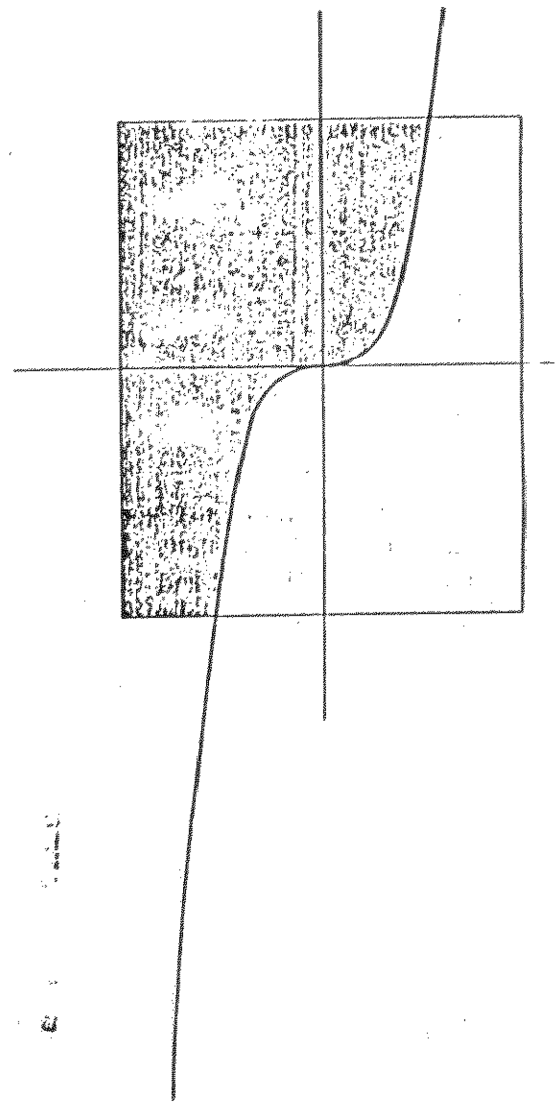
Power regression

- The regression formula is $y = A \cdot x^B$ ($\ln y = \ln A + B \ln x$). Enter both data x and y as logarithms (ln).
- Correction is performed the same as in linear regression. Constant term A is obtained by [SHIFT] [e^x] [SHIFT] [A] [EXE], estimated value $\hat{y}$ is obtained by [ln] x [SHIFT] [$\hat{y}$] [EXE] [SHIFT] [e^x] [Ans] [EXE], and estimated value $\hat{x}$ is obtained by [ln] y [SHIFT] [$\hat{x}$] [EXE] [SHIFT] [e^x] [Ans] [EXE]. Σx, Σx^2, Σy, Σy^2 and Σxy are obtained by $\Sigma \ln x$, $\Sigma (\ln x)^2$, $\Sigma \ln y$, $\Sigma (\ln y)^2$ and $\Sigma \ln x \cdot \ln y$ respectively.

Example	Operation	Display
	[MODE] [÷]	
x_i / y_i	[SHIFT] [Scl] [EXE]	
28 / 2410	[ln] 28 [SHIFT] [,] [ln] 2410 [DT]	3.33220451
30 / 3033	[ln] 30 [SHIFT] [,] [ln] 3033 [DT]	3.401197382
33 / 3895	[ln] 33 [SHIFT] [,] [ln] 3895 [DT]	3.496507561
35 / 4491	[ln] 35 [SHIFT] [,] [ln] 4491 [DT]	3.555348061
38 / 5717	[ln] 38 [SHIFT] [,] [ln] 5717 [DT]	3.63758616
Through power regression of the above data, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtain the respective estimated values $\hat{x}$ and $\hat{y}$ when $xi = 40$ and $yi = 1000$.	(Constant term A) [SHIFT] [e^x] [SHIFT] [A] [EXE]	0.2388010724
	(Regression coefficient B) [SHIFT] [B] [EXE]	2.771866153
	(Correlation coefficient r) [SHIFT] [r] [EXE]	0.9989062542
	($\hat{y}$ when $xi = 40$) [ln] 40 [SHIFT] [$\hat{y}$] [EXE] [SHIFT] [e^x] [Ans] [EXE]	6587.67458
	($\hat{x}$ when $yi = 1000$) [ln] 1000 [SHIFT] [$\hat{x}$] [EXE] [SHIFT] [e^x] [Ans] [EXE]	20.2622568

3.
GRAPHS



The graph function of this unit makes it possible to produce a wide variety of function and statistical graphs quickly and easily on a 95 X 63 dot display. (Upmost and leftmost lines are not used.)
Besides the built-in function graphs, a generous selection of functions can also be input for graphic representation.
Graph commands can be used manually or in programs, but here all examples will be centered around manual operations. Programmed graphs are identical to those produced manually, and details can be found on page 132.

* *Some of keys used for the operation examples in this manual show alphabetic character key markings. On the actual unit, alphabetic characters are marked under the keys by which they are represented.*

3-1 BUILT-IN FUNCTION GRAPHS

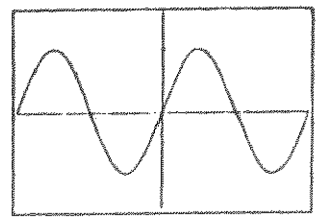
The COMP mode of the RUN mode should be used when graphing functions. Some graphs can be produced in the SD and LR modes, but certain graphs cannot be produced in these modes. The Base-n mode cannot be used for graphs. This unit contains a total of 20 built-in graphs making it possible to produce the graphs of basic functions.

