CASIO

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fx-7300G Owner's manual

CASIO

GRAPHICS

fx-7300G

Owner's manual

°C (英)

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GUIDELINES LAID DOWN BY FCC RULES FOR USE OF THE UNIT IN THE U.S.A. (not applicable to other areas).

NOTICE

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Caution : Changes or modification to the product not expressly approved by CASIO could void the user's authority to operate the product.

GRAPHICS
fx-7300G

Contents

Handling Precautions

- Your calculator is made up of precision components. Never try to take it apart.
- Avoid dropping your calculator and subjecting it to other strong impact.
- Do not store the calculator or leave it in areas exposed to high temperatures or humidity, or large amounts of dust. When exposed to low temperatures, the calculator may require more time to display results and may even fail to operate. Correct operation will resume once the calculator is brought back to normal temperature.
- The display will go blank and keys will not operate during calculations. When you are operating the keyboard, be sure to watch the display to make sure that all your key operations are being performed correctly.
- Replace batteries once every 2 years regardless of how much the calculator is used during that period. Never leave dead batteries in the battery compartment. They can leak and damage the unit.
- Avoid using volatile liquids such as thinner or benzine to clean the unit. Wipe it with a soft, dry cloth, or with a cloth that has been dipped in a solution of water and a neutral detergent and wrung out.
- In no event will the manufacturer and its suppliers be liable to you or any other person for any damages, expenses, lost profits, lost savings or any other damages arising out of loss of data and/or formulas arising out of malfunction, repairs, or battery replacement. The user should prepare physical records of data to protect against such data loss.
- Never dispose of batteries, the liquid crystal panel, or other components by burning them.
- When the "Low battery" message appears on the display, replace the batteries as soon as possible.
- Be sure that the power switch is set to OFF when replacing batteries.
- If the calculator is exposed to a strong electrostatic charge, its memory contents may be damaged or the keys may stop working. In such a case, perform the All Reset operation to clear the memory and restore normal key operation.
- Note that strong vibration or impact during program execution can cause execution to stop or can damage the calculator's memory contents.
- Using the calculator near a television or radio can cause interference with TV or radio reception.
- Before assuming malfunction of the unit, be sure to carefully reread this manual and ensure that the problem is not due to insufficient battery power, programming or operational errors.

Important

In no event shall CASIO Computer Co., Ltd. be liable to anyone for special, collateral, incidental, or consequential damages in connection with or arising out of the purchase or use of these materials. Moreover, CASIO Computer Co., Ltd. shall not be liable for any claim of any kind whatsoever against the use of these materials by any other party.

About This Manual.....

This manual is divided into chapters to help you find the operation you want quickly and easily.

Chapter 1 Getting Acquainted

This chapter gives you a general introduction to the various capabilities of the unit. It contains important information about the unit, so you should be sure to read it before starting operation.

Chapter 2 Manual Calculations

Manual calculations are those that you input manually, as on the simplest of calculators. This chapter provides various examples to help you become familiar with manual calculations.

Chapter 3 Statistical Calculations

This chapter tells you how to perform single-variable statistical calculations using standard deviation, and paired-variable statistical calculations using regression.

Chapter 4 Graphing

This chapter explains everything you need to know to fully use the versatile graphing capabilities of the unit.

Chapter 5 Programming

This chapter tells you how to use the program memory of the unit. Once you program a calculation, you can call it up and execute it using any values you want at the touch of a key.

Appendix

The appendix contains information on battery replacement, error messages, specifications, and other technical details.

Important

Reset your calculator before using it for the first time!

See page 144 for details on the reset procedure.

Be sure to keep physical records of all important data!

The large memory capacity of the unit makes it possible to store large amounts of data. You should note, however, that low battery power or incorrect replacement of the batteries that power the unit can cause the data stored in memory to be corrupted or even lost entirely. Stored data can also be affected by strong electrostatic charge or strong impact.

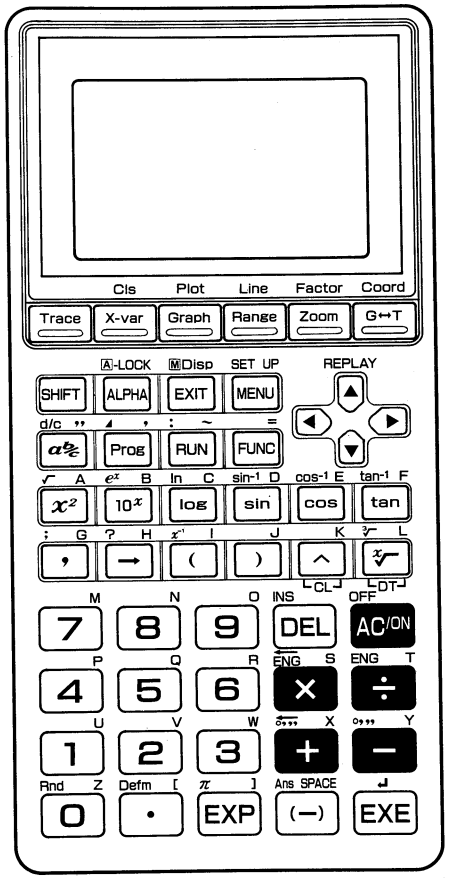
Chapter 1

Getting Acquainted

Chapter 1 Getting Acquainted

This chapter gives you a general introduction to the various capabilities of the unit. It contains important information about the unit, so you should be sure to read it before starting operation.

1-1 Keys and Their Functions



■The Keyboard

Many of the unit's keys are used to perform more than one function. The functions marked on the keyboard are color coded to help you find the one you need quickly and easily.

Shifted function (orange)—**In C**— Alpha function (red)
Primary function—**log**

Also note that green dots on the keyboard indicate the names of menus that appear when [SHIFT] is pressed.

• Primary Functions

These are the functions that are normally executed when you press the key.

• Shifted Functions

You can execute these functions by first pressing the [SHIFT] key, followed by the key that is assigned the shifted function you want to execute.

• Alpha Functions

An alpha function is actually the simple input of an alphabetic letter. Press the [ALPHA] key, followed by the key that is assigned the letter you want to input.

Alpha Lock

Normally, once you press [ALPHA] and then a key to input an alphabetic character, the keyboard reverts to its primary functions immediately. If you press [SHIFT] and then [ALPHA], the keyboard locks in alpha input until you press [ALPHA] again.

■Key Operations

[Trace] Trace Key

•Press this key to cause a pointer to trace along the graph on the display. The x-coordinate and y-coordinate of the current pointer location is also shown.

Cls [X-var] X Variable Input/Clear Screen Key

•Press this key to input the X variable, which is used in graph functions.
•Press [SHIFT] [Cls] [EXE] to clear the graph from the screen. Clearing a graph switches to the text display, which shows the message "done".

Plot [Graph] Graphic/Plot Key

•Press this key before inputting a calculation to be used in drawing a graph. Doing so causes the message "Graph Y=" to appear.
•Press this key following [SHIFT] to cause a pointer (for plotting individual points) to appear on the graphic display.

Line [Range] Range Setting/Line Key

•Press this key to set range parameters or to check current range settings.
•Press this key following [SHIFT] to connect two points plotted on the display with a straight line.

Factor
[Zoom] **Zoom/Factor Key**

- Press this key to zoom in or zoom out on the displayed graph.
- Press this key following [SHIFT] to set a zoom factor or to check the current zoom factor setting.

Coord
[G↔T] **Graphic Display ↔ Text Display/Coordinate Key**

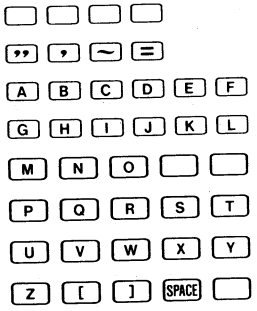
- Press this key to switch between the graphic display and the text display.
- Press this key following [SHIFT] to switch the displayed coordinate value (indicating the Trace function pointer location) between that for the x-coordinate and the y-coordinate.

[SHIFT] **Shift Key**

- Press this key to shift the keyboard and access the functions marked in orange. The [S] indicator flashes on the display to indicate that the keyboard is shifted. Pressing [SHIFT] again unshifts the keyboard and clears the [S] indicator from the display.

A-LOCK
[ALPHA] **Alpha Key**

- Press this key to input a letter marked in red on the keyboard.
- Press this key following [SHIFT] to lock the keyboard into alphabetic character input. To return to normal input, press [ALPHA] again.



M-Disp
[EXIT] **Exit/Mode Display Key**

- Press this key to exit any of the following types of displays:
  - Function menu or set up display
  - Range setting or zoom factor input display
  - Program or graph function input display
- Hold down this key following [SHIFT] to view the current mode settings. The settings remain on the display as long as you keep this key depressed.

SET UP
[MENU] **Menu/Set Up Key**

- Press this key to display the Main Menu.
- Press this key following [SHIFT] while a set up display is shown to change to the set up edit display.

REPLAY

Cursor/Replay Keys

- Use these keys to move the cursor on the display.
- After you press the [EXE] key following input of a calculation or value, press ◀ to display the calculation from the end, or ▶ to display it from the beginning. You can then execute the calculation again, or edit the calculation and then execute it. See page 30 for details on the Replay Function.

d/c
[a b/c] **Fraction Key**

- Use this key when entering fractions and mixed fractions. To enter the fraction 23/45, for example, press 23[a b/c]45. To enter 2-3/4, press 2[a b/c]3[a b/c]4.
- Press this key while a fraction is on the display to convert the fraction to a decimal value.
- Press [SHIFT][a b/c] to display an improper fraction.

[Prog] **Program Command/Output Command Key**

- Press [Prog][0] ~ [9] (any number key from 0 to 9) [EXE] to run a program (page 122).
- Press this key following [SHIFT] to input a "◢" symbol into a program calculation or sequential calculation. This symbol tells the calculator to interrupt execution and display the intermediate calculation result up to that point.

[RUN] **Program Run/Graph/Multi-Statement Key**

- Press this key while the menu of programs is displayed in the PRGM Mode to run the program that is selected.
- Press this key while menu of functions is displayed in the GRAPH Mode to draw the graph for the function that is selected.
- Press this key following [SHIFT] to input a ";" symbol into a program calculation or sequential calculation. This symbol connects two expressions into a single expression called a multi-statement (page 28, 121).

[FUNC] **Function Key**

- Press this key to display a menu of calculator functions.

