Graphing

A collection of versatile graphing tools plus a large 127 × 63-dot display makes it easy to draw a variety of function graphs quickly and easily. This calculator is capable of drawing the following types of graphs.

- Rectangular coordinate (Y =) graphs
- Polar coordinate (r =) graphs
- Parametric graphs
- X = constant graphs
- Inequality graphs
- Integration graphs (in the RUN mode only)

A selection of graph commands also makes it possible to incorporate graphing into programs.

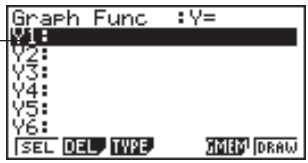
8-1 Before Trying to Draw a Graph

■ Entering the Graph Mode

On the Main Menu, select the **GRAPH** icon and enter the GRAPH Mode. When you do, the Graph Function menu appears on the display. You can use this menu to store, edit, and recall functions and to draw their graphs.

Memory area

Use ▲ and ▼ to change selection.



F1 (SEL) ..... Draw/non-draw status

F2 (DEL) ..... Graph delete

F3 (TYPE) ..... Graph Type Menu

F5 (GMEM) ... Graph memory save/recall

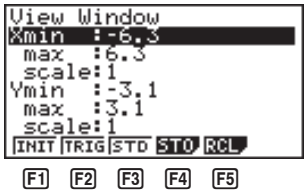
F6 (DRAW) .... Draws graph

8-2 View Window (V-Window) Settings

Use the View Window to specify the range of the *x*-and *y*-axes, and to set the spacing between the increments on each axis. You should always set the View Window parameters you want to use before drawing a graph. Press [SHIFT] [F3] to display the View Window.

1. Press [SHIFT] [F3] to display the View Window.

[SHIFT] [F3] (V-Window)



P.129 [F1] (INIT) ..... View Window initial settings

P.129 [F2] (TRIG) ..... View Window initial settings using specified angle unit

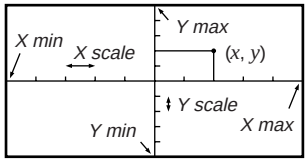
P.130 [F3] (STD) ..... Standardized View Window settings

P.130 [F4] (STO) ..... Store View Window settings to View Window memory.

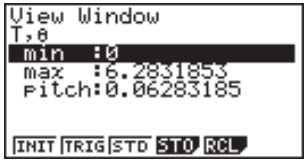
P.130 [F5] (RCL) ..... Recall View Window settings from View Window memory.

X min ..... Minimum *x*-axis value
X max ..... Maximum *x*-axis value
X scale ..... Spacing of *x*-axis increments
Y min ..... Minimum *y*-axis value
Y max ..... Maximum *y*-axis value
Y scale ..... Spacing of *y*-axis increments

The following illustration shows the meaning of each of these parameters.



2. Input a value for a parameter and press [EXE]. The calculator automatically selects the next parameter for input.
   - You can also select a parameter using the ▼ and ▲ keys.
   - There are actually nine View Window parameters. The remaining three parameters appear on the display when you move the highlighting down past the Y scale parameter by inputting values and pressing ▼.

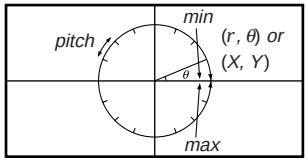


T, θ min ..... T, θ minimum values

T, θ max ..... T, θ maximum values

T, θ pitch ..... T, θ pitch

The following illustration shows the meaning of each of these parameters.



3. To exit the View Window, press [EXIT] or [SHIFT] [QUIT].
   - Pressing [EXE] without inputting any value also exits the View Window.

- The following is the input range for View Window parameters.
  –9.9999E+97 to 9.99999E+97
- You can input parameter values up to 14 digits long. Values greater than 10^7 or less than 10^{-2}, are automatically converted to a 7-digit mantissa (including negative sign) plus a 2-digit exponent.
- The only keys that enabled while the View Window is on the display are: [0] to [9], [·], [EXP], [(–)], [▲], [▼], [◀], [▶], [+], [–], [×], [÷], [(], [)], [SHIFT] [π], [EXIT], [SHIFT] [QUIT]. You can use [(–)] or [–] to input negative values.
- The existing value remains unchanged if you input a value outside the allowable range or in the case of illegal input (negative sign only without a value).
- Inputting a View Window range so the min value is greater than the max value, the axis is inverted.
- You can input expressions (such as 2π) as View Window parameters.
- When the View Window setting does not allow display of the axes, the scale for the *y*-axis is indicated on either the left or right edge of the display, while that for the *x*-axis is indicated on either the top or bottom edge.

- When View Window values are changed, the graph display is cleared and the newly set axes only are displayed.
- View Window setting may cause irregular scale spacing.
- Setting maximum and minimum values that create too wide of a View Window range can result in a graph made up of disconnected lines (because portions of the graph run off the screen), or in graphs that are inaccurate.
- The point of deflection sometimes exceeds the capabilities of the display with graphs that change drastically as they approach the point of deflection.
- Setting maximum and minimum values that create to narrow of a View Window range can result in an error (Ma ERROR).

■ Initializing and Standardizing the View Window

●To initialize the View Window

a. Press [SHIFT] [F3] (V-Window) [F1] (INIT) to initialize the View Window to the following settings.

Xmin	= –6.3	Ymin	= –3.1
Xmax	= 6.3	Ymax	= 3.1
Xscale	= 1	Yscale	= 1

b. Press [SHIFT] [F3] (V-Window) [F2] (TRIG) to initialize the View Window to the following settings.

Deg Mode

Xmin	= –540	Ymin	= –1.6
Xmax	= 540	Ymax	= 1.6
Xscale	= 90	Yscale	= 0.5

Rad Mode

Xmin	= –9.4247779
Xmax	= 9.42477796
Xscale	= 1.57079632

Gra Mode

Xmin	= –600
Xmax	= 600
Xscale	= 100

- The settings for Y min, Y max, Y pitch, T/θ min, T/θ max, and T/θ pitch remain unchanged when you press [F2] (TRIG).