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

Any time a built-in graph is executed, the ranges (see page 61) are automatically set to their optimum values, and any graph previously on the display is cleared.

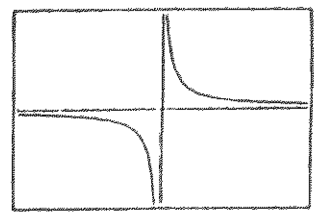
Ex. 1) **Sine curve**

[MODE] [+]
[Graph] [sin] [EXE]



Ex. 2) $y = \frac{1}{x}$ graph

[Graph] [x^{-1}] [EXE]

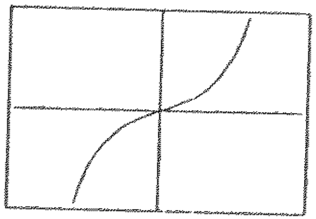


■ Overwriting built-in function graphs

Two or more different built-in function graphs can be written together on the same display. Since the range for the first graph is automatically set, all subsequent graphs on the same display are produced according to the range of the first graph.
The first graph is produced by using the previously mentioned operation ([Graph] [function key] [EXE]).
Subsequent graphs are produced using the variable X in the operation [Graph] [function key] [ALPHA] [X] [EXE] ([X] : [+] key). By inputting [ALPHA] [X] after the function key, the range is unchanged and the next graph is produced without clearing the existing display. (See page 67 for details.)

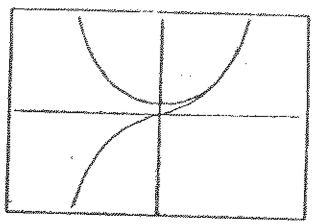
Ex. Overwrite the graph for $y=\cosh x$ on the graph for y sinh x.
First, draw the graph for $y=\sinh x$.

[Graph] [hyp] [sin] [EXE]



Next, draw the graph for $y=\cosh x$ without changing the existing range.

[Graph] [hyp] [cos] [ALPHA] [X] [EXE]



〈Note〉
Built-in function graphs cannot be used in multistatements (see page 38) and cannot be written into programs.

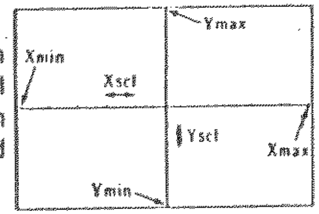
3-2 USER GENERATED GRAPHS

Built-in function graphs can also be used in combination with each other. Graphing a formula such as $y=2x^2+3x-5$ makes it possible to visually represent the solution.
Unlike built-in functions, the ranges of user generated graphs are not set automatically, so graphs produced outside of the display range do not appear on the display.

■ Ranges

The ranges of the x and y-axes, as well as the scale (distance between points) for both axes can be set or checked using the [Range] key.

● Ranges contents
Ranges consist of Xmin (x-axis minimum value), Xmax (x-axis maximum value), Xscl (x-axis scale), Ymin (y-axis minimum value), Ymax (y-axis maximum value), and Yscl (y-axis scale).



● Range display
Ranges are displayed as shown on the right when the [Range] key is pressed. The range value at the cursor position can be changed.

Cursor

```
Range
Xmin:-5.
 max:5.
 scl:2.
Ymin:-10.
 max:10.
 scl:5.
```

* Values shown here are only an example. Actual values may differ.

● Range setting
Range settings are made from the current cursor position and proceed in the order of Xmin→Xmax→Xscl→Ymin→Ymax→Yscl. Input a numeric value at the cursor position and then press [EXE]. Any value input while the cursor is at the first (extreme left) digit of the displayed value will replace the displayed value when [EXE] is pressed.
If the [⇨] key is used to move the cursor to the second or subsequent digit of the displayed value, only the portion of the displayed value starting from the cursor position will be affected by the new input when [EXE] is pressed.

Here, let's try changing the currently set range values to those listed below:

Xmin	→	0	Ymin	→	−5
Xmax	→	5	Ymax	→	15
Xscl	→	1	Yscl	→	5

① Input 0 for Xmin.

0 [EXE]

```
Range
Xmin:0
 max:5.
 scl:2.
Ymin:-10.
 max:10
 scl:5.
```

② The Xmax value is the same, so simply press [EXE].

[EXE]
([⇩] key can also be used.)

```
Range
Xmin:0
 max:5.
 scl:2.
Ymin:-10.
 max:10
 scl:5.
```

③ Input 1 for Xscl.

1 [EXE]

```
Range
Xmin:0
 max:5.
 scl:1
Ymin:-10.
 max:10
 scl:5.
```


⑤ To change Ymax to 15, use the [⇨] key to move the cursor one digit to the right and input 5.

[⇨] 5 [EXE]

```
Range
Xmin:0
 max:5.
 scl:1
Ymin:-5
 max:15
 scl:5.
```

⑥ The Yscl value is the same, so simply press [EXE].

[EXE]

Once all settings are complete, the display that was shown before pressing the [Range] key is retrieved.
Press the [Range] key again to confirm whether settings are correct.

[Range]

```
Range
Xmin:0.
 max:5.
 scl:1.
Ymin:-5.
 max:15.
 scl:5.
```

The [⇧] and [⇩] keys can be used to move the cursor from line to line.