A
[x^2] **Square/Square Root Key**

- Enter a value and press this key to square the entered value.
- Press [SHIFT][√] and then enter a value to obtain the square root of the value.
- Press this key in the BASE-N Mode to input the hexadecimal value A16.

B
[10^x] **Antilogarithm/Exponential Key**

- Press this key and enter a value to make the value an exponent of 10.
- Press this key following [SHIFT] and then enter a value make the value an exponent of e.
- Press this key in the BASE-N Mode to input the hexadecimal value B16.

C
[log] **Common Logarithm/Natural Logarithm Key**

- Press this key and enter a value to obtain the common logarithm (base 10) of the entered value.
- Press this key following [SHIFT] and then enter a value to obtain the natural logarithm (base e) of the entered value.
- Press this key in the BASE-N Mode to input the hexadecimal value C16.

sin⁻¹ D sin Sine Key

- Press this key and enter a value to obtain the sine for the entered value.
- Press this key following SHIFT and then enter a value to obtain the inverse sine for the entered value.
- Press this key in the BASE-N Mode to input the hexadecimal value D_{16}.

cos⁻¹ E cos Cosine Key

- Press this key and enter a value to obtain the cosine for the entered value.
- Press this key following SHIFT and then enter a value to obtain the inverse cosine for the entered value.
- Press this key in the BASE-N Mode to input the hexadecimal value E_{16}.

tan⁻¹ F tan Tangent Key

- Press this key and enter a value to obtain the tangent for the entered value.
- Press this key following SHIFT and then enter a value to obtain the inverse tangent for the entered value.
- Press this key in the BASE-N Mode to input the hexadecimal value F_{16}.

; G , Comma/Semicolon Key

- Press this key to input a comma.
- Press this key following SHIFT to input a semicolon.

? H → Assign (Store)/Input Command Key

- Use this key to assign a calculation result to a value memory.

Example **To store the result of 12 + 45 to value memory A**

1 2 + 4 5 → ALPHA A EXE

- Press this key following SHIFT to enter the input command, which causes execution of a program or calculation to pause and ask for input of a value.

x⁻¹ I (Open Parenthesis/Reciprocal Key

- Press this key to enter an open parenthesis in a formula.
- Enter a value and then press SHIFT x⁻¹ to calculate the reciprocal of the value.

J) Close Parenthesis

- Press this key to enter a close parenthesis in a formula.

K CL Power/Statistical Data Delete Key

- Input any value for x, press this key, and enter any value for y to raise x to the power of y.
- You can press this key (CL) while in the SD or LR Mode to delete statistical data.

∛ L √ DT Root/Cube Root/Statistical Data Input Key

- Input any value for x, press this key, and enter any value for y to obtain the x root of y.
- Input any value and press this key followed by SHIFT to obtain the cube root of the entered value.
- You can press this key (DT) while in the SD or LR Mode to input statistical data.

Rnd Z 0 ~ 9, Defm [. 10-key Pad

- Use these keys to input values from left to right. Use . to input a decimal point. You can input up to 10 digits.
- Press Rnd following SHIFT to round off the value being used internally for calculations (and the contents of the Ans memory) to 10 digits. If you have made a number of decimal places (page 57) or the number of significant digits (page 57) specification, the internal value is cut off at the specified point. In this case, the internal value becomes identical to the value shown on the display.
- Press Defm following SHIFT to specify an increase in the number of available value memories (page 34). You can increase the number of value memories by up to 26.

INS DEL Delete/Insert Key

- Press this key to delete the character at the current cursor location.
- Press SHIFT INS to display the insert cursor (_). You can insert characters while the insert cursor is displayed.

OFF AC/ON All Clear/ON/OFF Key

- Press this key to switch power on.
- Press this key while power is on to clear the display.
- Press this key following SHIFT to switch power off.

°‴ X °‴ Y ENG S ENG T + − × ÷ Arithmetic Operator Keys

- Use these keys to input arithmetic operators.
- Press − before inputting a value to indicate that the value is negative.
- Input a decimal value and then press SHIFT °‴ to convert the value to its sexagesimal equivalent.
- Input a sexagesimal value and then press SHIFT °‴ to convert the value to its decimal equivalent.
- Input a value and then press SHIFT ENG to raise the exponent of the value by three (10^3 = kilo, 10^6 = mega, 10^9 = giga).
- Input a value and then press SHIFT ENG to reduce the exponent of the value by three (10^{-3} = milli, 10^{-6} = micro, 10^{-9} = nano, 10^{-12} = pico).

π] EXP Exponent/Pi Key

- Use this key when entering a mantissa and exponent. To input 2.56×10^{34}, for example, enter 2.56 EXP 34. Note that the maximum value that can be used for an exponent is ±99. Any value outside this range results in a syntax error (Syn ERROR).
- Press SHIFT π to input the value of π.
- Press this key following ALPHA to enter the closed bracket].

Ans SPACE (−) (−)/Answer/Space Key

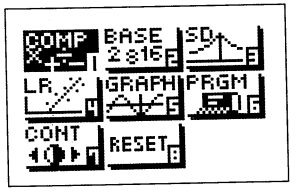
- Press this key when entering a negative value.
- Press SHIFT and then this key to recall the most recent calculation result obtained using the EXE key.
- Press ALPHA and then this key to enter a space.

EXE Execute/Newline Key

- Press this key to obtain the result of a calculation. You can press this key following data input, or after a result is obtained to execute the calculation again using the previous result.
- Press SHIFT EXE to perform a newline operation (page 121).

1-2 Modes

You can control the operations of the unit by entering the correct *mode*. To select the mode you need, select the appropriate icon from the *Main Menu*. The Main Menu appears whenever you press the MENU key.



The icon that is highlighted is the one that is currently *selected*. Use the cursor keys to move the highlighting around the display to select the mode that you want. To enter the highlighted mode, press the EXE key.
In addition to using the cursor keys to select a mode's icon, you can also select a mode by inputting a number. Input the number in the lower right corner of the icon to select the mode you want.
Use only the procedures described above to enter a mode. If you use any other procedure, you may end up in a mode that is different than the one you thought you selected.

The following explains the meaning of each icon in the Main Menu.

COMP Mode
Use this mode for arithmetic calculations and function calculations, for drawing graphs and for executing programs.

BASE Mode
Use this mode for binary, octal, decimal, and hexadecimal calculations and conversions. This mode is also used for logical operations.

SD Mode
Use this mode for single-variable statistical calculations (standard deviation), and for drawing single-variable statistical graphs.

LR Mode
Use this mode for paired-variable statistical calculations (regression).

GRAPH Mode
Use this mode to input functions and draw their graphs.

PRGM Mode
Use this mode to store programs in the program area and to execute programs.

CONT Mode
Use this mode to adjust the display contrast.

RESET Mode
Use this mode to reset the calculator to its initial parameters.

■Set Up Displays

Except for the CONT and RESET Modes, a *set up display* appears first whenever you enter a mode. The set up display shows the current status of settings that are related to the mode you just entered. The set of a mode has an effect on the calculation results it produces.
The following procedure shows how to change the set up of a mode. The displays in these examples show initial settings that are in effect whenever the RESET operation (page 144) is performed.

• To change a set up

Select the COMP Mode icon and press EXE to display the set up display.

```
RUN
COMP
angle    :Deg
display:Norm1
```

Press SHIFT SETUP to switch to the set up edit display.

```
1.GRAPH TYPE
  :RECT
2.DRAW TYPE
  :CONNECT
```

Each item on the set up edit display is identified by a number. Enter the number that corresponds to the mode settings you want to change. When you do, one of the mode setting menus described in the following sections appears.
After making all the changes you want, press EXIT to return to the set up display.

Using the Mode Setting Menus

This section explains how to use the various mode setting menus that appear when you input a number to select a mode setting in the set up edit display. While a mode setting menu is displayed, enter the number that corresponds to the setting you want to make, as described below.

•Graph Type (GRAPH TYPE)

```
GRAPH TYPE
   :RECT

1.RECT
2.INEQ
```

"1. RECT" ..... Rectangular coordinate graph
"2. INEQ" ..... Inequality graph

•Graph Drawing Type (DRAW TYPE)

```
DRAW TYPE
   :CONNECT

1.CONNECT
2.PLOT
```

"1. CONNECT" ... Connection of plotted points
"2. PLOT" ..... No connection of plotted points

•Statistical Graph Drawing (STAT-GRAPH)

```
STAT-GRAPH
   :NON-DRAW

1.DRAW
2.NON-DRAW
```

"1. DRAW" ..... Drawing of graph using single-variable or paired-variable calculation results
"2. NON-DRAW" .... No drawing of graph using single-variable or paired-variable calculation results

•Simultaneous Graphing (SIMUL GRAPH)

```
SIMUL GRAPH
   :OFF

1.ON
2.OFF
```

"1. ON" ..... Simultaneous drawing of graphs for functions stored in graph function memory
"2. OFF" ..... One-by-one drawing of graphs for functions stored in graph function memory

•Graphic Function Display Settings (FUNC DISP)

```
FUNC DISP
   :ON

1.ON
2.OFF
```

"1. ON" ..... Switches on display of the function when drawing a graph or using Trace in the GRAPH Mode.
"2. OFF" ..... Switches display of the function off.

•After you select the PRGM Mode, you can use the set up display to specify the calculation mode (CAL MODE) for program execution.

```
CAL MODE
   :COMP
1.COMP
2.BASE-N
3.SD
4.LR
```

"1. COMP" ..... Computation Mode
"2. BASE-N" ..... Base-*n* Mode
"3. SD" ..... Standard Deviation Mode
"4. LR" ..... Regression Mode

1-3 Function Menus

This calculator is easy to use thanks to a function menu system that lets you select the function you want by simply inputting a number. To display the function menu, simply press the [FUNC] key in any mode. The type of function menu that appears depends on the mode you are in when you press [FUNC].

Example 1

•In the COMP Mode

```
1. CAL
2. DRG
3. DISP
4. MATH
5. PRGM
6. CLEAR
```

The following is a general explanation for the items that make up the various menus.

"1. CAL"
•Select this item to display a menu of calculation commands that can be used in the mode you are in. For details on each calculation command menu, see the sections that explain operations in each mode.

"2. DRG"
•Select this item to display a menu that lets you specify the unit of angular measurement. See page 22 for details.

"3. DISP"
•Select this item to display a menu that lets you specify the number of decimal places, the number of significant digits, and the display format. See page 22 for details.