●To standardize the View Window

Press [SHIFT] [F3] (V-Window) [F3] (STD) to standardize the View Window to the following settings.

Xmin	= –10	Ymin	= –10
Xmax	= 10	Ymax	= 10
Xscale	= 1	Yscale	= 1

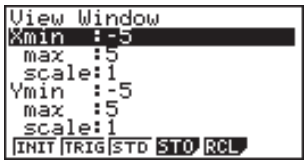
■ View Window Memory

You can store up to six sets of View Window settings in View Window memory for recall when you need them.

●To save View Window settings

Example **To save the following View Window settings :**

Xmin	**= –5**	**Ymin**	**= –5**
Xmax	**= 5**	**Ymax**	**= 5**
Xscale	**= 1**	**Yscale**	**= 1**



[F4]

[F4] (STO)

[F1] (V·W1)

- Storing View Window settings in a memory area (V·W1 through V·W6) that already contains settings replaces the existing settings with the new ones.

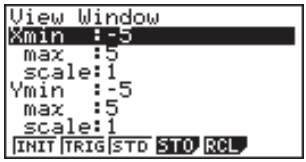
●To recall View Window settings

Example **To recall the View Window settings in V·W1**

[F5]

[F5] (RCL)

F1 (V·W1)



- Recalling View Window settings causes the settings currently on the display to be deleted.

- You can change View Window settings in a program using the following syntax.
  View Window [X min value], [X max value], [X scale value],
  [Y min value], [Y max value], [Y scale value],
  [T, θ min value], [T, θ max value], [T, θ pitch value]

8-3 Graph Function Operations

You can store up to 20 functions in memory. Functions in memory can be edited, recalled, and graphed. The types of functions that can be stored in memory are: rectangular coordinate functions, polar coordinate functions, parametric functions, inequalities, and X = constant expressions.

■ Specifying the Graph Type

Before you can store a graph function in memory, you must first specify its graph type.

1. While the Graph Function Menu is on the display, press [F3] (TYPE) to display a Graph Type Menu.

[F3](TYPE)

[F1] (Y =) ..... Rectangular coordinate graph
[F2] (*r* =) ..... Polar coordinate graph
[F3] (Parm) ..... Parametric graph
[F4] (X = c) ..... X = constant graph
[F6] (▷) ..... Next menu

[F6](▷)

[F1] (Y >) ..... Y > $f(x)$ inequality
[F2] (Y <) ..... Y < $f(x)$ inequality
[F3] (Y ≥) ..... Y ≧ $f(x)$ inequality
[F4] (Y ≤) ..... Y ≦ $f(x)$ inequality
[F6] (▷) ..... Previous menu

2. Press the function key that corresponds to the graph type you want to specify.

■ Storing Graph Functions

●To store a rectangular coordinate function (Y =)

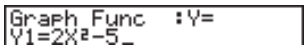
Example **To store the following expression in memory area Y1 :**
***y* = 2 *x*² – 5**

[F3](TYPE) [F1](Y =)

(Specifies rectangular coordinate expression.)

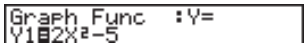
[2] [X,θ,T] [x^2] [−] [5]

(Inputs expression.)



[EXE]

(Stores expression.)



- You will not be able to store the expression in an area that already contains a parametric function. Select another area to store your expression or delete the existing parametric function first. This also applies when storing *r* = expressions, X = constant expressions, and ineqalities.

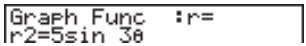
●To store a polar coordinate function (*r* =)

Example **To store the following expression in memory area r2 :**

***r* = 5 sin 3 θ**

[F3](TYPE) [F2](*r* =)

(Specifies polar coordinate expression.)

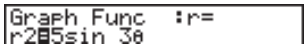


[5] [sin] [3] [X,θ,T]

(Inputs expression.)

[EXE]

(Stores expression.)



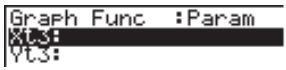
●To store a parametric function

Example **To store the following functions in memory areas Xt3 and Yt3 :**

***x* = 3 sin T**
***y* = 3 cos T**

[F3](TYPE) [F3](Parm)

(Specifies parametric expression.)

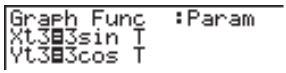


[3] [sin] [X,θ,T] [EXE]

(Inputs and stores *x* expression.)

[3] [cos] [X,θ,T] [EXE]

(Inputs and stores *y* expression.)

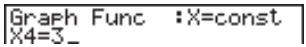


- You will not be able to store the expression in an area that already contains a rectangular coordinate expression, polar coordinate expression, X = constant expression or inequality. Select another area to store your expression or delete the existing expression first.

●To store an X = constant expression

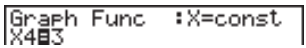
Example **To store the following expression in memory area X4 :**
X = 3

[F3](TYPE) [F4](X = c)
(Specifies X = constant expression.)



[3]
(Inputs expression.)

[EXE]
(Stores expression.)

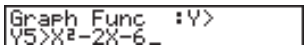


- Inputting X, Y, T, *r*, or *θ* for the constant in the above procedures causes an error (Syn ERROR).

●To store an inequality

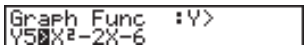
Example **To store the following inequality in memory area Y5 :**
$y > x^2 - 2x - 6$

[F3](TYPE) [F6](▷) [F1](Y>)
(Specifies an inequality.)



[X,θ,T] [x²] [−] [2] [X,θ,T] [−] [6]
(Inputs expression.)

[EXE]
(Stores expression.)

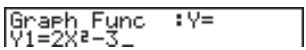


■ Editing Functions in Memory

●To edit a function in memory

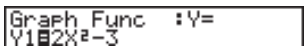
Example **To change the expression in memory area Y1 from $y = 2x^2 - 5$ to $y = 2x^2 - 3$**

(▶)
(Displays cursor.)



(▶)(▶)(▶)(▶)[3]
(Changes contents.)

[EXE]
(Stores new graph function.)