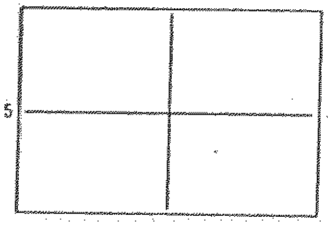
* *The input range for graph ranges is −9.9999E+98 through 9.99999E+98.*
* *Only numeric value keys from [0] through [9], [.], [EXP], [(−)], [⇦], [⇨], [⇧], [⇩], and [Range] can be used during range display. Other key operation is ignored.*
  (Use the [(−)] key for negative value input.)
* *To completely change an existing range setting, ensure that the cursor is located at the first digit (all the way to the left) of the displayed value. If the cursor has been moved to another digit of the value, only the portion of the value from the cursor position (to the right) will be changed. The portion of the value to the left of the cursor will remain unchanged.*

Ex.

Key	Display
	⊖25
[⇨]	−25
3	−35
[EXE]	−3

* *Values up to nine significant digits can be input.*
  Values less than 10^{-2} and equal to or greater than 10^{6} are displayed with a 6-digit mantissa (including negative sign) and a 2-digit exponent.
* *If input is improper (outside the allowable calculation range or inputting only a negative sign), the existing value will remain unchanged. (The improper input, however, will be temporarily displayed.)*
* *Inputting 0 for Xscl or Yscl does not set any scale.*
* *Inputting a maximum value that is less than the minimum value will reverse the respective axis.*

Ex. Xmin : 5
    Xmax : −5



* *If the maximum and minimum values of an axis are equal, an error (Ma ERROR) will be generated when an attempt is made to produce a graph.*
* *When a range setting is used that 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. (In both cases, the location of the scale is the edge which is closest to the origin (0, 0)).*
* *When range values are changed (reset), the graph display is cleared and the newly set axes only are displayed.*
* *Range settings may cause irregular scale spacing.*
* *If the range is set too wide, the graph produced may not fit on the display.*
* *Points of deflection sometimes exceed the capabilities of the display with graphs that change drastically as they approach the point of deflection.*
* *An Ma ERROR may be generated when a range value is specified that exceeds the allowable range.*

  Ex. Xmin 9.E99
      Xmax 9.9E99
      Xscl 1.E99 ⇒ Falls outside of range.
      ⋮

* *An Ma ERROR is generated when ranges are extremely narrow.*

● Range reset

Range values are reset to their initial values by pressing [SHIFT] [DEL] during range display.

[Range] (Not required when range display is already being shown.)
[SHIFT] [DEL]

```
Range
Xmin:-4.7
 max:4.7
 scl:1.
Ymin:-3.1
 max:3.1
 scl:1.
```

〈Reference〉

Range settings are performed within programs using the following format:

[Range] Xmin value, Xmax value, Xscl value, Ymin value, Ymax value, Yscl value

Up to six data items are programmed after the [Range] command. When less than six items are programmed, range setting is performed in the order from the beginning of the above format.

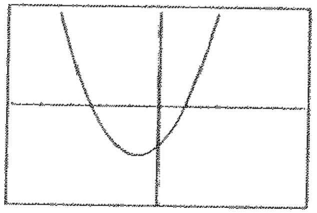
User generated function graphs

After performing range settings, user generated graphs can be drawn simply by entering the function (formula) after pressing [Graph].
Here, let's try drawing a graph for $y=2x^2+3x-4$.
Set the ranges to the values shown below.

```
Range
Xmin:-5.
 max:5.
 scl:1.
Ymin:-10.
 max:10.
 scl:2.
```

Input the functional formula after pressing the [Graph] key.

[Graph] 2 [ALPHA] [X] [x^2] [+]
3 [ALPHA] [X] [−] 4 [EXE]



The result produces a visual representation of the formula.

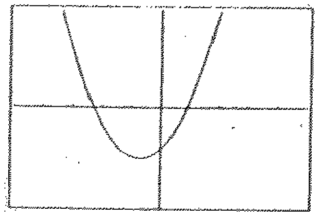
Function graph overwrite

Two or more function graphs can be overwritten which makes it easy to determine intersection points and solutions that satisfy all the equations.

Ex. Here, let's find the intersection points of the previously used $y=2x^2+3x-4$ and $y=2x+3$.

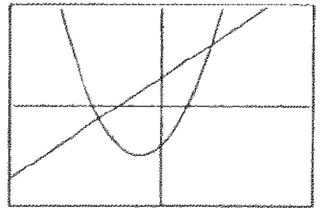
First, clear the graph screen in preparation for the first graph.

[SHIFT] [Cls] [EXE]
[Graph] 2 [ALPHA] [X] [x^2] [+]
3 [ALPHA] [X] [−] 4 [EXE]



Next, overwrite the graph for $y=2x+3$.

[Graph] 2 [ALPHA] [X] [+] 3 [EXE]



In this way it can be easily seen that there are two intersections for the two function graphs. The approximate coordinates for these two intersections can be found using the trace function described in the following section.

* *Be sure to input variable X ([ALPHA] [X]) into the function when using built-in graphs for overwrite.*
If variable X is not included in the second formula, the second graph is produced after clearing the first graph.