"4. MATH"
•Select this item to display a menu of mathematical functions that are not printed on the key panel of the calculator. See page 31 for details.

"5. PRGM"
•Select this item to display a menu of special program commands. See page 127 for details.

"6. CLEAR"
•Select this item to display a menu that lets you clear value memory contents (page 25).

Example 2

•In the GRAPH Mode

```
1. GRAPH TYPE
2. SELECT
3. DELETE
```


"1. GRAPH TYPE"
•Select this item to display a menu of graph types. See page 90 for details.

"2. SELECT"
•Select this item to display a menu that lets to specify whether or not the graph of a stored function should be drawn on the screen. See page 95 for details.

"3. DELETE"
•Select this item to display a menu for deleting graph functions. See page 93 for details.

Example 3

•In the PRGM Mode

```
1. DELETE
```

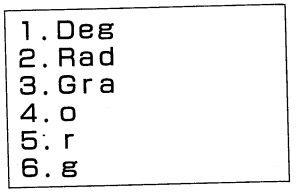
"1. DELETE"
•Select this item to display a menu for deleting programs. See page 123 for details.

1-4 Basic Set Up

This section tells you how to perform basic set up required by the calculator.

■To Specify the Default Unit of Angular Measurement

[2](DRG)



The following are the items that are available from this menu.

"1. Deg" ..... Specifies degrees as the default angular measurement unit.
"2. Rad" ..... Specifies radians as the default angular measurement unit.
"3. Gra" ..... Specifies grads as the default angular measurement unit.
"4. o" ..... Specifies an input value as degrees.
"5. r" ..... Specifies an input value as radians.
"6. g" ..... Specifies an input value as grads.

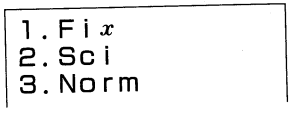
Example **To set the default unit of angular measurement as degrees (Deg).**

[2](DRG)
[1](Deg)[EXE]

- The relationship between the angular measurement unit is shown below.
  $360° = 2\pi$ radians = 400 grads
  $90° = \pi/2$ radians = 100 grads

■About the DISP Menu

[3](DISP)



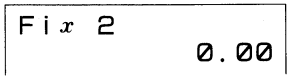
The following are the items that are available from this menu.

"1. Fix" ..... Displays a screen for specification of the number of decimal places.
"2. Sci" ..... Displays a screen for specification of the number of significant digits.
"3. Norm" .... Switches the display format between Norm 1 and Norm 2.

• To specify the number of decimal places

Example **To set the number of decimal places to 2**

[3](DISP)
[1](Fix)[2][EXE]



- With the above setting (two decimal places), all displayed values will be rounded off to two decimal places.
- You can input any single-digit value in the range of 0 to 9 to specify the number of decimal places.
- Note that the number of decimal places setting is cancelled whenever you switch between the Norm 1 and Norm 2 display formats (see page 45).

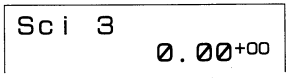
Important

- The specification for the number of decimal places is applied to the displayed value only. The calculator still stores the entire 15-digit mantissa and 2-digit exponent of the result in memory. If you change the number of decimal places specification while a calculation result is displayed, the display changes to show the result using the new specification.

• To specify the number of significant digits

Example **To set the number of significant digits to 3**

[3](DISP)
[2](Sci)[3][EXE]



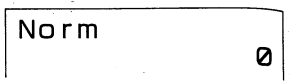
- With the above setting (three significant digits), all displayed values will be shown with three significant digits.
- You can input any single-digit value in the range of 0 to 9 to specify the number of significant digits.
- Specifying 0 sets the number of significant digits to 10. Though the display only shows up to nine significant digits, 10 are used internally.
- Note that the number of significant digits setting is cancelled whenever you switch between the Norm 1 and Norm 2 display formats (see page 45).

Important

- The specification for the number of significant digits is applied to the displayed value only. The calculator still stores the entire 15-digit mantissa and 2-digit exponent of the result in memory. If you change the number of significant digits specification while a calculation result is displayed, the display changes to show the result using the new specification.

• To specify the display format

[3](DISP)
[3](Norm)[EXE]



•The display format switches between Norm 1 and Norm 2 each time you perform the above operation. See page 45 for full details on Norm 1 and Norm 2.

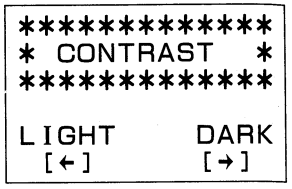
Important

•The specification for the display format is applied to the displayed value only. The calculator still stores the entire 15-digit mantissa and 2-digit exponent of the result in memory. If you change the display format specification while a calculation result is displayed, the display changes to show the result using the new specification.

■To Adjust the Contrast of the Display

Highlight the **CONT** icon on the Main Menu and then press [EXE].

◀ to make the screen lighter
▶ to make the screen darker
[MENU] to return to the Main Menu



Important

If the display remains dim even when you adjust the contrast, you should replace batteries as soon as possible.

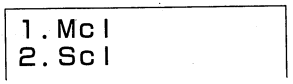
1-5 Basic Operation

The operations described here are fundamental calculations that you need to get started with the unit. Graphing, programming, and statistical calculations are covered in their own separate sections.

■Using the Clear Menu

The Clear Menu lets you clear either the entire memory of the unit or specific parts of the memory.

[6](CLEAR)



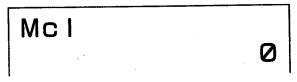
The following are the items that are available from this menu.
"1. Mcl" ..... Clears all value memory contents.
"2. Scl" ..... Clears only statistical memory contents.

Important

•The procedures described below cannot be undone. Make sure that you do not need data any more before you delete it.
•You can call up the Clear Menu while the unit is in any mode.

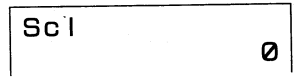
• To clear the entire memory

[6](CLEAR)
[1](Mcl)[EXE]



• To clear statistical memories only

[6](CLEAR)
[2](Scl)[EXE]



•This operation clears any values assigned to Σx^2, Σx, n, Σy^2, Σy, and Σxy.
•The above operation clears bar graph memory (extra value memory) contents when the STAT-GRAPH mode is set to **DRAW** for single variable statistics (SD Mode).

■Inputting Calculations

When you are ready to input a calculation, first press [AC] to clear the display. Next, input your calculation formulas exactly as they are written, from left to right, and press [EXE] to obtain a result.

Example $2(5+4)\div(4\times3)=$

[AC] [2] [(] [5] [+] [4] [)] [÷] [(] [4] [×] [3] [)] [EXE]

```
2(5+4)÷(4×3)
          1.5
```

The unit uses two types of functions: Type A functions and Type B functions. With Type A functions, you press the function key after you enter a value. With Type B functions, you press the function key first and then enter a value.

Example 1 **(Type A function)**

	Example	Key Operation
Square:	4^2	[4] [x^2]

Example 2 **(Type B function)**

	Example	Key Operation
Sine:	2 sin45°	[2] [sin] [4] [5]

•For detailed examples on all of the possible calculations available, see the section titled "Calculation Priority Sequence" on page 42.

• To clear an entire calculation and start again

Press the [AC] key to clear the error along with the entire calculation. Next, re-input the calculation from the beginning.

■Editing Calculations

Use the [◀] and [▶] keys to move the cursor to the position you want to change, and then perform one of the operations described below. After you edit the calculation, you can execute it by pressing [EXE].

• To change a step

Example **To change cos60 to sin60**

[cos] [6] [0]

```
cos 60_
```

[◀] [◀] [◀]

```
cos 60
```

[sin]

```
sin 60
```


• To delete a step

Example **To change $36\times\times2$ to 36×2**

[3] [6] [×] [×] [2]

```
36××2_
```

[◀] [◀] [DEL]

```
36×2
```

• To insert a step

Example **To change 2^2 to $\sin2^2$**

[2] [x^2]

```
2²_
```

[◀] [◀]

```
2²
```

[SHIFT] [INS]

```
2²
```

[sin]

```
sin 2²
```

•When you press [SHIFT] [INS] a space is indicated by the symbol "[ ]". The next function or value you input is inserted at the location of "[ ]". To abort the insert operation without inputting anything, move the cursor, press [SHIFT] [INS] again, or press [EXE].

• To make corrections in the original calculation

Example **$14\div0\times2.3$ entered by mistake for $14\div10\times2.3$**

[AC] [1] [4] [÷] [0] [×] [2] [•] [3] [EXE]

```
14÷0×2.3
    Ma  ERROR
```

Press [◀] or [▶].

```
14÷0×2.3
```

Cursor is positioned automatically at the location of the cause of the error.

Make necessary changes.
[◀] [SHIFT] [INS] [1]

```
14÷10×2.3
```

Execute it again.
[EXE]

```
14÷10×2.3
         3.22
```

■Answer Function

The unit's Answer Function automatically stores the last result you calculated by pressing [EXE] (unless the [EXE] key operation results in an error). The result is stored in the answer memory.

• To recall the contents of the answer memory

[SHIFT] [Ans] [EXE]

• To use the contents of the answer memory in a calculation

Example 123 + 456 = 579
789 − 579 = 210

[AC] [1] [2] [3] [+] [4] [5] [6] [EXE]

```
123+456
          579
```

[7] [8] [9] [−] [SHIFT] [Ans] [EXE]

```
789−Ans
          210
```

- The largest value that the answer memory can hold is one with 15 digits for the mantissa and 2 digits for the exponent.
- Answer memory contents are not cleared when you press the [AC] key or when you switch power off.
- Note that answer memory contents are not changed by an operation that assigns values to value memory (such as: [5] [→] [ALPHA] [A] [EXE]).

■Using Multistatements

Multistatements are formed by connecting a number of individual statements for sequential execution. You can use multistatements in manual calculations and in programmed calculations. There are three different ways that you can use to connect statements to form multistatements.

•Colon (:)

Statements that are connected with colons are executed from left to right, without stopping.

•Display Result Command (◢)

When execution reaches the end of a statement followed by a display result command, execution stops and the result up to that point appears on the display. You can resume execution by pressing the [EXE] key.

