Find the greater of the two roots of the quadratic function.

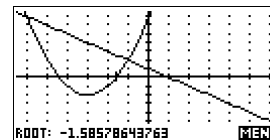
Note: Ensure you switch to $F2(x) = (x + 3)^2 - 2$ using the  or  keys to locate the cursor on the quadratic function, then trace the cursor near $x = -1$ using the  and  keys.

FCN *Select Root*

OK



The root value is displayed at the bottom of the screen.



To find the intersection of the two functions

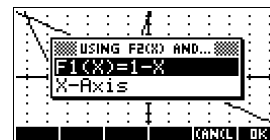
10. Find the intersection of the two functions.

MENU FCN OK

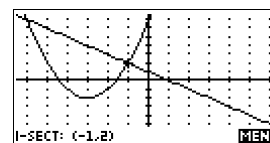


11. Choose the linear function whose intersection with the quadratic function you wish to find.

OK



The intersection point is displayed at the bottom of the screen.

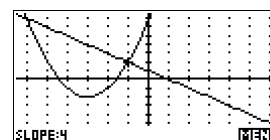


To find the slope of the quadratic function

12. Find the slope of the quadratic function at the intersection point.

MENU FCN
Select Slope
OK

The slope value will be displayed at the bottom of the screen.

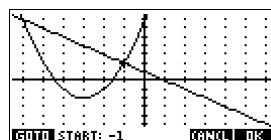


To find the signed area of the two functions

13. Find $\int_{-1}^{-2} F1(x) - F2(x) dx$.

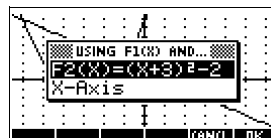
Note: Ensure you switch to $F1(x) = 1 - x$ by using the \blacktriangle and \blacktriangledown keys to position the cursor on the linear function, then

\blacktriangle MENU FCN
Select Signed area
OK



14. Trace the cursor to $x = -1$ using the \blacktriangleright and \blacktriangleleft keys.

OK



15. Accept using $F2(x) = (x + 3)^2 - 2$ as the other boundary for the integral.

OK

GOTO

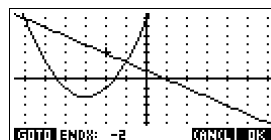
$\boxed{(-)} 2$



16. Choose the end value for x .

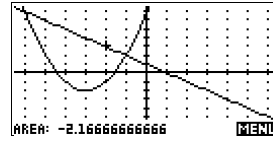
OK

The cursor jumps to $x = -2$ on the linear function.



17. Display the numerical value of the integral.

OK



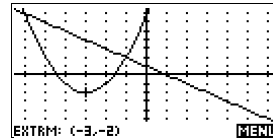
To find the extremum of the quadratic

18. Find the extremum of the quadratic.

Note: Ensure you switch to $F2(x) = (x + 3)^2 - 2$ by using the \blacktriangle or \blacktriangledown keys to position the cursor on the quadratic function, then trace the cursor to $x = -1$ using the \blacktriangleright and \blacktriangleleft keys.

\blacktriangle MENU FCN
Select Extremum OK

The extremum is displayed as an ordered pair at the bottom of the screen.



Note: When a function has more than one extremum, the HP 39G/40G uses the current cursor x-value as a seed to start the search for an extremum. To start the search, move the cursor close to the required extremum and then invoke the Extremum command.



The Root and Extremum operations return one value only even if the function has more than one root or extremum. The operation finds the value closest to the position of the cursor only. You need to re-locate the cursor to find other roots or extrema that may exist.

Display the numeric view

19. Display the numeric view.

NUM

X	F1	F2	
0	1.4	2.61	
.1	.9	1.24	
.2	.4	.89	
.3	0	.56	
.4	.6	10.25	
.5	1.1		
0			
ZOOM		BIG	DEFN

Set up the table

20. Display the numeric setup.

SHIFT **SETUP-NUM**

FUNCTION NUMERIC SETUP			
NUMSTART:	6		
NUMSTEP:	.1		
NUMTYPE:	Automatic		
NUMZOOM:	4		
ENTER STARTING VALUE FOR TABLE			
EDIT			PLOT

See “Setting up the table (numeric view setup)” on page 2-51 for more information.