Trace function

The pointer (blinking dot) can be moved using the cursor keys ([⇦] [⇨]) to determine the x and y coordinates of any point on a graph.
After a graph is produced on the display, press [SHIFT] [Trace] and the point will appear at the extreme left plot of the graph. The x-coordinate value (X=. . . .) will appear on the bottom line of the display. The pointer can be moved using the [⇦] and [⇨] cursor keys, and the x-coordinate value changes as the pointer moves. To change from the x-coordinate to the y-coordinate value, press [SHIFT] [X↔Y]. The displayed coordinate switches between x and y with each press of [SHIFT] [X↔Y].

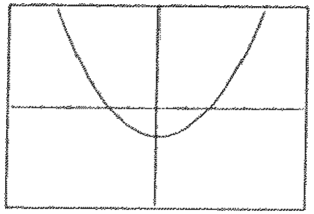
Ex. Determine the points of intersection of the graphs for $y=x^2-3$ and $y=-x+2$.

The range values should be set as follows:

```
Range
Xmin:-5.
 max:5.
 scl:1.
Ymin:-10.
 max:10.
 scl:2.
```

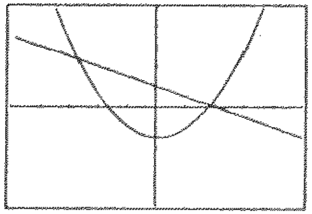
First, draw the graph for $y=x^2-3$.

[Graph] [ALPHA] [X] [x^2] [−] 3 [EXE]



Next, draw the graph for $y=-x+2$.

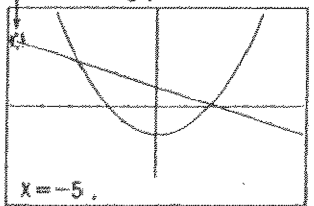
[Graph] [(−)] [ALPHA] [X] [+] 2 [EXE]



Finally, let's use the trace function.

[SHIFT] [Trace]

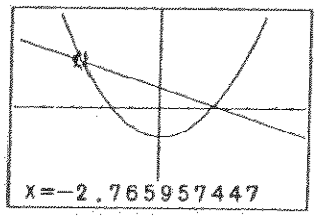
Blinking pointer



x-coordinate value

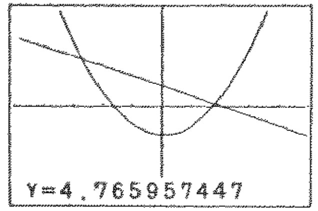
The pointer appears at the extreme left plot of the graph. The [⇨] key moves the pointer to the right along the graph. Each press of [⇨] moves the pointer one point, while holding it down causes continuous movement.

[⇨] ~
(Hold down)



Hold [⇨] down until the pointer reaches the intersection of the two graphs. Note the x-coordinate value, and then press [SHIFT] [X↔Y] for the y-coordinate value.

[SHIFT] [X↔Y]

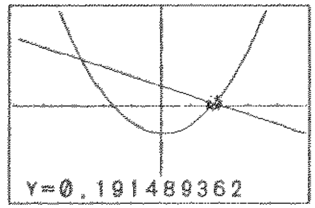


In this way, it can be determined that the coordinates of the first intersection are $x=-2.765957447$ and $y=4.765957447$.

* *The pointer does not move at the fixed distance because the distance is located along the dots of the display. Therefore, the x-y coordinates for the point of intersection are approximate values.*

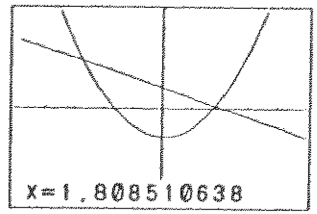
Similarly, press [⇨] to move the pointer to the next point of intersection.

[⇨] ~



This time, press [SHIFT] [X↔Y] to display the x-coordinate value.

[SHIFT] [X↔Y]



Using the operations outlined above, the approximate x-y coordinates for points along graphs can be obtained.

* *The trace function can only be used immediately after a graph is drawn. This function cannot be used if other calculations or operations (except [M Disp], [Range], or [G↔T]) have been employed after a graph has been drawn.*
* *The x-y coordinate values at the bottom of the display consist of a 10-digit mantissa or a 5-digit mantissa plus a 2-digit exponent.*

* *The trace function cannot be written into a program.*
* *The trace function can be used during a "—DISP—" display.*
* *When the format [Graph] formula ◢ [Graph] formula [EXE] is executed and a graph is drawn by pressing [EXE] directly after executing the trace function during halt status, the previous coordinate value remains on the display. After the trace function is executed and the text display is brought up using the [G↔T] key, pressing [EXE] causes the next graph to appear and the coordinate value to clear.*
Examine the above using [Graph] [ALPHA] [X] [x^2] [SHIFT] [◢] [Graph] 2 [ALPHA] [X] [+] 5

■ Plot function

The plot function is used to mark a point on the screen of a graph display. The point can be moved left, right, up and down using the cursor keys, and the coordinates for the graph displayed can be read. Two points can also be connected by a straight line (see Line function, page 73).

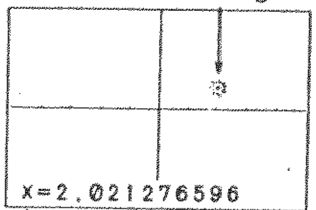
Press [SHIFT] [Plot] and specify the x and y-coordinates after the "Plot" message.