• To use multistatements

Example 6.9 × 123 = 848.7
123 ÷ 3.2 = 38.4375

[AC] [1] [2] [3] [→] [ALPHA] [A] [SHIFT] [:]
[6] [•] [9] [×] [ALPHA] [A] [SHIFT] [◢]
[ALPHA] [A] [÷] [3] [•] [2] [EXE]

```
123→A:6.9×A◢
A÷3.2
          848.7
       - Disp -
```

[EXE]

```
123→A:6.9×A◢
A÷3.2
          848.7
       38.4375
```

- Note that the final result of a multistatement is always displayed, regardless of whether it ends with a display result command.
- You cannot construct a multistatement in which one statement directly uses the result of the previous statement.

Example 123 × 456 : × 5
Invalid

■Multiplication Operations without a Multiplication Sign

You can omit the multiplication sign (×) in any of the following operations.

- Before Type B functions (page 42) and coordinate transformation functions:

Example 2sin30, 2√3, etc.

- Before constants, variable names, value memory names

Example 2π, 2AB, 3Ans, etc.

- Before an open parenthesis

Example 3(5 + 6), (A + 1)(B − 1), etc.

■Performing Continuous Calculations

The unit lets you use the result of one calculation as one of the arguments in the next calculation. The precision of such calculations is 12 digits (for the mantissa).

Example 1 ÷ 3 = **(continuing)** × 3 =

[AC] [1] [÷] [3] [EXE]

```
1÷3
 0.3333333333
```

(Continuing) [×] [3] [EXE]

```
Ans×3
                1
```

Continuous calculations can also be used with Type A functions (see page 42).

■Using the Replay Function

The Replay Function automatically stores the last calculation performed in replay memory. You can recall the contents of the replay memory by pressing ◀ or ▶. If you press ▶, the calculation appears with the cursor at the beginning. Pressing ◀ causes the calculation to appear with the cursor at the end. You can make changes in the calculation as you wish and then execute it again.

Example **To perform the following two calculations**
4.12 × 6.4 = 26.368
4.12 × 7.1 = 29.252

[AC] [4] [·] [1] [2] [×] [6] [·] [4] [EXE]

```
4.12×6.4
          26.368
```

[◀] [◀] [◀] [◀]

```
4.12×6.4
```

[7] [·] [1]

```
4.12×7.1_
```

[EXE]

```
4.12×7.1
          29.252
```

- The maximum capacity of the replay memory is 127 bytes.
- The last calculation performed is retained in replay memory, even when you press [AC]. This means you can clear the display using [AC] and then use the Replay Function to recall the last calculation.
- Note that replay memory is cleared whenever you press [EXE] to select a mode in the Main Menu.

■Built-in Scientific Functions

In addition to the scientific functions that you can access directly from the keyboard, this calculator also provides a selection of other built-in functions. Use the MATH Menu to access these built-in functions.

• To call up the MATH Menu

[FUNC] [4] (MATH)

```
1. HYP
2. NUM
3. PROB
4. COORD
```

Enter the number to call up the sub-menu that contains the type of operation you want to perform.

- **"1. HYP"** ..... Hyperbolic Function Menu for hyperbolic and inverse hyperbolic functions
- **"2. NUM"** ..... Numeric Function Menu for absolute value calculations, integer and decimal part extractions
- **"3. PROB"** ..... Probability Function Menu for factorials, permutations, combinations, and random numbers
- **"4. COORD"** ..... Coordinate Function Menu for rectangular and polar coordinate transformations

• To use the Hyperbolic Function Menu

[1] (HYP)

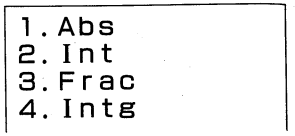
```
1. sinh
2. cosh
3. tanh
4. sinh⁻¹
5. cosh⁻¹
6. tanh⁻¹
```

The following are the items that are available from this menu.

- **"1. sinh"** ..... hyperbolic sine
- **"2. cosh"** ..... hyperbolic cosine
- **"3. tanh"** ..... hyperbolic tangent
- **"4. sinh^{-1}"** ..... inverse hyperbolic sine
- **"5. cosh^{-1}"** ..... inverse hyperbolic cosine
- **"6. tanh^{-1}"** ..... inverse hyperbolic tangent

• To use the Numeric Function Menu

[2](NUM)

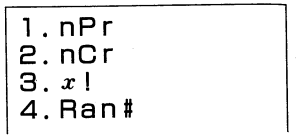


The following are the items that are available from this menu.

"1. Abs" ..... absolute value
"2. Int" ..... integer extraction
"3. Frac" ..... fraction extraction
"4. Intg" ..... maximum value that does not exceed argument

• To use the Probability Function Menu

[3](PROB)

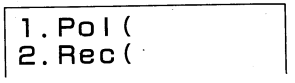


The following are the items that are available from this menu.

"1. *n*Pr" ..... permutation
"2. *n*Cr" ..... combination
"3. *x*!" ..... factorial of x
"4. Ran#" ..... random number generation

• To use the Coordinate Function Menu

[4](COORD)



The following are the items that are available from this menu.

"1. Pol (" ..... transformation of rectangular coordinates to polar coordinates
"2. Rec (" ..... transformation of polar coordinates to rectangular coordinates

■Value Memories

This calculator comes with 26 value memories as standard (which can be expanded up to 50). You can use value memories to store values to be used inside of calculations. The maximum size of values that you can assign to value memories is 15 digits for the mantissa and 2 digits for the exponent. Value memory contents are retained even when you switch power off.

Important

•Some value memories are used by the unit for certain types of calculations. Note the following.

Type of Calculation	Value Memories Used
Coordinate Conversion	I, J
Single-Variable Statistics	U, V, W
Paired-Variable Statistics	P, Q, R, U, V, W

Note that you cannot assign values to the value memories named in the "Value Memories Used" column when you are performing a coordinate conversion or statistical calculation. You should also clear these value memories before starting coordinate conversion or statistical calculations. Be especially careful during programmed calculations to avoid problems caused by values mistakenly assigned to memories that are used by the calculator.

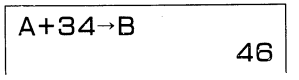
• To assign a value to a value memory

Example **To assign 12 to value memory A**

AC 1 2 → ALPHA A EXE

Example **To add 34 to value memory A and store the result in value memory B**

AC ALPHA A + 3 4 → ALPHA B EXE



• To display the contents of a value memory

Example **To display the contents of value memory A**

AC ALPHA A EXE

• To clear a value memory

Example **To clear value memory A**

AC 0 → ALPHA A EXE

• To clear all value memory contents

[FUNC] [6] (CLEAR) [1] (Mcl) [EXE]

```
Mc l
                    0
```

• To assign the same value to multiple value memories

Example **To assign the value 10 to value memories A through F**

[AC] [1] [0] [→] [SHIFT] [ALPHA] [A] [~] [F] [EXE]

```
10→A~F
                   10
```

■Increasing the Number of Value Memories

Though 26 value memories are provided as standard, you can configure the memory of the unit to increase the number of value memories and decrease the amount of program memory. Each additional value memory takes up ten bytes of program memory.

Number of Value Memories	26	27	28	.....	50
Number of Program Memory Bytes	500	490	480	.....	0

The maximum number of value memories possible is 50 (an increase of 24).

Important

- You may not be able to increase the number of value memories to the level you want if the memory already contains programs, or statistical data. If there is not enough unused memory available to increase to the number you specify, an error message will appear on the display.
- The [SHIFT] [Defm] specification can also be included within a program.

• To increase the number of value memories

Example **To increase the number of value memories by 10 (for a total of 26 + 10 = 36)**

[SHIFT] [Defm] [1] [0] [EXE]

```
MEMORY STATUS
MEMORY  : 36
PROGRAM:  0
GRAPH   :  0

400bytes free
```


• To check the current memory status

[SHIFT] [Defm] [EXE]

• To initialize the number of value memories

[SHIFT] [Defm] [0] [EXE]

```
MEMORY STATUS
MEMORY  : 26
PROGRAM:  0
GRAPH   :  0

300bytes free
```

■About Memory Names

You can use the additional memories you create from program memory just as you use the original 26. The names of the additional memories are Z[1], Z[2], Z[3], etc. If you increase the number of value memories by 5, you can access the original 26 memories, plus memories Z[1] through Z[5].

1-6 Using the BASE Mode

You can use the BASE Mode to perform calculations with binary, octal, decimal and hexadecimal values. You should also use this mode to convert between number systems and for logical operations.

- You cannot use scientific functions in the BASE Mode.
- You can use only integers in the BASE Mode, so fractional values are not allowed. If you input a value that includes a decimal part, the unit automatically cuts off the decimal.
- If you attempt to enter a value that is invalid in the number system (binary, octal, decimal, hexadecimal) you are using, the calculator displays an error message. The following shows the numerals that can be used in each number system.
  Binary: 0, 1
  Octal: 0, 1, 2, 3, 4, 5, 6, 7
  Decimal: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
  Hexadecimal: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F
- The alphabetic characters used in the hexadecimal number appear differently on the display to distinguish them from text characters.
  Normal Text: A, B, C, D, E, F
  Hexadecimal Values: A, B, C, D, E, F
- Negative binary, octal, and hexadecimal values are produced using the two's complement of the original value.
- The following are the display capacities for each of the number systems.

Number System	Display Capacity
Binary	16 digits
Octal	11 digits
Decimal	10 digits
Hexadecimal	8 digits

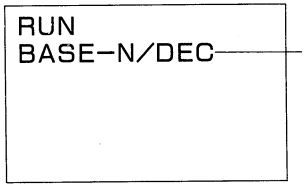
- The following are the calculation capacities for each of the number systems.

Calculation Ranges in BASE Mode
Binary Values
  Positive : $0 \leqq x \leqq 011111111111$
  Negative : $100000000000 \leqq x \leqq 111111111111$
Octal Values
  Positive : $0 \leqq x \leqq 17777777777$
  Negative : $20000000000 \leqq x \leqq 37777777777$
Decimal Values
  Positive : $0 \leqq x \leqq 2147483647$
  Negative : $-2147483648 \leqq x \leqq -1$
Hexadecimal Values
  Positive : $0 \leqq x \leqq 7FFFFFFF$
  Negative : $80000000 \leqq x \leqq FFFFFFFF$

- The BASE Mode can handle integers only. They cannot handle values that include decimal parts or exponents.
- Mathematical functions cannot be used in the BASE Mode.
- The decimal part of a BASE Mode calculation result, if present, is automatically cut off.

• To enter the BASE Mode

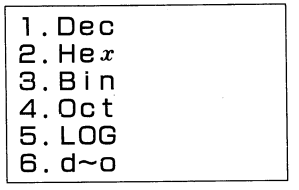
Highlight the **BASE** icon on the Main Menu and press [EXE] to enter the BASE Mode.