●To delete a function

1. While the Graph Function Menu is on the display, press ▲ or ▼ to display the cursor and move the highlighting to the area that contains the function you want to delete.
2. Press F2 (DEL).

3. Press F1 (YES) to delete the function for F6 (NO) to abort the procedure without deleting anything.

Parametric functions come in pairs (Xt and Yt).

When editing a parametric function, clear the graph functions and re-input from the beginning.

■ Drawing a Graph

Before actually drawing a graph, you should first make the following specification.

●To specify the draw/non-draw status of a graph

You can specify which functions out of those stored in memory should be used for a draw operation.

- Graphs for which there is no draw/non-draw status specification are not drawn.

Example **To select the following functions for drawing :**

Y1 = $2x^2 - 5$

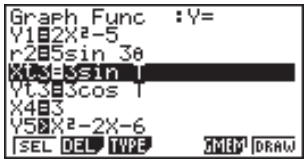
r2 = 5 sin3θ

Use the following View Window parameters.

Xmin	**= –5**	**Ymin**	**= –5**
Xmax	**= 5**	**Ymax**	**= 5**
Xscale	**= 1**	**Yscale**	**= 1**

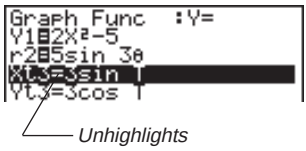
▼▼

(Select a memory area that contains a function for which you want to specify non-draw.)



F1 (SEL)

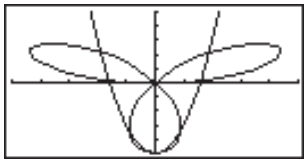
(Specify non-draw.)



▼ ▼ F1 (SEL)
▼ F1 (SEL)

F6

F6 (DRAW) or EXE
(Draws graphs.)

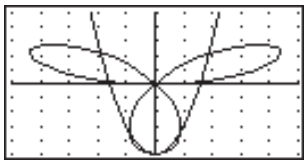


• Pressing SHIFT F6 (G↔T) or AC returns to the Graph Function Menu.

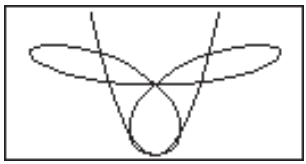
P.6

• You can use the set up screen settings to alter the appearance of the graph screen as shown below.

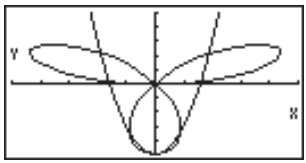
• Grid: On
This setting causes dots to appear at the grid intersects on the display.



• Axes: Off
This setting clears the axis lines from the display.



• Label: On
This setting displays labels for the *x*- and *y*-axes.



- A polar coordinate (r =) or parametric graph will appear coarse if the settings you make in the View Window cause the T, θ pitch value to be too large, relative to the differential between the T, θ min and T, θ max settings. If the settings you make cause the T, θ pitch value to be too small relative to the differential between the T, θ min and T, θ max settings, on the other hand, the graph will take a very long time to draw.
- Attempting to draw a graph for an expression in which X is input for an X = constant expression results in an error (Syn ERROR).

8-4 Graph Memory

Graph memory lets you store up to six sets of graph function data and recall it later when you need it.

A single save operation saves the following data stored in graph memory.

- All graph functions in the currently displayed Graph Function Menu (up to 20)
- Graph types
- Draw/non-draw status
- View Window settings (1 set)

●To save graph functions in graph memory

Example **To store the graph functions shown on the screen below in graph memory GM1**

F5

F5(GMEM)

F1

F1(STO)

F1

F1(GM1)

- Storing data in a memory area (GM1 through GM6) that already contains data replaces the existing data with the new data.
- If the data exceeds the calculator's remaining memory capacity, an error (Mem ERROR) occurs.

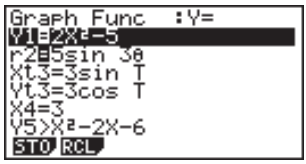
●To recall graph functions from graph memory

Example **To recall the data in graph memory GM1**

F5 (GMEM)

F2 (RCL)

F1 (GM1)



- Recalling data from graph memory causes any data currently on the Graph Function Menu to be deleted.

8-5 Drawing Graphs Manually

After you select the **RUN** icon in the Main Menu and enter the RUN Mode, you can draw graphs manually. First press [SHIFT] [F4] (Sketch) [F5] (GRPH) to recall the Graph Command Menu, and then input the graph function.

[SHIFT] [F4] (Sketch)
[F5] (GRPH)

[F1] (Y =) ..... Rectangular coordinate graph
[F2] (r =) ..... Polar coordinate graph
[F3] (Parm) ..... Parametric graph
[F4] (X = c) ..... X = constant graph
[F5] (G$\int dx$) ..... For drawing integration graphs
[F6] (▷) ..... Next menu

[F6] (▷)

[F1] (Y >) ..... Y > $f(x)$ inequality
[F2] (Y <) ..... Y < $f(x)$ inequality
[F3] (Y ≥) ..... Y ≧ $f(x)$ inequality
[F4] (Y ≤) ..... Y ≦ $f(x)$ inequality
[F6] (▷) ..... Previous menu

●To graph using rectangular coordinates (Y =)

You can graph functions that can be expressed in the format $y = f(x)$.

Example **To graph $y = 2x^2 + 3x - 4$**

Use the following View Window parameters.

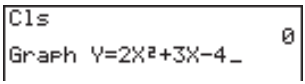
Xmin	**= –5**	**Ymin**	**= –10**
Xmax	**= 5**	**Ymax**	**= 10**
Xscale	**= 2**	**Yscale**	**= 5**

1. In the set-up screen, specify the appropriate graph type for Func Type.

[SHIFT] [SETUP] [▼] [F1] (Y =) [EXIT]

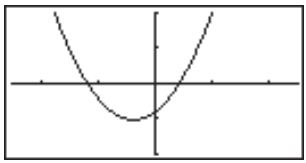
2. Input the rectangular coordinate (Y =) expression.