Ex. Plot a point at $x=2$ and $y=2$ on the axes created by the following range values:

```
Range
Xmin:-5.
 max:5.
 scl:1.
Ymin:-10.
 max:10.
 scl:2.
```

[SHIFT] [Plot] 2 [SHIFT] [,] 2 [EXE]

Blinking dot

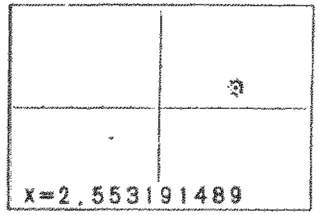


x-coordinate value display

The blinking pointer is positioned at the specified coordinates.
* *Due to limitations caused by the resolution of the display, the actual position of the pointer can only be approximate.*

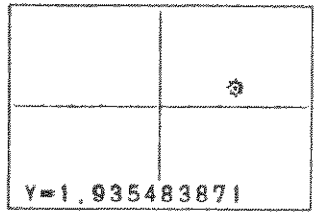
The pointer can be moved left, right, up, and down using the cursor keys. The current position of the pointer is always shown at the bottom of the display.

[⇨] [⇨] [⇨] [⇨] [⇨]

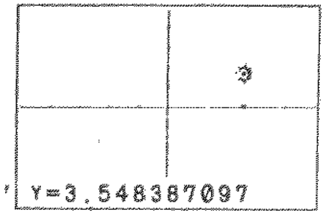


To find the y-coordinate value:

[SHIFT] [X↔Y]

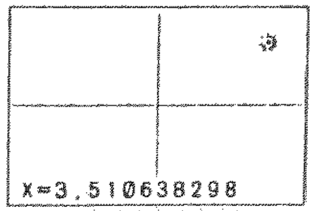


[⇧] [⇧] [⇧] [⇧] [⇧]



Now, inputting a new coordinate value causes the new pointer to blink without clearing the present pointer.

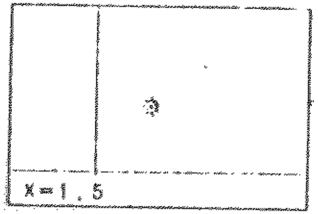
[SHIFT] [Plot] 3.5 [SHIFT] [,] 6.5 [EXE]



If x-y coordinates are not specified for the plot function, the pointer appears at the center of the screen.
Set the following range values:

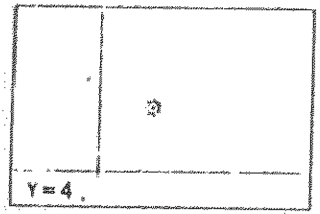
```
Range
Xmin:-2.
 max:5.
 scl:1.
Ymin:-2.
 max:10.
 scl:2.
```

[SHIFT] [Plot] [EXE]



To find the Y-coordinate value:

[SHIFT] [X↔Y]



* *Attempting to plot a point outside of the preset range is disregarded.*
* *The x and y-coordinates of the pointer used in the plot function are respectively stored in the X memory and Y memory.*
* *A blinking pointer becomes a fixed point (not blinking) when a new pointer is created.*

■ Line function

The line function makes it possible to connect two points (including the blinking pointer) created with the plot function with a straight line. With this funciton, user generated lines can be added to graphs to make them easier to read.

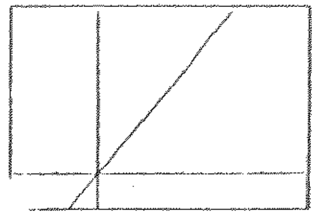
Ex. Draw perpendiculars from point (2,0) on the x-axis to its intersection with the graph for $y=3x$. Then draw a line from the point of intersection to the y-axis.

The range values for the graph are as follows:

```
Range
Xmin:-2.
 max:5.
 scl:1.
Ymin:-2.
 max:10.
 scl:2.
```

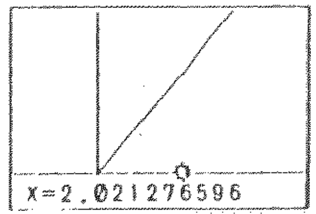
Clear the graph display and draw the graph for $y=3x$.

[SHIFT] [Cls] [EXE]
[Graph] 3 [ALPHA] [X] [EXE]



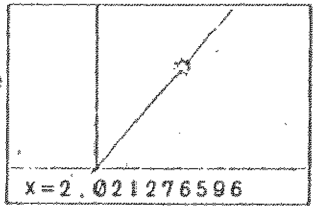
Next, use the plot function to locate a point at (2,0).

[SHIFT] [Plot] 2 [SHIFT] [,] 0 [EXE]



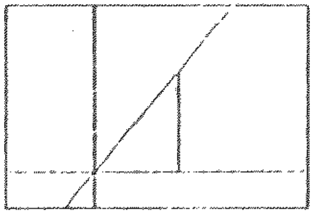
Now plot a point at (2,0) again and use the cursor key ([⇧]) to move the pointer up to the point on the graph ($y=3x$).

[SHIFT] [Plot] 2 [SHIFT] [,] 0 [EXE]
[⇧] ~ [⇧]
(Move the pointer up to the point on the graph for $y=3x$.)



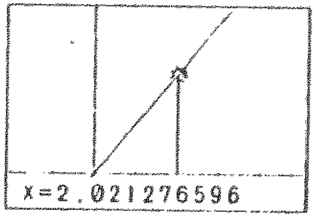
Draw a line using the line function.