21. Match the table settings to the pixel columns in the graph view.

PLOT **OK**

FUNCTION NUMERIC SETUP			
NUMSTART:	-6.5		
NUMSTEP:	.1		
NUMTYPE:	Automatic		
NUMZOOM:	4		
ENTER STARTING VALUE FOR TABLE			
EDIT			PLOT

Explore the table

22. Display a table of numeric values.

NUM

X	F1	F2	
-6.5	2.5	10.25	
-6.4	2.4	9.56	
-6.3	2.3	8.89	
-6.2	2.2	8.24	
-6.1	2.1	7.61	
-6			
-6.5			
ZOOM		BIG	DEFN

To navigate around a table

23. Move to $x=-5.9$ using arrow keys.

▼ 5 times

X	F1	F2	
-6.4	2.4	9.56	
-6.3	2.3	8.89	
-6.2	2.2	8.24	
-6.1	2.1	7.61	
-6			
-5.9	5.9	34.81	
-5.9			
ZOOM		BIG	DEFN

To go directly to a value

24. Move directly to $x=10$.

10 OK

X	F1	F2	
9.5	-8.5	154.25	
9.6	-8.6	156.76	
9.7	-8.7	159.29	
9.8	-8.8	161.84	
9.9	-8.9	164.41	
10			
10			
ZOOM		BIG	DEFN

To access the zoom options

25. Zoom in on $x=10$ by a factor of 4. *Note: NUMZOOM has a setting of 4.*

ZOOM
OK

X	F1	F2
9.875	-8.875	163.766
9.9	-8.9	164.41
9.925	-8.925	165.056
9.95	-8.95	165.703
9.975	-8.975	166.350
10	-9	167

10

ZOOM | BIG | DEFN

To change font
size

26. Display table numbers in large font.

BIG

X	F1	F2
9.875	-8.875	163.766
9.9	-8.9	164.41
9.925	-8.925	165.056
9.95	-8.95	165.703
9.975	-8.975	166.350
10	-9	167

10

ZOOM | BIG | DEFN

To display the
symbolic
definition of a
column

27. Display the symbolic definition for the F1 column.

DEFN

The symbolic definition of
F1 is displayed at the bottom
of the screen.

X	F1	F2
9.875	-8.875	163.766
9.9	-8.9	164.41
9.925	-8.925	165.056
9.95	-8.95	165.703
9.975	-8.975	166.350
10	-9	167

1-X

ZOOM | BIG | DEFN

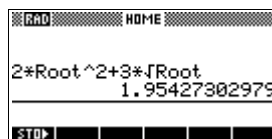
Function aplet interactive analysis

From the Plot view (**PLOT**), you can use the operations on the FCN menu to find roots, intersections, slopes, and areas for a function defined in the Function aplet (and any Function-based aplets). See “Access the FCN menu” on page 3-65. The FCN operations act on the currently selected graph.

The results of the FCN operations are saved in the following variables:

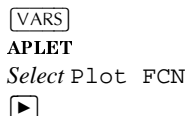
- AREA
- EXTREMUM
- ISECT
- ROOT
- SLOPE

For example, if you use the ROOT function to find the root of a plot, you can use the result in calculations in Home.



Access FCN variables

The FCN variables are contained in the VARS menu.



Access the FCN menu

1. In Symbolic view in a Function aplet, select the expression (for Intersect, *two* expressions) whose curve you want to study.
2. Press **PLOT** to plot the function or functions.
3. Press **◀** or **▶** to position the cursor to where you want it to be before pressing **MENU** to display the FCN menu key.
4. Press **FCN**, then select an operation from the menu list and press **OK**.

- To perform another operation, press **MENU** to turn the menu-key labels back on.



FCN operations

Operation	Description
Root	Select Root to find the root of the current function nearest the crosshairs. If no root is found, but only an extremum, then the result is labeled EXTR : instead of ROOT : . (The root-finder is also used in the Solve applet. See also “Interpreting results” on page 7-88.) The cursor is moved to the root value on the x -axis and the resulting x -value is saved in a variable named ROOT .
Extremum	Select Extremum to find the maximum or minimum of the current function nearest the crosshairs. This displays the coordinate values and moves the crosshairs to the extremum. The resulting value is saved in a variable named EXTREMUM .
Slope	Select Slope to find the numeric derivative at the current. The result is saved in a variable named SLOPE .