[SHIFT] [F4] (Sketch) [F1] (Cls) [EXE]
[F5] (GRPH) [F1] (Y =)
[2] [X,θ,T] [x^2] [+] [3] [X,θ,T] [−] [4]



3. Press [EXE] to draw the graph.

[EXE]



- You can draw graphs of the following built-in scientific functions.

• sin x	• cos x	• tan x
• $\sin^{-1} x$	• $\cos^{-1} x$	• $\tan^{-1} x$
• sinh x	• cosh x	• tanh x
• $\sinh^{-1} x$	• $\cosh^{-1} x$	• $\tanh^{-1} x$
• $\sqrt{x}$	• x^2	• log x
• ln$x$	• 10^x	• e^x
• x^{-1}	• $\sqrt[3]{x}$	

View Window settings are made automatically for built-in graphs.

●To graph using polar coordinates (*r* =)

You can graph functions that can be expressed in the format $r = f(\theta)$.

Example **To graph $r = 2 \sin 3\theta$**

Use the following View Window parameters.

Xmin	**= –3**	**Ymin**	**= –2**
Xmax	**= 3**	**Ymax**	**= 2**
Xscale	**= 1**	**Yscale**	**= 1**
T, θ min	**= 0**	**T, θ max**	**= π**
T, θ pitch	**= π÷36**		

1. In the set-up screen, specify the appropriate graph type for Func Type.

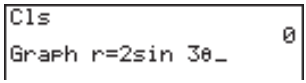
[SHIFT] [SETUP] [▼] [F2] (*r* =)

2. Set the default unit of angular measurement to radians (Rad).

[▼] [▼] [▼] [F2] (Rad) [EXIT]

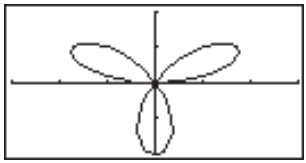
3. Input the polar coordinate expression (r =).

SHIFT F4 (Sketch) F1 (Cls) EXE
F5 (GRPH) F2 (r =)
2 sin 3 X,θ,T



4. Press EXE to draw the graph.

EXE



- You can draw graphs of the following built-in scientific functions.

• sin θ	• cos θ	• tan θ
• $\sin^{-1}\theta$	• $\cos^{-1}\theta$	• $\tan^{-1}\theta$
• sinh θ	• cosh θ	• tanh θ
• $\sinh^{-1}\theta$	• $\cosh^{-1}\theta$	• $\tanh^{-1}\theta$
• $\sqrt{\theta}$	• θ^2	• log θ
• lnθ	• 10^{θ}	• e^{θ}
• θ^{-1}	• $\sqrt[3]{\theta}$	

- View Window settings are made automatically for built-in graphs.

●To graph parametric functions

You can graph parametric functions that can be expressed in the following format.

(X, Y) = (f(T), g(T))

Example **To graph the following parametric functions:**
x = 7 cos T – 2 cos 3.5T
y = 7 sin T – 2 sin 3.5T

Use the following View Window parameters.

Xmin	**= –20**	**Ymin**	**= –12**
Xmax	**= 20**	**Ymax**	**= 12**
Xscale	**= 5**	**Yscale**	**= 5**
T, θ min	**= 0**	**T, θ max**	**= 4π**
T, θ pitch	**= π÷36**		

1. In the set-up screen, specify the appropriate graph type for Func Type.

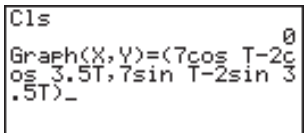
   [SHIFT] [SETUP] [▼] [F3] (Parm)

2. Set the default angle unit to radians (Rad).

   [▼] [▼] [▼] [F2] (Rad) [EXIT]

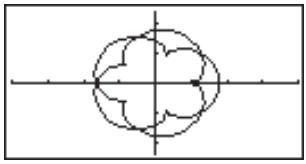
3. Input the parametric functions.

   [SHIFT] [F4] (Sketch) [F1] (Cls) [EXE]
   [F5] (GRPH) [F3] (Parm)
   [7] [cos] [X,θ,T] [−] [2] [cos] [3] [•] [5] [X,θ,T] [•]
   [7] [sin] [X,θ,T] [−] [2] [sin] [3] [•] [5] [X,θ,T] [)]



4. Press [EXE] to draw the graph.

   [EXE]



●To graph X = constant

You can graph functions that can be expressed in the format X = constant.

Example **To graph X = 3**

Use the following View Window parameters.

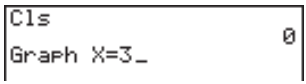
Xmin	**= –5**	**Ymin**	**= –5**
Xmax	**= 5**	**Ymax**	**= 5**
Xscale	**= 1**	**Yscale**	**= 1**

1. In the set-up screen, specify the appropriate graph type for Func Type.

   [SHIFT] [SETUP] [▼] [F4] (X = c) [EXIT]

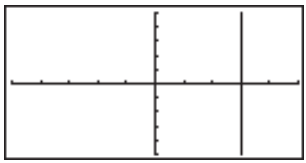
2. Input the expression.

   [SHIFT] [F4] (Sketch) [F1] (Cls) [EXE]
   [F5] (GRPH) [F4] (X = c) [3]



3. Press [EXE] to draw the graph.

[EXE]



●To graph inequalities

You can graph inequalities that can be expressed in the following four formats.

- $y > f(x)$
- $y < f(x)$
- $y \geqq f(x)$
- $y \leqq f(x)$

Example **To graph the inequality $y > x^2 - 2x - 6$**

Use the following View Window parameters.

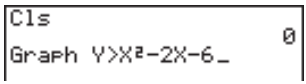
Xmin	**= –6**	**Ymin**	**= –10**
Xmax	**= 6**	**Ymax**	**= 10**
Xscale	**= 1**	**Yscale**	**= 5**

1. In the set-up screen, specify the appropriate graph type for Func Type.

[SHIFT] [SETUP] [▼] [F6] (▷) [F1] (Y>) [EXIT]

2. Input the inequality.

[SHIFT] [F4] (Sketch) [F1] (Cls) [EXE]
[F5] (GRPH) [F6] (▷)
[F1] (Y>) [X,θ,T] [x^2] [−] [2] [X,θ,T] [−] [6]



3. Press [EXE] to draw the graph.

[EXE]

●To draw an integration graph

You can graph an integration calculation performed using the function $y = f(x)$.