[SHIFT] [Line] [EXE]

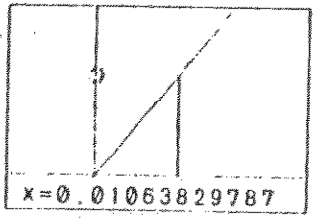


Next, a perpendicular will be drawn from the same point on the graph to the y-axis. First, plot the point on the graph and use the cursor key ([⇦]) to move the pointer to the y-axis. This can be accomplished using Plot X, Y since the x-y coordinates of the point on the graph are stored in the X and Y memories.

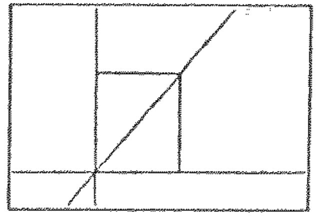
[SHIFT] [Plot] [ALPHA] [X] [SHIFT]
[,] [ALPHA] [Y] [EXE]



[⇦] ~ [⇦]
(Move the pointer to the y-axis.)



[SHIFT] [Line] [EXE]



* *The line function can only be used to draw lines between the blinking pointer and a fixed point created using the plot function.*

■ Factor function

The factor function is used to magnify or reduce the range of a graph centered around the blinking pointer provided with the plot function or trace function.
For magnification, the minimum value and maximum value of the range are multiplied by $1/n$. For reduction, they are multiplied by n.

● Operation

[SHIFT] [Factor] m [SHIFT] [,] n [EXE] ············ x is magnified m times and y is magnified n times centered around the pointer.

[SHIFT] [Factor] n [EXE] ························ x and y are both magnified n times centered around the pointer.

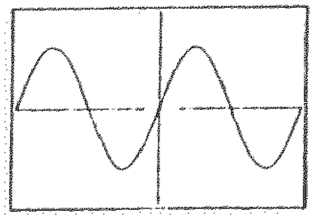
The graph display is cleared when the factor function is executed because of changes in the range values.

Ex. After setting the range values specified below, magnify the graph for $y=\sin x$ centered on the origin.

```
Range
Xmin:-360.
 max:360.
 scl:180.
Ymin:-1.6
 max:1.6
 scl:0.5
```

Draw the graph for $y=\sin x$ after setting the range values.

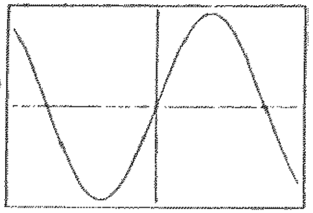
[Graph] [sin] [ALPHA] [X] [EXE]



Now use the plot function to blink the pointer at the origin of the graph and then use the factor function to magnify the graph 1.5 times.

[SHIFT] [Plot] [:] [SHIFT] [Factor] 1.5 [:]
[Graph] [sin] [ALPHA] [X] [EXE]

** The multistatement function is used to produce the graph in a single step.*



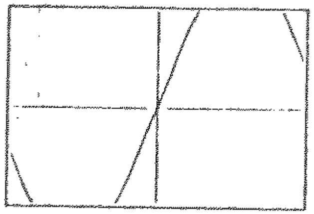
The following shows the resulting range values:

```
Range
Xmin:-240.
 max:240.
 scl:180.
Ymin:-1.06666667
 max:1.06666667
 scl:0.5
```

This indicates that the range values for the x and y-axes are equal to 1/1.5 of their original values.

Now let's try magnifying the graph another 1.5 times.
This time, it is not necessary to input any further commands. The existing graph is magnified by simply pressing [EXE]. Since the original magnification was accomplished using the multistatement function, the replay function becomes operational.

[EXE]



Now the graph is so large that little of it remains on the display. Let's try to reduce the graph to half its present size to make it more manageable.

The replay function is used to change the magnification value from 1.5 to 0.5.

[⇦]

```
Plot :Factor 1.5
:Graph Y=sin X
```

[⇨] [⇨] [⇨]

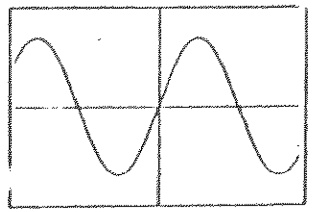
```
Plot :Factor 1.5
:Graph Y=sin X
```

0

```
Plot :Factor 0.5
:Graph Y=sin X
```

Now execute the function.

[EXE]



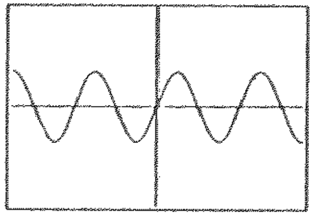
The following display shows the new range values:

[Range]

```
Range
Xmin:-320.
 max:320.
 scl:180.
Ymin:-1.42222223
 max:1.42222221
 scl:0.5
```

To reduce the graph by half again:

[EXE]



Now let's double the x-axis and increase the y-axis by 1.5 times.

[⇨]

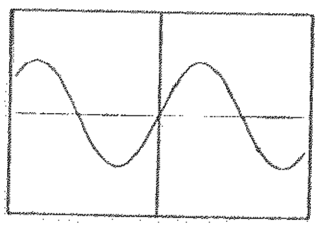
```
Plot :Factor 0.5
:Graph Y=sin X
```

[⇨] [⇨] [⇨] [SHIFT] [INS]
2 [SHIFT] [,]
[SHIFT] [INS] 1

```
Plot :Factor 2,1
.5:Graph Y=sin X
```

Now execute the function.