• BASE Mode CAL Menu

In the BASE Mode, press [FUNC] [1] (CAL) to display the BASE Mode CAL Menu.

[FUNC] [1] (CAL)



The following are the items that are available from this menu.
- **"1. Dec"** ..... decimal (default)
- **"2. Hex"** ..... hexadecimal (default)
- **"3. Bin"** ..... binary (default)
- **"4. Oct"** ..... octal (default)
- **"5. LOG"** ..... Menu of logical operations
- **"6. d~o"** ..... Menu of number systems (single value)

• To set the default BASE Mode number system

Example **To convert 22_D to its binary and octal equivalents.**

AC FUNC 1 (CAL) 1 (Dec) EXE
2 2 EXE

```
Dec
                    0
22
                   22
```

FUNC 1 (CAL) 3 (Bin) EXE

```
Bin
 000000010110
```

FUNC 1 (CAL) 4 (Oct) EXE

```
Oct
   00000000026
```

• To input values of mixed number systems

You can also specify the number system for each value you input. To do so, you must use the following procedure to display the CAL menu for the BASE Mode, and then input 6 (d~o) to display the menu of number systems for individual values.

FUNC 1 (CAL)
6 (d~o)

```
1.d
2.h
3.b
4.o
```

The following are the items that are available from this menu.

- **"1. d"** ..... decimal
- **"2. h"** ..... hexadecimal
- **"3. b"** ..... binary
- **"4. o"** ..... octal

Example **To convert 123_D and 1010_B to their hexadecimal equivalents.**

AC FUNC 1 (CAL) 2 (Hex) EXE
FUNC 1 (CAL) 6 (d~o) 1 (d)
1 2 3 EXE

```
Hex
        00000000
d123
        0000007B
```

FUNC 1 (CAL) 6 (d~o) 3 (b)
1 0 1 0 EXE

```
b1010
        0000000A
```


• To perform arithmetic operations

Example $10111_B + 11010_B$

AC FUNC 1 (CAL) 3 (Bin) EXE
1 0 1 1 1 + 1 1 0 1 0
EXE

```
Bin
 000000000000
10111+11010
 000000110001
```

Example $123_O \times ABC_H$

AC FUNC 1 (CAL) 1 (Dec) EXE
FUNC 1 (CAL) 6 (d~o) 4 (o)
1 2 3 × FUNC 1 (CAL) 6 (d~o)
2 (h) A B C EXE

```
Dec
                    0
o123×hABC
       228084
```

FUNC 1 (CAL) 2 (Hex) EXE

```
Hex
        00037AF4
```

• To input logical operators

Use the following procedure to display the CAL menu for the BASE Mode, and then input 5 (LOG) to display the menu of logical operators.

FUNC 1 (CAL)
5 (LOG)

```
1.Neg
2.Not
3.and
4.or
5.xor
6.xnor
```

The following are the items that are available from this menu.

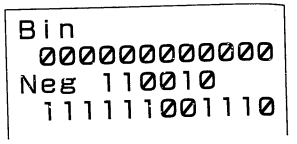
- **"1. Neg"** ..... negation
- **"2. Not"** ..... NOT
- **"3. and"** ..... AND
- **"4. or"** ..... OR
- **"5. xor"** ..... XOR
- **"6. xnor"** ..... XNOR

• To obtain a two's complement

The following procedure can be used to obtain the two's complement of a binary, octal, or hexadecimal value.

Example **To obtain the two's complement for 110010_B.**

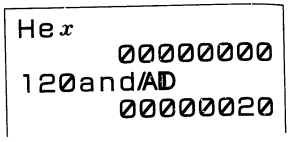
AC FUNC 1 (CAL) 3 (Bin) EXE
FUNC 1 (CAL) 5 (LOG) 1 (Neg)
1 1 0 0 1 0 EXE



• To perform logical operations

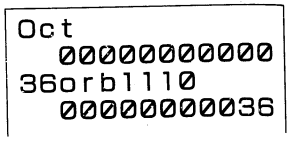
Example **120_H AND AD_H**

AC FUNC 1 (CAL) 2 (Hex) EXE
1 2 0 FUNC 1 (CAL) 5 (LOG)
3 (and) A D EXE



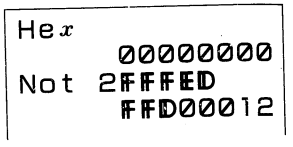
Example **36_O OR 1110_B (octal result)**

AC FUNC 1 (CAL) 4 (Oct) EXE
3 6 FUNC 1 (CAL) 5 (LOG)
4 (or) FUNC 1 (CAL) 6 (d ~ o)
3 (b) 1 1 1 0 EXE



Example **NOT $2FFFED_H$**

AC FUNC 1 (CAL) 2 (Hex) EXE
FUNC 1 (CAL) 5 (LOG) 2 (Not)
2 F F F E D EXE



1-7 Graphic and Text Displays

The COMP, SD and LR modes use both a graphic display and a text display. The graphic display is used for graphics, while the text display is used for calculations and instructions. The contents of each type of display are stored in independent memory areas.

• To switch between the graphic display and text display

Press the G↔T key. You should also note that the key operations used to clear each type of display are different.

• To clear the graphic display

Press SHIFT CLS EXE.

• To clear the text display

Press AC.

If you press AC while in the graphic display, the calculator clears the display and automatically switches to the text display. Though the graphic display is cleared, it remains in memory, so you can return the graph to the display by pressing G↔T.

1-8 Technical Information

This section provides information on the internal workings of the unit.

■Calculation Priority Sequence

This calculator employs true algebraic logic to calculate the parts of a formula in the following order:

①Coordinate transformation
Pol (x, y), Rec (r, θ)

②Type A functions
With these functions, the value is entered and then the function key is pressed.
x^2, x^{-1}, $x!$, °' ''

③Power/root
$\wedge(x^y)$, $\sqrt[x]{\ }$

④Fractions
$a^b/_c$

⑤Abbreviated multiplication format in front of π, memory or parenthesis
2π, 5A, πR, etc.

⑥Type B functions
With these functions, the function key is pressed and then the value is entered.
$\sqrt{\ }$, $\sqrt[3]{\ }$, log, ln, e^x, 10^x, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, (−), parenthesis, (following in BASE Mode only) d, h, b, o, Neg, Not

⑦Abbreviated multiplication format in front of Type B functions
$2\sqrt{3}$, A log2, etc.

⑧Permutation, combination
nPr, nCr

⑨×, ÷

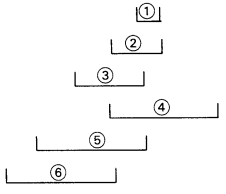
⑩+, −

⑪and
⑫or, xor, xnor
] BASE Mode only

•When functions with the same priority are used in series, execution is performed from right to left.
$e^{x}\ln\sqrt{120} \rightarrow e^{x}\{\ln(\sqrt{120})\}$
Otherwise, execution is from left to right.

•Anything contained within parentheses receives highest priority.

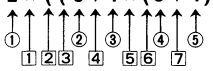
Example $2+3\times(\log \sin 2\pi^2 + 6.8) = 22.07101691$ (angle unit = Rad)



■Stacks

The unit employs memory blocks, called *stacks*, for storage of low priority values and commands. There is a 10-level *numeric value stack*, a 26-level *command stack*, and a 10-level *program subroutine stack*. If you execute a formula so complex it exceeds the amount of stack space available, an error message appears on the display (Stk ERROR during calculations or Ne ERROR during execution of a program subroutine).

Example $2\times((3+4\times(5+4)\div3)\div5)+8=$



Numeric Value Stack

①	2
②	3
③	4
④	5
⑤	4
⋮	

Command Stack

1	×
2	(
3	(
4	+
5	×
6	(
7	+
⋮	

•Calculations are performed according to the priority sequence described on page 42. Once a calculation is executed, it is cleared from the stack.

■Value Input and Output Limitations

The allowable range for both input and output values is 10 digits for the mantissa and 2 digits for the exponent. Internally, however, the unit performs calculations using 15 digits for the mantissa and 2 digits for the exponent.

Example $3\times10^5\div7-42857=$

AC 3 EXP 5 ÷ 7 EXE

3 EXP 5 ÷ 7 − 4 2 8 5 7 EXE

```
3E5÷7
   42857.14286
3E5÷7-42857
  0.1428571428
```

•Calculation results that are greater than 10^{10} (10 billion) or less than 10^{-2} (0.01) are automatically displayed in exponential form.

■Input Capacity

This unit has a 127-byte area for execution of calculations. Each time you press a numeric key or arithmetic operation key, one byte of memory is used.
Even key operations that require more than one key operation (like SHIFT $\sqrt{x}$) require only one byte.

A calculation can consist of up to 127 bytes. After you input 122nd byte of any calculation, the cursor changes from "_" to "■" on the display to let you know that you are running out of memory. If you still need to input more, you should divide your calculation into two or more parts.

Note:
- As you input numeric values or commands, they appear flush left on the display. Calculation results, on the other hand, are displayed flush right.

■Overflow and Errors

Exceeding a specified input or calculation range, or attempting an illegal input causes an error message to appear on the display. Further operation of the calculator is impossible while an error message is displayed. The following events cause an error message to appear on the display.

- When any result, whether intermediate or final, or any value in memory exceeds $\pm 9.999999999 \times 10^{99}$ (Ma ERROR)
- When an attempt is made to perform a function calculation that exceeds the input range (Ma ERROR) (see page 154)
- When an illegal operation is attempted during statistical calculations (Ma ERROR)
  For example, attempting to obtain $\bar{x}$ or $x\sigma n$ without data input.
- When the capacity of the numeric value stack or command stack is exceeded (Stk ERROR)
  For example, entering 25 successive (, followed by 2+3×4EXE.
- When an attempt is made to perform a calculation using an illegal formula (Syn ERROR)
  For example, 5××EXE.
- When an illegal memory specification is made (Mem ERROR)
- When an illegal command or function argument is used (Arg ERROR)

Notes:
- Further operation becomes impossible whenever an error message appears on the display to indicate an error. To clear the error and return to normal operation, press AC.
- Other errors can occur during program execution. See page 152 for details.

■Exponential Display

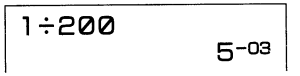
During normal calculation, the unit is capable of displaying up to 10 digits. Values that exceed this limit, however, are automatically displayed in exponential format. You can choose between 2 different types of exponential display formats.