Example **To graph the following:**

$$\int_{-2}^{1} (x + 2)(x - 1)(x - 3)\,dx$$

Use the following View Window parameters.

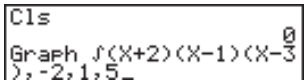
Xmin	**= –4**	**Ymin**	**= –8**
Xmax	**= 4**	**Ymax**	**= 12**
Xscale	**= 1**	**Yscale**	**= 5**

1. In the set-up screen, specify the appropriate graph type for Func Type.

   [SHIFT] [SETUP] [▼] [F1] (Y =) [EXIT]

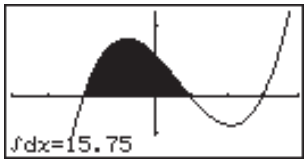
2. Input the integration graph expression.

   [SHIFT] [F4] (Sketch) [F1] (Cls) [EXE]
   [F5] (GRPH) [F5] (G$\int dx$) [(] [X,θ,T] [+] [2] [)]
   [(] [X,θ,T] [−] [1] [)] [(] [X,θ,T] [−] [3] [)]
   [,] [(−)] [2] [,] [1] [,] [5]



3. Press [EXE] to draw the graph.

   [EXE]



- Before drawing an integration graph, be sure to always press [SHIFT] [F4] (Sketch) [F1] (Cls) to clear the screen.
- You can also incorporate an integration graph command into programs.

8-6 Other Graphing Functions

The functions described in this section tell you how to read the *x*- and *y*-coordinates at a given point, and how to zoom in and zoom out on a graph.

- These functions can be used with rectangular coordinate, polar coordinate, parametric, X = constant, and inequality graphs only.

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■ Connect Type and Plot Type Graphs (Draw Type)

You can use the Draw Type setting of the set-up screen to specify one of two graph types.

- Connect

Points are plotted and connected by lines to create a curve.

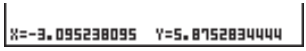
- Plot

Points are plotted without being connected.

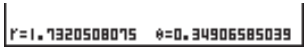
■ Trace

With trace, you can move a flashing pointer along a graph with the ▲, ▼, ◀, and ▶ cursor keys and obtain readouts of coordinates at each point. The following shows the different types of coordinate readouts produced by trace.

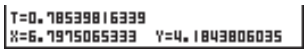
- Rectangular Coordinate Graph



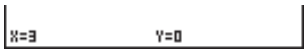
- Polar Coordinate Graph



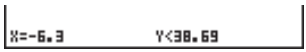
- Parametric Function Graph



- X = Constant Graph



- Inequality Graph



●To use trace to read coordinates

Example **To determine the points of intersection for graphs produced by the following functions:**

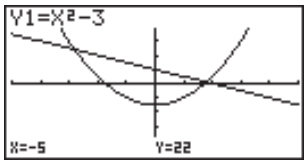
Y1 = x^2 – 3
Y2 = –x + 2

Use the following View Window parameters.

Xmin = –5	**Ymin = –10**
Xmax = 5	**Ymax = 10**
Xscale = 1	**Yscale = 2**

1. After drawing the graphs, press [F1] (Trace) to make the pointer appear at the far left of the graph.

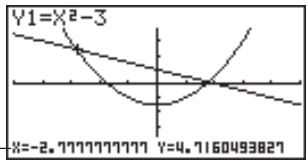
[F1](Trace)



- The pointer may not be visible on the graph when you press [F1] (Trace).

2. Use ▶ to move the pointer to the first intersection.

▶ ~ ▶

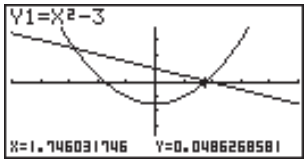


x/*y* coordinate values

- Pressing ◀ and ▶ moves the pointer along the graph. Holding down either key moves the pointer at high speed.

3. Use ▲ and ▼ to move the pointer between the two graphs.
4. Use ▶ to move the pointer to the other intersection.

▶ ~ ▶



- To abort a trace operation, press [F1] (Trace).
- Do not press the [AC] key while performing a trace operation.

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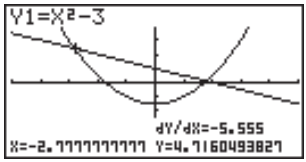
●To display the derivative

If the Derivative item in the set-up screen is set to "**On**", the derivative appears on the display along with the coordinate values.



- The following shows how the display of coordinates and the derivative changes according to the Graph Type setting.

- Rectangular Coordinate Graph

```
                dY/dX=-5.555
X=-2.777777777777 Y=4.716049382
```

- Polar Coordinate Graph

```
dr/dθ=4.2426    dY/dX=0.6602
r=1.414213562   θ=0.261799387
```

- Parametric Function Graph

```
dX/dT=3         dY/dT=0
T=0             dY/dX=0
```

- X = Constant Graph

```
                dY/dX=ERROR
X=3             Y=0
```

- Inequality Graph

```
                dY/dX=-12.6
X=-6.3          Y<38.69
```

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- The derivative is not displayed when you use trace with a built-in scientific function.

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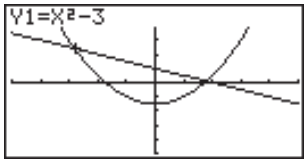
- Setting the Coord item in the set-up screen to "**Off**" turns display of the coordinates for the current pointer location off.



●Scrolling

When the graph you are tracing runs off the display along either the *x*- or *y*-axis, pressing the ▶ or ◀ cursor key causes the screen to scroll in the corresponding direction eight dots.

- You can scroll only rectangular coordinate and inequality graphs while tracing. You cannot scroll polar coordinate graphs, parametric function graphs, or X = constant graphs.
- The graph on the screen does not scroll when you are tracing while the Dual Screen Mode is set to "**Graph**" or "**G to T**".