[EXE]



Using the operations outlined in this section, graphs can be magnified or reduced. In the examples given here, the graphs were magnified and reduced centered around the origin, but any pointer on the display can be used as a central point for magnification and reduction.

3-3 GRAPH FUNCTION APPLICATIONS

Even complex equations can be graphically represented. A number of graphs for the equations will be presented in this section.

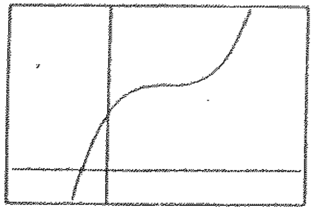
Ex. 1) Draw the graph for the third degree equation, $y=x^3-9x^2+27x+50$.

The range values for the graph are given on the right.

```
Range
Xmin:-5.
 max:10.
 scl:2.
Ymin:-30.
 max:150.
 scl:20.
```

Operation

[SHIFT] [Cls] [EXE]
[Graph] [ALPHA] [X] [x^y] 3 [−] 9 [ALPHA] [X] [x^2] [+]
27 [ALPHA] [X] [+] 50 [EXE]



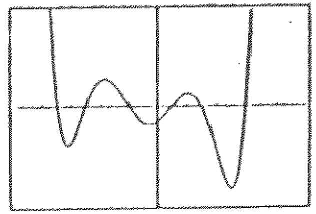
Ex. 2) Draw the graph for the polynomial equation, $y=x^6+4x^5-54x^4-160x^3+641x^2+828x-1260$.

The range values for the graph are given on the right.

```
Range
Xmin:-10.
 max:10.
 scl:2.
Ymin:-8000.
 max:8000.
 scl:2000.
```


Operation

[SHIFT] [Cls] [EXE]
[Graph] [ALPHA] [X] [x^y] 6 [+] 4 [ALPHA] [X] [x^y] 5
[−] 54 [ALPHA] [X] [x^y] 4 [−] 160 [ALPHA] [X] [x^y]
3 [+] 641 [ALPHA] [X] [x^2] [+] 828 [ALPHA] [X] [−]
1260 [EXE]



Ex. 3) Find the maximum and minimum for the equation, $y=x^4+4x^3-36x^2-160x+300$.

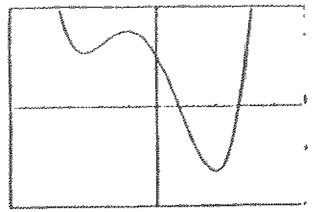
* *If this equation is graphed, the minimum and maximum can be easily understood without differentiation.*

The range values for the graph are given on the right.

```
Range
Xmin:-10.
 max:10.
 scl:2.
Ymin:-600.
 max:600.
 scl:200
```

Operation

[SHIFT] [Cls] [EXE]
[Graph] [ALPHA] [X] [x^y] 4 [+] 4 [ALPHA] [X] [x^y] 3 [−]
36 [ALPHA] [X] [x^2] [−] 160 [ALPHA] [X] [+]
300 [EXE]



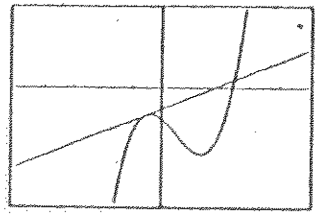
Ex. 4) Determine whether the two graphs for equations, $y=x^3-3x^2-6x-16$ and $y=3x-11$ have a point of tangency.

The range values for the graphs are given on the right.

```
Range
Xmin:-10.
 max:10.
 scl:2.
Ymin:-60.
 max:40.
 scl:10.
```

Operation

[SHIFT] [Cls] [EXE]
[Graph] [ALPHA] [X] [x^y] 3 [−] 3 [ALPHA] [X] [x^2] [−]
6 [ALPHA] [X] [−] 16 [EXE]
[Graph] 3 [ALPHA] [X] [−] 11 [EXE]



3-4 SINGLE VARIABLE STATISTICAL GRAPHS

- Single variable statistical graphs are drawn in the SD2 mode ([SHIFT] [MODE] [×]).
- Bar graphs, line graphs, and normal distribution curves can be produced as single variable statistical graphs.
- Function graphs are also possible in the SD2 mode, so graphs of theoretical values and graphs of actual values can be overwritten.
  ** Abs and √‾ cannot be used in the SD2 mode.*
- Number of data is determined by expanding memories.
- Graphs are drawn with the x-coordinate as the data range and the y-coordinate as the number of items (frequency) of each data.
- The [DT] key ([,]) is used for data input.
- The [CL] key ([x^2]) is used for data correction.

■ Drawing single variable statistical graphs

- Procedure

① Specify the SD2 mode ([SHIFT] [MODE] [×]).
② Set the range values ([Range]).
③ Expand the memory in accordance with the number of bars ([MODE] [·] n [EXE]).
④ Clear the statistical memories ([SHIFT] [Scl] [EXE]).
⑤ Input data (Data [DT] ([,])).
⑥ Draw the graph.
- Bar graph.. [Graph] [EXE]
- Line graph .... [Graph] [SHIFT] [Line] [EXE]
- Normal distribution curve................ [Graph] [SHIFT] [Line] 1 [EXE]

** Data input method in step 5 is the same as that for standard deviation computations (see page 50).*

Ex. Use the following data to draw a ranked graph.