Norm 1: $10^{-2}(0.01) > |x|, |x| \geqq 10^{10}$

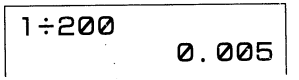
Norm 2: $10^{-9}(0.000000001) > |x|, |x| \geqq 10^{10}$

You can select between Norm 1 and Norm 2 using the Display Mode (page 24). Pressing SHIFT MDisp displays the current mode settings.

AC 1 ÷ 200 EXE →



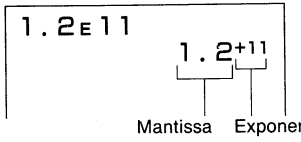
(Norm 1 display format)



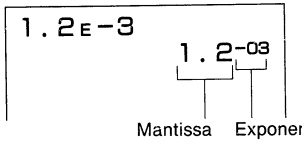
(Norm 2 display format)

(All of the examples in this manual show calculation results using Norm 1.)

How to interpret exponential format



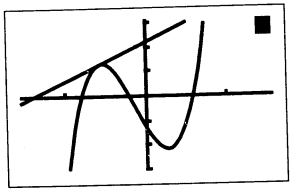
1.2^{+11} indicates that the result is equivalent to 1.2×10^{11}. This means that you should move the decimal point in 1.2 eleven places to the right, because the exponent is positive. This results in the value 120,000,000,000.



1.2^{-03} indicates that the result is equivalent to 1.2×10^{-3}. This means that you should move the decimal point in 1.2 three places to the left, because the exponent is negative. This results in the value 0.0012.

■Calculation Execution Display

When the calculator is busy drawing a graph or executing a long, complex calculation or program, a black box (■) flashes in the upper right corner of the display. This black box indicates that the calculator is performing an internal operation.



■When Errors Keep Occurring...

If you find that errors keep occurring when you try to perform an operation, use the following procedure to bring the calculator back to its initial settings and try again.

(1) Press [MENU] to display the Main Menu.
(2) Use the cursor keys to highlight the COMP icon and then press [EXE].
(3) Press [FUNC][2](DRG)[1](Deg)[EXE] to set degrees as the angular unit.
(4) Press [FUNC][3](DISP)[3](Norm)[EXE] to set Norm 1 as the display format.

Chapter 2

Manual Calculations

Chapter 2 Manual Calculations

Manual calculations are those that you input manually, as on the simplest of calculators. They are to be distinguished from programmed calculations. This chapter provides various examples to help you become familiar with the manual calculation capabilities of the unit.

2-1 Arithmetic Calculations

- Enter arithmetic calculations as they are written, from left to right.
- Use the (−) key to input the minus sign before a negative value.
- Calculations are performed internally with a 15-digit mantissa. The display is rounded to a 10-digit mantissa before it is displayed.

Example	Operation	Display
$23+4.5-53=-25.5$	23 + 4.5 − 53 EXE	−25.5
$56\times(-12)\div(-2.5)=268.8$	56 × (−) 12 ÷ (−) 2.5 EXE	268.8
$12369\times7532\times74103=6.90368061\times10^{12}$ (6903680610000)	12369 × 7532 × 74103 EXE	6.90368061^{+12}
$(4.5\times10^{75})\times(-2.3\times10^{-79})=-1.035\times10^{-3}$ (−0.001035)	4.5 EXP 75 × (−) 2.3 EXP (−) 79 EXE	-1.035^{-03} (Norm 1 display format)
$(2+3)\times10^{2}=500$	(2 + 3) × 1 EXP 2 EXE	500
• (2 + 3) EXP 2 does not produce the correct result. Be sure to enter this calculation as shown.		

- For mixed arithmetic calculations, multiplication and division are given priority over addition and subtraction.

Example	Operation	Display
$3+5\times6=33$	3 + 5 × 6 EXE	33
$7\times8-4\times5=36$	7 × 8 − 4 × 5 EXE	36
$1+2-3\times4\div5+6=6.6$	1 + 2 − 3 × 4 ÷ 5 + 6 EXE	6.6

Calculations Using Parentheses

Example	Operation	Display
$100-(2+3)\times4=80$	100 − (2 + 3) × 4 EXE	80
$2+3\times(4+5)=29$	2 + 3 × (4 + 5 EXE	29
• The final closed parentheses (immediately before operation of the EXE key) may be omitted, no matter how many are required.		
$(7-2)\times(8+5)=65$	(7 − 2) (8 + 5 EXE	65
• A multiplication sign immediately before an open parenthesis may be omitted.		
$10-\{2+7\times(3+6)\}=-55$	10 − (2 + 7 (3 + 6 EXE	−55
• In this manual, the multiplication sign is always shown.		
$\frac{2\times3+4}{5}=(2\times3+4)\div5=2$	(2 × 3 + 4) ÷ 5 EXE	2
$\frac{6}{4\times5}=0.3$	6 ÷ (4 × 5) EXE	0.3
• The above is identical to 6 ÷ 4 ÷ 5 EXE.		

2-2 Units of Angular Measurement

- See page 22 for full details on specifying the unit of angular measurement.
- Once you specify a unit of angular measurement, it remains in effect until you specify a different one. The specification is retained even if you switch power off.
- The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
Result displayed in degrees. To convert 4.25 rad to degrees.	[FUNC][2](DRG)[1](Deg)[EXE] **4.25**[FUNC][2](DRG)[5](r)[EXE]	**243.5070629**
$47.3° + 82.5\text{rad} = 4774.20181°$	**47.3**[+]**82.5**[FUNC][2](DRG) [5](r)[EXE]	**4774.20181**

2-3 Trigonometric and Inverse Trigonometric Functions

- Be sure to set the unit of angular measurement before performing trigonometric function and inverse trigonometric function calculations.
- The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
$\sin 63°52'41'' = 0.897859012$	[FUNC][2](DRG)[1](Deg)[EXE] [sin]**63**[SHIFT][°'''] **52**[SHIFT][°'''] **41**[SHIFT][°'''][EXE]	**0.897859012**
$\cos\left(\frac{\pi}{3}\text{ rad}\right) = 0.5$	[FUNC][2](DRG)[2](Rad)[EXE] [cos][(][SHIFT][π][÷]**3**[)][EXE]	**0.5**
$\tan(-35\text{gra}) = -0.6128007881$	[FUNC][2](DRG)[3](Gra)[EXE] [tan][(−)]**35**[EXE]	**−0.6128007881**
$2\cdot\sin 45° \times \cos 65° = 0.5976724775$	[FUNC][2](DRG)[1](Deg)[EXE] **2**[×][sin]**45**[×][cos]**65**[EXE] ↑ ↑ Can be omitted.	**0.5976724775**

2-4 Logarithmic and Exponential Functions

- The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
$\log 1.23$ ($\log_{10}1.23$) = $8.99051114 \times 10^{-2}$	[log]**1.23**[EXE]	**0.0899051114**
$\ln 90$ ($\log 90$) = 4.49980967	[SHIFT][ln]**90**[EXE]	**4.49980967**
$10^{1.23} = 16.98243652$ (To obtain the antilogarithm of common logarithm 1.23)	[10^x]**1.23**[EXE]	**16.98243652**
$e^{4.5} = 90.0171313$ (To obtain the antilogarithm of natural logarithm 4.5)	[SHIFT][e^x]**4.5**[EXE]	**90.0171313**
$10^4 \cdot e^{-4} + 1.2 \cdot 10^{2.3} = 422.5878667$	[10^x]**4**[×][SHIFT][e^x][(−)]**4**[+] **1.2**[×][10^x]**2.3**[EXE]	**422.5878667**
$(-3)^4 = (-3)\times(-3)\times(-3)\times(-3) = 81$	[(][(−)]**3**[)][^]**4**[EXE]	**81**
$-3^4 = -(3\times3\times3\times3) = -81$	[(−)]**3**[^]**4**[EXE]	**−81**
$5.6^{2.3} = 52.58143837$	**5.6**[^]**2.3**[EXE]	**52.58143837**
$\sqrt[7]{123}$ ($= 123^{\frac{1}{7}}$) $= 1.988647795$	**7**[$\sqrt{\ }$]**123**[EXE]	**1.988647795**

2-5 Hyperbolic and Inverse Hyperbolic Functions

•The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
$\sinh 3.6 = 18.28545536$	FUNC 4(MATH) 1(HYP) 1(sinh) 3.6 EXE	**18.28545536**
$\cosh^{-1}\left(\frac{20}{15}\right) = 0.7953654612$	FUNC 4(MATH) 1(HYP) 5($\cosh^{-1}$)(20 ÷ 15) EXE	**0.7953654612**
Determine the value of x when $\tanh 4x = 0.88$ $x = \frac{\tanh^{-1}0.88}{4}$ $= 0.3439419141$	FUNC 4(MATH) 1(HYP) 6($\tanh^{-1}$) 0.88 ÷ 4 EXE	**0.3439419141**

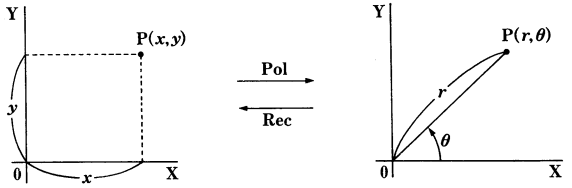
2-6 Other Functions

•The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
$\sqrt{2}+\sqrt{5} = 3.65028154$	SHIFT √ 2 + SHIFT √ 5 EXE	**3.65028154**
$(-3)^2 = (-3)\times(-3) = 9$	((−) 3) x^2 EXE	**9**
$-3^2 = -(3\times3) = -9$	(−) 3 x^2 EXE	**−9**
$2^2+3^2+4^2+5^2 = 54$	2 x^2 + 3 x^3 + 4 x^2 + 5 x^2 EXE	**54**
$\frac{1}{\frac{1}{3}-\frac{1}{4}} = 12$	(3 SHIFT x^{-1} − 4 SHIFT x^{-1}) SHIFT x^{-1} EXE	**12**
$8!(=1\times2\times3\times\ldots\ldots\times8)$ $= 40320$	8 FUNC 4(MATH) 3(PROB) 3($x!$) EXE	**40320**
$\sqrt[3]{-27} = -3$	SHIFT $\sqrt[3]{}$ (−) 27 EXE	**−3**
What is the absolute value of the common logarithm of $\frac{3}{4}$? $\left\|\log\frac{3}{4}\right\| = 0.1249387366$	FUNC 4(MATH) 2(NUM) 1(Abs) log (3 ÷ 4) EXE	**0.1249387366**
What is the integer part of −3.5?	FUNC 4(MATH) 2(NUM) 2(Int) (−) 3.5 EXE	**−3**
What is the decimal part of −3.5?	FUNC 4(MATH) 2(NUM) 3(Frac) (−) 3.5 EXE	**−0.5**
What is the nearest integer not exceeding −3.5?	FUNC 4(MATH) 2(NUM) 4(Intg) (−) 3.5 EXE	**−4**

2-7 Coordinate Conversion

•Rectangular Coordinates **•Polar Coordinates**



•Calculation results are stored in value memories I and J.