Operation	Description (Continued)
Signed area	Select Signed area to find the numeric integral. (If there are two or more expressions checkmarked, then you will be asked to choose the second expression from a list that includes the x -axis.) Select a starting point, then move the cursor to selection ending point. The result is saved in a variable named AREA.
Intersection	Select Intersection to find the intersection of two graphs nearest the crosshairs. (<i>You need to have at least two selected expressions in Symbolic view.</i>) Displays the coordinate values and moves the crosshairs to the intersection. (Uses Solve function.) The resulting x -value is saved in a variable named ISECT.

Change cursor starting position

To change the starting position of the cursor after having selected an operation, press **CANCL**, move the cursor, and re-select the FCN operation.

Clear shading

To remove the shading produced by the AREA operation, press **□PLOT** to re-draw the plot.

Further examples

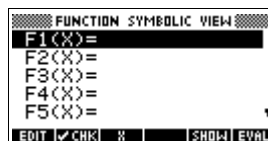
Plotting a piecewise defined function

To graph the following piecewise defined function

$$f(x) = \begin{cases} x + 2 & ; x \leq -1 \\ x^2 & ; -1 < x \leq 1 \\ 4 - x & ; x \geq 1 \end{cases}$$

1. Open the Function applet.

Select
 Function



2. Highlight the line you want to use, and enter the expression. (You can press to delete an existing line, or CLEAR to clear all lines.)

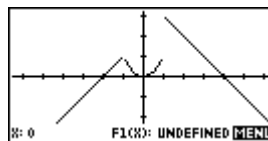
CHARS-

 CHARS->
 AND X
 CHARS-≤

 CHARS->



When we divide by the domain of the function we are dividing by a quantity which is 1 within the domain (result: no effect on function) and zero outside the domain (result: function is undefined & not graphed).



Plotting a circle

Plot the circle, $x^2 + y^2 = 9$. To plot the equation, you need to rearrange it to the following:

$$y = \pm\sqrt{9 - x^2}$$

To plot both the positive and negative y values, you need to define two equations as follows:

$$y = \sqrt{9 - x^2}$$

$$y = -\sqrt{9 - x^2}$$

1. In the Function applet, specify the functions.

[APLET] *Select*
 Function
 [SHIFT] [√] [9]
 [-] [X,T,θ] [X²] [)] [ENTER]
 [-] [SHIFT] [√] [9]
 [-] [X,T,θ]
 [X²] [)] [ENTER]

```

  FUNCTION SYMBOLIC VIEW
  ✓F1(X)=√(9-X²)
  ✓F2(X)=-√(9-X²)
  F3(X)=
  F4(X)=
  F5(X)=
  EDIT  ✓CHK  %  SHOW EVAL
  
```

- Reset the graph setup to the default settings.

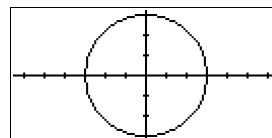
[SHIFT] *SETUP-PLOT*
 [SHIFT] *CLEAR*

```

  FUNCTION PLOT SETUP
  XRMG: -6.5 6.5
  YRMG: -3.1 3.2
  XTICK: 1 YTICK: 1
  RES: Detail
  ENTER MINIMUM HORIZONTAL VALUE
  EDIT  PAGE  ▼
  
```

- Plot the two functions.

[PLOT]



- Reset the numeric setup to the default settings.

[SHIFT] *SETUP-NUM*
 [SHIFT] *CLEAR*

```

  FUNCTION NUMERIC SETUP
  NUMSTART: 0
  NUMSTEP: .1
  NUMTYPE: Automatic
  NUMZOOM: 4
  ENTER STARTING VALUE FOR TABLE
  EDIT  PLOT▶
  
```

- Display the functions in numeric form.

[NUM]

X	F1	F2
0		
.1	.998333	-3.99833
.2	.993326	-3.99333
.3	.984962	-3.98496
.4	.973214	-3.97321
.5	.95804	-3.95804
0		
ZOOM		BIG DEFN