Rank No.	Rank	Frequency
1	0	1
2	10	3
3	20	2
4	30	2
5	40	3
6	50	5
7	60	6
8	70	8
9	80	15
10	90	9
11	100	2

Perform graph preparation in accordance with the following procedure:

① Specify the SD2 mode ([SHIFT] [MODE] [X]).

② Set the range values.

The highest value to be plotted on the x-axis is 100, but for graphing purposes the maximum value (Xmax) is set at 110. (The general rule is that the minimum value should be equal to or greater than the minimum range value and the maximum value should be less than the maximum range value, so here we set the x-axis ranges to 0 through 110.)

Ymax value is set to 20 for the y-axis because the maximum frequency is 15.

```
Range
Xmin:0.
 max:110.
 scl:10.
Ymin:0.
 max:20.
 scl:2.
```

③ Since the number of bars is 11(0～9, 10～19, 20～29, . . . 100～109) expand memories by 11.

[MODE] [·] 11 [EXE]

```
** Defm **

 Program :  0

  Memory :37

  334 Bytes Free
```


④ Clear the statistical memory.

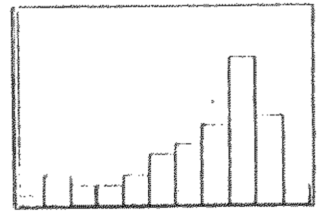
[SHIFT] [Scl] [EXE]

⑤ Input the data.

0 [DT] 10 [DT] [DT] [DT] 20 [DT] [DT] 30 [DT] [DT] 40 [DT] [DT] [DT]
50 [SHIFT] [;] 5 [DT] 60 [SHIFT] [;] 6 [DT] 70 [SHIFT] [;] 8 [DT]
80 [SHIFT] [;] 15 [DT] 90 [SHIFT] [;] 9 [DT] 100 [DT] [DT]

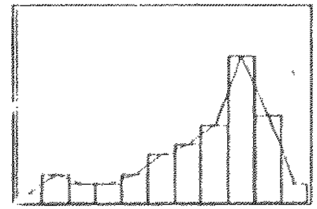
⑥ First, draw a bar graph.

[Graph] [EXE]



Next, overwrite a line graph.

[Graph] [SHIFT] [Line] [EXE]

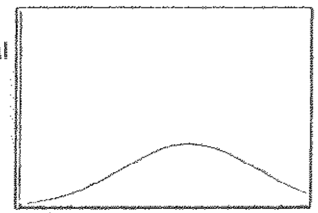


- Finally, draw a normal distribution curve. Since the y-axis value is relatively small when compared with the bar and line graphs, the same range values cannot be used. Change the range values to those shown below.

```
Range
Xmin:0.
 max:110.
 scl:10.
Ymin:0.
 max:0.05
 scl:0.01
```

[Graph] [SHIFT] [Line] 1 [EXE]

Inputting the number 1 causes a normal distribution curve to be drawn.



<Summary>

- Be sure to expand the memory in accordance with the number of bars. A Mem-error is generated if memory expansion is not performed.
- If the number of expanded memories is changed during data input, the number of data divisions also changes, thus making it impossible to produce a proper graph.
- When a value that exceeds the preset ranges is input, it is input to the statistical memory, but not into the graph memory.
- When more data than the preset y-axis range is input, the bar graph is drawn to the upper limit of the display, and the points outside the range cannot be connected.
- The formula used for normal distribution curves is:

$$y = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-\frac{(x-m)^2}{2\sigma^2}}$$

** Keyboard designation of σ is $x\sigma n$, m is $\bar{x}$.*

- The following must be true in the case of range settings: Xmin < Xmax.
- After a bar or line graph is executed, "done" is displayed in the text display.

3-5 PAIRED VARIABLE STATISTICAL GRAPHS

- Paired variable graphs are drawn in the LR2 mode ([SHIFT] [MODE] [÷]).
- Paired variable graphs can be drawn as regression lines.
- Standard function graphs can also be drawn in the LR2 mode, so theoretical graphs, data distribution and regression line graphs can be overwritten.
- After data input in the LR2 mode, points are displayed immediately, and data is input to the statistical memory.
- When a value that exceeds the preset range is input, it is input to the statistical memory, the point is not displayed.
- Data is input using the [DT] ([;]) key in the following format: x data [SHIFT] [,] y data [SHIFT] [;] frequency [DT].
- The [CL] ([ ]) key is used to edit data after input is complete, but points that are produced on the display are not cleared. (Point appears even when data is corrected by the [CL] key).
- Points on the display cannot be retrieved if the display is cleared ([SHIFT] [Cls] [EXE]).

■ Drawing paired variable statistical graphs

- Procedure

(1) Specify the LR2 mode ([SHIFT] [MODE] [÷]).
(2) Set the range values ([Range]).
(3) Clear the statistical memory ([SHIFT] [Scl] [EXE]).
(4) Input data (x data [SHIFT] [,] y data [SHIFT] [;] frequency [DT]).
(5) Draw the graph ([Graph] [SHIFT] [Line] 1 [EXE]).

** Data input method in step 4 is the same as that for Regression computation (Page 52).*

Ex. Perform linear regression on the following data and draw a regression line graph.

x_i	y_i
−9	−2
−5	−1
−3	2
1	3
4	5
7	8