	I	J
Pol	r	θ
Rec	x	y

•With polar coordinates, θ can be calculated and displayed within a range of $-180° < \theta \leqq 180°$ (radians and grads have the same range).
•The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
To calculate r and $\theta°$ when $x=14$ and $y=20.7$.	FUNC 2 (DRG) 1 (Deg) EXE FUNC 4 (MATH) 4 (COORD) 1 (Pol( ) **14** ▸ **20.7**) EXE (Continuing) ALPHA J EXE SHIFT ⇆	**24.98979792** (r) **55.92839019** **55°55'42.2''** (θ)
To calculate x and y when $r=4.5$ and $\theta=\frac{2}{3}\pi$ rad.	FUNC 2 (DRG) 2 (Rad) EXE FUNC 4 (MATH) 4 (COORD) 2 (Rec( ) **4.5** ▸ (**2** ÷ **3** × SHIFT π)) EXE (Continuing) ALPHA J EXE	**−2.25** (x) **3.897114317** (y)

2-8 Permutation and Combination

•Permutation

$${}_nPr=\frac{n!}{(n-r)!}$$

•Combination

$${}_nCr=\frac{n!}{r!\,(n-r)!}$$

•The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
To calculate the possible number of different arrangements using 4 items selected from among of 10 items. ${}_{10}P_4=5040$	**10** FUNC 4 (MATH) 3 (PROB) 1 ($_nPr$) **4** EXE	**5040**
To calculate the possible number of different combinations of 4 items that can be selected from among 10 items. ${}_{10}C_4=210$	**10** FUNC 4 (MATH) 3 (PROB) 2 ($_nCr$) **4** EXE	**210**

2-9 Fractions

- Fractional values are displayed with the integer first, followed by the numerator and then the denominator.
- The following calculations cannot be performed in the BASE Mode.

Example	Operation	Display
$\frac{2}{5}+3\frac{1}{4}=3\frac{13}{20}$	2 a⅞ 5 + 3 a⅞ 1 a⅞ 4 EXE	3⌟13⌟20
$=3.65$	(Conversion to decimal) a⅞	3.65
• Fractions can be converted to decimal values and vice versa.		
$3\frac{456}{78}=8\frac{11}{13}$ (Reduced)	3 a⅞ 456 a⅞ 78 EXE	8⌟11⌟13
	(Continuing) SHIFT d/c	115⌟13
• Fractions and improper fractions that can be reduced become reduced fractions when you press a calculation command key. Press SHIFT d/c to convert the value to an improper fraction.		
$\frac{1}{2578}+\frac{1}{4572}$		
$=6.066202547\times10^{-4}$	1 a⅞ 2578 + 1 a⅞ 4572 EXE	6.06620254 −04 (Norm 1 display format)
• When the total number of characters, including integer, numerator, denominator and delimiter marks exceeds 10, the input fraction is automatically displayed in decimal format.		
$\frac{1}{2}\times0.5=0.25$	1 a⅞ 2 × . 5 EXE	0.25
• Calculations containing both fractions and decimals are calculated in decimal format.		
$\frac{1}{\frac{1}{3}+\frac{1}{4}}=1\frac{5}{7}$	1 a⅞ (1 a⅞ 3 + 1 a⅞ 4) EXE	1⌟5⌟7
• You can include fractions within the numerator or denominator of a fraction by putting the numerator or denominator in parentheses.		

2-10 Number of Decimal Places, Number of Significant Digits, Display Format

- See page 23 for details on specifying the number of decimal places.
- See page 23 for details on specifying the number of significant digits.
- See page 24 for details on specifying the display format.

Example	Operation	Display
$100\div6=16.66666666\ldots$	100 ÷ 6 EXE	16.66666667
	(4 decimal places) FUNC 3 (DISP) 1 (Fix) 4 EXE	16.6667
	(Cancels specification) FUNC 3 (DISP) 3 (Norm) EXE	16.66666667
	(5 significant digits) FUNC 3 (DISP) 2 (Sci) 5 EXE	1.6667 +01
	(Cancels specification) FUNC 3 (DISP) 3 (Norm) EXE	16.66666667
• Displayed values are rounded off to the place you specify.		
$200\div7\times14=400$	200 ÷ 7 × 14 EXE	400
	(3 decimal places) FUNC 3 (DISP) 1 (Fix) 3 EXE	400.000
	(Calculation continues using display capacity of 10 digits) 200 ÷ 7 EXE	28.571
	×	Ans × _
	14 EXE	400.000
	If the same calculation is performed using the specified number of digits: 200 ÷ 7 EXE	28.571
	(The value stored internally is cut off to the number of decimal places you specify.) SHIFT Rnd EXE	28.571
	×	Ans × _
	14 EXE	399.994
	(Cancels specification) FUNC 3 (DISP) 3 (Norm) EXE	399.994

2-11 Calculations Using Memory

•See page 32 for details on value memories.

Example	Operation	Display
	193.2 → ALPHA A EXE	193.2
193.2 ÷ 23 = 8.4	ALPHA A ÷ 23 EXE	8.4
193.2 ÷ 28 = 6.9	ALPHA A ÷ 28 EXE	6.9
$\frac{9\times6+3}{(7-2)\times8}$ = 1.425	9 × 6 + 3 → ALPHA B EXE	57
	(7 − 2) × 8 → ALPHA C EXE	40
	ALPHA B ÷ ALPHA C EXE	1.425

•The same result can be produced by entering (9 × 6 + 3) ÷ ((7 − 2) × 8) EXE.

Chapter 3

Statistical Calculations

Chapter 3 Statistical Calculations

There are two types of statistical calculations: *single-variable statistical calculations* performed using standard deviation, and *paired-variable statistical calculations* performed using regression.

3-1 Single-Variable Statistical Calculations

You should use the Standard Deviation Mode to perform single-variable statistical calculations. In this mode, you can calculate the population standard deviation, the sample standard deviation, the mean, the sum of squares of the data, the sum of the data, and the number of data items.

■To Enter the Standard Deviation Mode

Highlight the **SD** icon on the Main Menu and press [EXE] to enter the SD Mode.

```
RUN
SD/NON-DRAW
angle   :Deg
display :Norml
```

The unit uses the following value memories to store values. Do not use these memories for storage if you plan to perform statistical operations.

Value Memory	U	V	W
Statistical Data	Σx^2	Σx	n

- When drawing a graph for single-variable statistical data, STAT-GRAPH must be set to the **DRAW** Mode (page 18).

• To input data

Before starting to input data, always be sure to first perform the following operation to clear statistical calculation memories U,V, and W.

[FUNC] [6] (CLEAR) [2] (Scl) [EXE]

Now input data as shown in the following examples.

Example 1 **To input the data 10, 20, 30**

10 [DT] 20 [DT] 30 [DT]

Example 2 **To input the data 10, 20, 20, 30**

10 [DT] 20 [DT] [DT] 30 [DT]

Note that pressing [DT] without entering a value automatically repeats the last value entered.

Example 3 **To input the data 10, 20, 20, 20, 20, 20, 20, 30**

10 [DT] 20 [SHIFT] [:] 6 [DT] 30 [DT]

You can input multiple data items by entering the data, inputting a semicolon, and then specifying the number of repeats.

• To delete data

Example 1 **Data: 40**

If you have not yet pressed [DT] to store the data, simply press [AC] to clear it.

Example 2 **Data 10, 20, 50, 40**

To delete 20 and 50, enter 20 [CL] 50 [CL].

Example 3 **Data 10, 20, 20, 20, 20, 30**

To delete two of the 20 entries (which were input using a semicolon as in Example 3), input 20 [SHIFT] [:] 2 [CL].

■Performing Single-Variable Statistical Calculations

• SD Mode CAL Menu

Use the following procedure to display the SD Mode CAL Menu, which contains a selection of statistical values you can calculate.

In the SD Mode, press [FUNC] [1] (CAL) to display the SD Mode CAL Menu.

```
1. x̄
2. xσn
3. xσn-1
4. Σx²
5. Σx
6. n
```

The following are the items that are available from this menu.

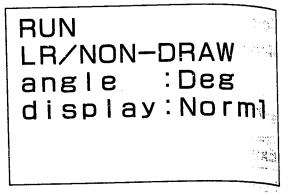
"1. $\bar{x}$" ..... Mean of x-data
"2. $x\sigma_n$" ..... Population standard deviation of x-data
"3. $x\sigma_{n-1}$" ..... Sample standard deviation of x-data
"4. Σx^2" ..... Sum of squares of x-data
"5. Σx" ..... Sum of x-data
"6. n" ..... Number of x-data items

3-2 Paired-Variable Statistical Calculations

You should use the Regression Mode to perform paired-variable statistical calculations.

■To Enter the Regression Mode

Highlight the **LR** icon on the Main Menu and press [EXE] to enter the LR Mode.



The unit uses the following value memories to store values. Do not use these memories for storage if you plan to perform statistical operations.

Value Memory	P	Q	R	U	V	W
Statistical Data	Σy^2	Σy	Σxy	Σx^2	Σx	n

•When drawing a graph for paired-variable statistical data, STAT-GRAPH must be set to the **DRAW** Mode (page 18).

• To input data

Before starting to input data, always be sure to first perform the following operation to clear statistical calculation memories P, Q, R, U, V, and W.

[FUNC][6](CLEAR)[2](Scl)[EXE]

Now input data as shown in the following examples.

Example 1 **To input the data 10/20, 20/30, 30/40**

10[,]20[DT]20[,]30[DT]30[,]40[DT]

Example 2 **To input the data 10/20, 20/30, 20/30, 40/50**

10[,]20[DT]20[,]30[DT][DT]40[,]50[DT]

Note that pressing [DT] without entering values automatically repeats the last pair of values entered.