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- Trace can be used only immediately after a graph is drawn. It cannot be used after changing the settings of a graph.
- The *x*- and *y*-coordinate values at the bottom of the screen are displayed using a 12-digit mantissa or a 7-digit mantissa with a 2-digit exponent. The derivative is displayed using a 6-digit mantissa.
- You cannot incorporate trace into a program.
- You can use trace on a graph that was drawn as the result of an output command (◢), which is indicated by the "-Disp-" indicator on the screen.

■ Scroll

You can scroll a graph along its *x*- or *y*-axis. Each time you press ▲, ▼, ◀, or ▶, the graph scrolls 12 dots in the corresponding direction.

■ Graphing in a Specific Range

You can use the following syntax when inputting a graph to specify a start point and end point.

<function> , SHIFT (<start point> , <end point> SHIFT) EXE

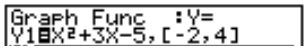
Example **To graph $y = x^2 + 3x - 5$ within the range of $-2 \leqq x \leqq 4$**

Use the following View Window parameters.

Xmin = –3	**Ymin = –10**
Xmax = 5	**Ymax = 30**
Xscale = 1	**Yscale = 5**

F3(TYPE) F1(Y =)

(Specifies graph type.)



X,θ,T x² + 3 X,θ,T − 5 ,

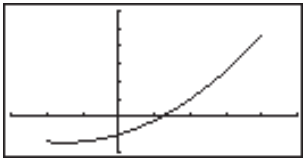
SHIFT ((−) 2 , 4 SHIFT) EXE

(Stores expression.)

F6

F6(DRAW) or EXE

(Draws graph.)



- You can specify a range for rectangular coordinate, polar coordinate, parametric, and inequality graphs.

■ Overwrite

Using the following syntax to input a graph causes multiple versions of the graph to be drawn using the specified values. All versions of the graph appear on the display at the same time.

<function with one variable> , SHIFT (<variable name> SHIFT = <value> , <value> , ... <value> SHIFT) EXE

Example **To graph $y = Ax^2 - 3$, substituting 3, 1, and –1 for the value of A**

Use the following View Window parameters.

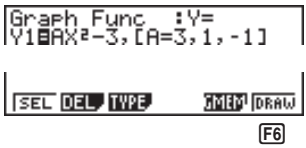
Xmin = –5 **Ymin = –10**
Xmax = 5 **Ymax = 10**
Xscale = 1 **Yscale = 2**

[F3](TYPE)[F1](Y =)

(Specifies graph type.)

[ALPHA][A][X,θ,T][x²][−][3][,]
[SHIFT][(][ALPHA][A][SHIFT][=][3][,]
[1][,][(−)][1][SHIFT][)][EXE]

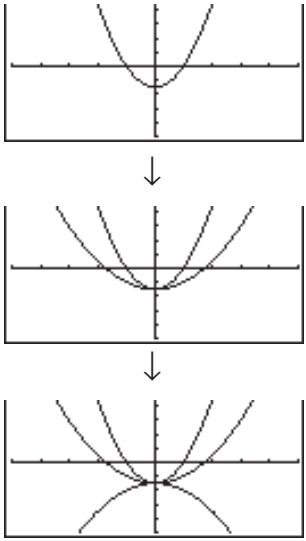
(Stores expression.)



[F6]

[F6](DRAW)

(Draws graph.)



- The function input using the above syntax can have only one variable.
- You cannot use X, Y, r, θ, or T as the variable name.
- You cannot assign a variable to the variable in the function.
- When the set-up screen's Simul Graph item is set to "**On**," the graphs for all the variables are drawn simultaneously.
- You can use overwrite with rectangular coordinate, polar coordinate, parametric, and inequality graphs.

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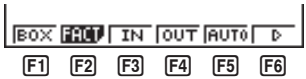
■ Zoom

The zoom feature lets you enlarge and reduce a graph on the display.

●Before using zoom

Immediately after drawing a graph, press F2 (Zoom) to display the Zoom Menu.

F2 (Zoom)



F1 (BOX) ..... Graph enlargement using box zoom
F2 (FACT) ..... Displays screen for specification of zoom factors
F3 (IN) ..... Enlarges graph using zoom factors
F4 (OUT) ..... Reduces graph using zoom factors
F5 (AUTO) .... Automatically sizes the graph so it fills the screen along the *y*-axis.
F6 (▷) ..... Next menu

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F6 (▷)

F1 (ORIG) ..... Original size
F2 (SQR) ..... Adjusts ranges so *x*-range equals *y*-range.
F3 (RND) ..... Rounds coordinates at current pointer location.
F4 (INTG) ..... Converts *x*- and *y*-axis values to integers.
F5 (PRE) ..... After a zoom operation, returns View Window parameters to previous settings.
F6 (▷) ..... Previous menu

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●To use box zoom

With box zoom, you draw a box on the display to specify a portion of the graph, and then enlarge the contents of the box.

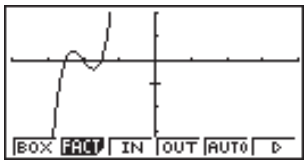
Example **To use box zoom to enlarge a portion of the graph $y = (x + 5)(x + 4)(x + 3)$**

Use the following View Window parameters.

Xmin = –8	**Ymin = –4**
Xmax = 8	**Ymax = 2**
Xscale = 2	**Yscale = 1**

1. After graphing the function, press [F2] (Zoom).

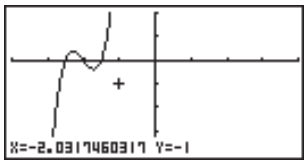
[F2](Zoom)



[F1]

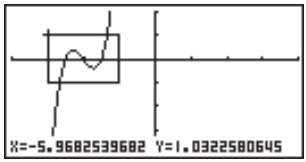
2. Press [F1] (BOX), and then use the cursor keys (◀, ▶, ▲, ▼) to move the pointer to the location of one of the corners of the box you want to draw on the screen. Press [EXE] to specify the location of the corner.

[F1](BOX)
◀ ~ ◀ [EXE]



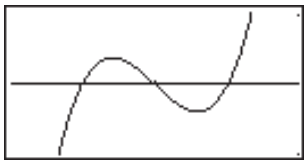
3. Use the cursor keys to move the pointer to the location of the corner that is diagonally across from the first corner.

▲ ~ ▲ ◀ ~ ◀



4. Press [EXE] to specify the location of the second corner. When you do, the part of the graph inside the box is immediately enlarged so it fills the entire screen.

[EXE]



- To return to the original graph, press [F2] (Zoom) [F6] (▷) [F1] (ORIG).

- Nothing happens if you try to locate the second corner at the same location or directly above the first corner.
- You can use box zoom for any type of graph.

●To use factor zoom

With factor zoom, you can zoom in or zoom out on the display, with the current pointer location being at the center of the new display.

- Use the cursor keys (◀, ▶, ▲, ▼) to move the pointer around the display.

Example **Graph the two functions below, and enlarge them five times in order to determine whether or not they are tangential.**

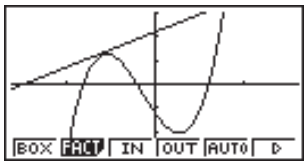
Y1 = (*x* + 4) (*x* + 1) (*x* – 3)
Y2 = 3*x* + 22

Use the following View Window parameters.

Xmin	**= –8**	**Ymin**	**= –30**
Xmax	**= 8**	**Ymax**	**= 30**
Xscale	**= 5**	**Yscale**	**= 10**

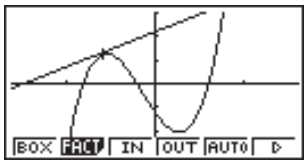
1. After graphing the functions, press [F2] (Zoom), and the pointer appears on the screen.

   [F2](Zoom)



2. Use the cursor keys (◀, ▶, ▲, ▼) to move the pointer to the location that you want to be the center of the new display.

   ◀ ~ ◀ ▲ ~ ▲



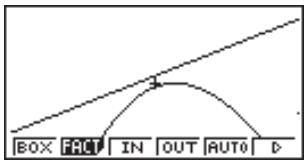
   [F2]

3. Press [F2] (FACT) to display the factor specification screen, and input the factor for the *x*- and *y*-axes.

   [F2](FACT)
   [5] [EXE] [5] [EXE]

4. Press [EXIT] to return to the graphs, and then press [F3] (IN) to enlarge them.

[EXIT]
[F3](IN)



This enlarged screen makes it clear that the graphs of the two expressions are not tangential.

Note that the above procedure can also be used to reduce the size of a graph (zoom out). In step 4, press [F4] (OUT).

- The above procedure automatically converts the *x*-range and *y*-range View Window values to 1/5 of their original settings. Pressing [F6] (▷) [F5] (PRE) changes the values back to their original settings.
- You can repeat the factor zoom procedure more than once to further enlarge or reduce the graph.

●To initialize the zoom factor

Press [F2] (Zoom) [F2] (FACT) [F1] (INIT) to initialize the zoom factor to the following settings.

Xfact = 2 Yfact = 2

- You can use the following syntax to incorporate a factor zoom operation into a program.

  Factor <X factor>, <Y factor>
- You can specify only positive value up to 14 digits long for the zoom factors.
- You can use factor zoom for any type of graph.

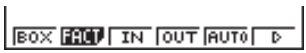
■ Using the Auto View Window

The auto View Window feature automatically adjusts *y*-range View Window values so that the graph fills the screen along the *y*-axis.

Example **To graph $y = x^2 - 5$ with Xmin = –3 and Xmax = 5, and then use auto View Window to adjust the *y*-range values**

1. After graphing the function, press [F2] (Zoom).

[F2](Zoom)



[F5]

2. Press [F5] (AUTO).

[F5](AUTO)

- You can use auto View Window with any type of graph.
- You cannot use auto View Window inside a program.
- You can use auto View Window with a graph produced by a multi-statement connected by ":", even if the multi-statement includes non-graph operations.
- When auto View Window is used in a statement that uses a display result command (◢) to draw a graph, auto View Window parameters are applied up to the display result command, but any graphs drawn after the display result command are drawn according to normal graph overdraw rules.

■ Adjusting the Ranges of a Graph (SQR)

This function makes the View Window x-range value the same as the y-range value. It is helpful when drawing circular graphs.

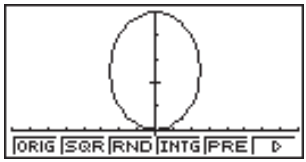
Example **To graph $r = 5\sin\theta$ and then adjust the graph.**

Use the following View Window parameters.

Xmin	**= –8**	**Ymin**	**= –1**
Xmax	**= 8**	**Ymax**	**= 5**
Xscale	**= 1**	**Yscale**	**= 1**

1. After drawing the graph, press [F2] (Zoom) [F6] (▷).

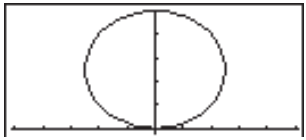
[F2](Zoom) [F6](▷)



[F2]

2. Press [F2] (SQR) to make the graph a circle.

[F2](SQR)



- You can use SQR with any type of graph.
- You cannot use SQR inside a program.
- You can use SQR with a graph produced by a multi-statement connected by ":", even if the multi-statement includes non-graph operations.
- When SQR is used in a statement that uses a display result command (◢) to draw a graph, Graph Adjust parameters are applied up to the display result command, but any graphs drawn after the display result command are drawn according to normal graph overwrite rules.

■ Rounding Coordinates (RND)

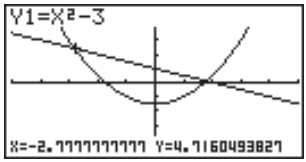
This feature rounds the coordinate values at the pointer location to the optimum number of significant digits. Rounding coordinates is useful when using trace and plot.

Example **To round the coordinates at the points of intersection of the two graphs drawn on page 146**

Use the same View Window parameters as in the example on page 146.

1. After graphing the functions, press [F1] (Trace) and move the pointer to the first intersection.

[F1](Trace)
▶ ~ ▶



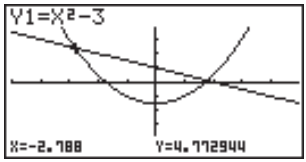
2. Press [F2] (Zoom) [F6] (▷).

[F2](Zoom) [F6](▷)

[F3]

3. Press [F3] (RND) and then [F1] (Trace). Use ▶ to move the pointer to the other intersection. The rounded coordinate values for the pointer position appear on the screen.

[F3](RND)
[F1](Trace)
▶ ~ ▶



- You can use RND with any type of graph.
- You cannot use RND inside a program.
- You can use RND with a graph produced by a multi-statement connected by ":", even if the multi-statement includes non-graph operations.
- When RND is used in a statement that uses a display result command (◢) to draw a graph, Rounding Coordinate parameters are applied up to the display result command, but any graphs drawn after the display result command are drawn according to normal graph overwrite rules.

■ Converting *x*- and *y*-axis Values to Integers (INTG)

This feature converts View Window values to the following, and redraws the graph with the current pointer position as the center point.

Xmin = center point –63.5 Ymin = center point –31.5
Xmax = center point +63.5 Ymax = center point +31.5
Xscale = 10 Yscale = 10

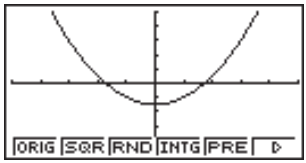
Example **To graph $y = x^2 - 3$ and then redraw it using INTG**

Use the following View Window parameters.

Xmin = –5 Ymin = –10
Xmax = 5 Ymax = 10
Xscale = 1 Yscale = 2

1. Press F2 (Zoom) F6 (▷) after drawing the graph.

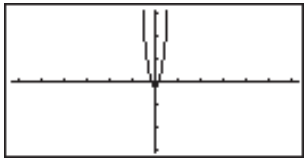
F2(Zoom) F6(▷)



F4

2. Press F4 (INTG).

F4(INTG)



- You can use INTG with any type of graph.
- You cannot use INTG inside a program.
- You can use INTG with a graph produced by a multi-statement connected by ":", even if the multi-statement includes non-graph operations.
- When INTG is used in a statement that uses a display result command (◢) to draw a graph, Integer parameters are applied up to the display result command, but any graphs drawn after the display result command are drawn according to normal graph overwrite rules.

■ Returning the View Window to Its Previous Settings

The following operation returns View Window parameters to their original settings following a zoom operation.

F6 (▷) F5 (PRE)

- You can use PRE with a graph altered by any type of zoom operation.

8-7 Picture Memory

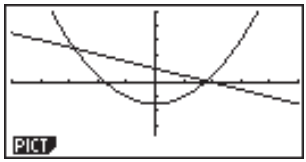
You can save up to six graphic image in picture memory for later recall. You can overdraw the graph on the screen with another graph stored in picture memory.

●To store a graph in picture memory

The following operation stores all points and lines currently on the screen.

Example **To store the graph drawn in the example on page 146 into picture memory Pic1**

[OPTN]



[F1]

[F1](PICT)

[F1]

[F1](STO)

[F1]

[F1](Pic1)

- Storing a graph in a memory area (Pic1 through Pic6) that already contains a graph replaces the existing graph with a new one.

●To recall a graph from memory

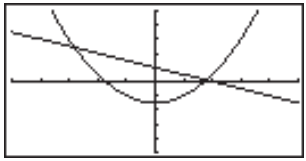
Example **To recall the graph stored in picture memory Pic1**

- In the GRAPH Mode:

[OPTN] [F1](PICT) [F2](RCL)

[F1]

[F1](Pic1)



- Dual Graph screens or any other type of graph that uses a split screen cannot be saved in picture memory.

8-8 Graph Background

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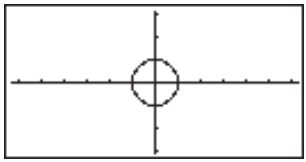
You can use the set-up screen to specify the memory contents of any picture memory area (Pict 1 through Pict 6) as the Background item. When you do, the contents of the corresponding memory area is used as the background of the graph screen.

- You can use a background in the RUN, STAT, GRAPH, DYNA, TABLE, RECUR, CONICS Modes.

Example 1 **With the circle graph $X^2 + Y^2 = 1$ as the background, use Dynamic Graph to graph $Y = X^2 + A$ as variable A changes value from –1 to 1 in increments of 1.**

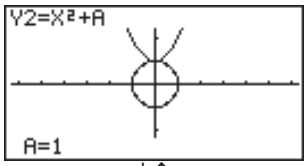
Recall the background graph.

($X^2 + Y^2 = 1$)

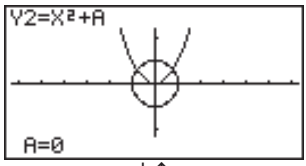


Draw the dynamic graph.

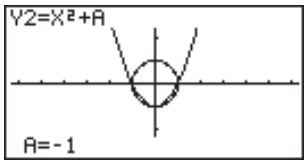
($Y = X^2 + 1$)



($Y = X^2$)



($Y = X^2 - 1$)



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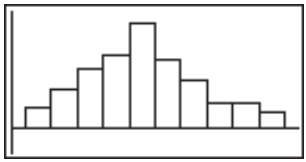
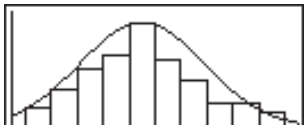
- See “14. Implicit Function Graphs” for details on drawing a circle graph, and “13. Dynamic Graph” for details on using the Dynamic Graph feature.

Example 2 **With a statistical histogram as the background, graph a normal distribution**

Recall the backgound graph.
(Histogram)



Graph the normal distribution.



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- See “18. Statistical Graphs and Calculations” for details on drawing a statistical graphs.