Example 3 **To input the data 10/20, 20/30, 20/30, 20/30, 40/50**

10[,]20[DT]20[,]30[SHIFT][;]3[DT]40[,]50[DT]

You can input multiple data pairs by entering the data, inputting a semicolon, and then specifying the number of repeats.

• To delete data

Example 1 **Data: 40/50**

If you have not yet pressed [DT] to store the data, simply press [AC] to clear it.

Example 2 **Data 10/20, 20/30, 50/60, 40/50**

To delete 50/60, enter 50 [,] 60 [CL].

Example 3 **Data 10/20, 20/30, 20/30, 20/30, 40/50**

To delete two of the 20/30 entries (which were input using a semicolon as in Example 3), input 20 [,] 30 [SHIFT][;] 2 [CL].

■Types of Paired-Variable Statistical Calculations

The calculator's linear regression formula ($y = A + Bx$) is applied to perform logarithmic, exponential and power regression. This section describes each of these types of calculations and explains how you can perform each one.

■Logarithmic Regression

The logarithmic regression formula is defined as: $y = A + B \cdot \ln x$.

• To input logarithmic regression data

You can use the same general procedures as described under "To input data" on page 62. The only difference is that you must input [SHIFT][ln] before inputting x data.

Example **To input logarithmic regression data 10/20**

[SHIFT][ln]10[,]20[DT]

All other procedures are the same.

•Remember to use [FUNC][6](CLEAR)[2](Scl)[EXE] to clear statistical memories before inputting data.

• To delete logarithmic regression data

You can use the same general procedure as described under "To delete data" on page 63. Note however, you must use [SHIFT][ln] to specify x data items.

Example 1 **To delete [SHIFT][ln]10[,]20[DT], press [SHIFT][ln]10[EXE][SHIFT][Ans][,]20[CL].**

Example 2 **To delete [SHIFT][ln]10[,]20[DT], press [SHIFT][ln]10[,]20[SHIFT][;] − 1[DT].**

• About logarithmic regression calculations

Logarithmic regression results can be produced when the calculation is performed in accordance with the following.

- estimated value of $x = e^{y\hat{x}}$
- estimated value of $y = \ln x\hat{y}$

If $\ln x = x$ is assumed for logarithmic regression formula $y = A + B \cdot \ln x$, this regression can be treated as linear regression $y = a + bx$. This means that constant term A, regression coefficient B, correlation coefficients r and x, and the estimated value of y can be determined using the same formula as that used for linear regression.

The following shows the difference between logarithmic regression results and linear regression results.

Linear Regression	Logarithmic Regression
Σx	$\Sigma \ln x$
Σx^2	$\Sigma (\ln x)^2$
Σxy	$\Sigma \ln x \cdot y$

■Exponential Regression

The exponential regression formula is defined as: $y = A \cdot e^{Bx}$ ($\ln y = \ln A + Bx$).

• To input exponential regression data

You can use the same general procedures as described under "To input data" on page 62. The only difference is that you must input [SHIFT] [ln] before inputting y data.

Example **To input exponential regression data 10/20**

10 [,] [SHIFT] [ln] 20 [DT]

All other procedures are the same.

- Remember to use [FUNC] [6] (CLEAR) [2] (Scl) [EXE] to clear statistical memories before inputting data.

• To delete exponential regression data

You can use the same general procedure as described under "To delete data" on page 63. Note however, you must use [SHIFT] [ln] to specify y data items.

Example 1 **To delete 10 [,] [SHIFT] [ln] 20 [DT], press [SHIFT] [ln] 20 [EXE] 10 [,] [SHIFT] [Ans] [CL].**

Example 2 **To delete 10 [,] [SHIFT] [ln] 20 [DT], press 10 [,] [SHIFT] [ln] 20 [SHIFT] [:] −1 [DT].**

• About exponential regression calculations

Exponential regression results can be produced when the calculation is performed in accordance with the following.

- fixed term $A = e^A$
- estimated value of $x = \ln y\hat{x}$
- estimated value of $y = e^{x\hat{y}}$

If $\ln y = y$ and $\ln A = a$ are assumed for exponential regression formula $y = A \cdot e^{Bx}$ ($\ln y = \ln A + Bx$), this regression can be treated as linear regression $y = a + bx$. This means that constant term A, regression coefficient B, correlation coefficients r and x, and the estimated value of y can be determined using the same formula as that used for linear regression.

The following shows the difference between exponential regression results and linear regression results.

Linear Regression	Exponential Regression
Σy	$\Sigma \ln y$
Σy^2	$\Sigma (\ln y)^2$
Σxy	$\Sigma x \cdot \ln y$

■Power Regression

The power regression formula is defined as: $y = A \cdot x^B$ ($\ln y = \ln A + B \ln x$).

• To input power regression data

You can use the same general procedures as described under "To input data" on page 62. The only difference is that you must input [SHIFT] [ln] before inputting both x data and y data.

Example **To input power regression data 10/20**

[SHIFT] [ln] 10 [,] [SHIFT] [ln] 20 [DT]

All other procedures are the same.

- Remember to use [FUNC] [6] (CLEAR) [2] (Scl) [EXE] to clear statistical memories before inputting data.

• To delete power regression data

You can use the same general procedure as described under "To delete data" on page 63. Note however, you must use [SHIFT] [ln] to specify both x data and y data items.

Example 1 **To delete [SHIFT] [ln] 10 [,] [SHIFT] [ln] 20 [DT], press [SHIFT] [ln] 10 [→] [ALPHA] [A] [EXE] [SHIFT] [ln] 20 [EXE] [ALPHA] [A] [,] [SHIFT] [Ans] [CL].**

Example 2 **To delete [SHIFT] [ln] 10 [,] [SHIFT] [ln] 20 [DT], press [SHIFT] [ln] 10 [,] [SHIFT] [ln] 20 [SHIFT] [:] −1 [DT].**

• About power regression calculations

Power regression results can be produced when the calculation is performed in accordance with the following.

- fixed term $A = e^A$
- estimated value of $x = e^{\ln y\hat{x}}$
- estimated value of $y = e^{\ln x\hat{y}}$

If $\ln y = y$, $\ln A = a$, and $\ln x = x$ are assumed for power regression formula $y = A \cdot x^B$ ($\ln y = \ln A + B \ln x$), this regression can be treated as linear regression $y = a + bx$. This means that constant term A, regression coefficient B, correlation coefficients r and x, and the estimated value of y can be determined using the same formula as that used for linear regression.

The following shows the difference between power regression results and linear regression results.

Linear Regression	Power Regression
Σx	$\Sigma \ln x$
Σx^2	$\Sigma (\ln x)^2$
Σy	$\Sigma \ln y$
Σy^2	$\Sigma (\ln y)^2$
Σxy	$\Sigma \ln x \cdot \ln y$

■Performing Paired-Variable Statistical Calculations

• LR Mode CAL Menu

Use the following procedure to display the LR Mode CAL Menu, which contains a selection of sub menus of that contain statistical values you can calculate.
In the LR Mode, press [FUNC] [1] to display the LR Mode CAL Menu.

```
1. DEV
2. Σ
3. REG
```

The following are the items that are available from this menu.

- **"1. DEV"** ..... Statistical menu
- **"2. Σ"** ..... Sum data menu
- **"3. REG"** ..... Regression/estimated value menu

Each of these menus is described in detail below.

• Statistical Menu

[1](DEV)

```
1. x̄
2. xσn
3. xσn-1
4. ȳ
5. yσn
6. yσn-1
```

The following are the items that are available from this menu.

- **"1. $\bar{x}$"** ..... Mean of x-data
- **"2. $x\sigma_n$"** ..... Population standard deviation of x-data
- **"3. $x\sigma_{n-1}$"** ..... Sample standard deviation of x-data
- **"4. $\bar{y}$"** ..... Mean of y-data
- **"5. $y\sigma_n$"** ..... Population standard deviation of y-data
- **"6. $y\sigma_{n-1}$"** ..... Sample standard deviation of y-data

• Sum Data Menu

[2](Σ)

```
1. Σx²
2. Σx
3. n
4. Σy²
5. Σy
6. Σxy
```

The following are the items that are available from this menu.

- **"1. Σx^2"** ..... Sum of squares of x-data
- **"2. Σx"** ..... Sum of x-data
- **"3. n"** ..... Number of items
- **"4. Σy^2"** ..... Sum of squares of y-data
- **"5. Σy"** ..... Sum of y-data
- **"6. Σxy"** ..... Sum of products of x-data and y-data

• Regression/Estimated Value Menu

[3](REG)

```
1. A
2. B
3. r
4. x̂
5. ŷ
```

The following are the items that are available from this menu.

- **"1. A"** ..... Constant term A
- **"2. B"** ..... Regression coefficient B
- **"3. r"** ..... Correlation coefficient r
- **"4. $\hat{x}$"** ..... Estimated value of x
- **"5. $\hat{y}$"** ..... Estimated value of y

3-3 Examples of Statistical Calculations

The following are the formulas used by the unit to calculate standard deviation and mean.

•Standard Deviation

$$\sigma_n = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n}} = \sqrt{\frac{\Sigma x^2-(\Sigma x)^2/n}{n}}$$

[Using all data from a finite population to determine the standard deviation for the population]

$$\sigma_{n-1} = \sqrt{\frac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}} = \sqrt{\frac{\Sigma x^2-(\Sigma x)^2/n}{n-1}}$$

[Using sample data from a population to determine the standard deviation for the population]

•Mean

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{\Sigma x}{n}$$

Example	Operation	Display
Data 55, 54, 51, 55, 53, 53, 54, 52	[FUNC][6](CLEAR)[2](Scl)[EXE] (Clears memory)	
	55[DT]54[DT]	
	51[DT]55[DT]	
	53[DT][DT]54[DT]	
	52[DT]	52
*You can press the function keys to obtain results in any sequence.		
	(Standard deviation σ_n) [FUNC][1](CAL)[2]($x\sigma_n$)[EXE]	1.316956719
	(Standard deviation σ_{n-1}) [FUNC][1](CAL)[3]($x\sigma_{n-1}$)[EXE]	1.407885953
	(Mean $\bar{x}$) [FUNC][1](CAL)[1]($\bar{x}$)[EXE]	53.375
	(Number of data n) [FUNC][1](CAL)[6](n)[EXE]	8
	(Sum total Σx) [FUNC][1](CAL)[5](Σx)[EXE]	427
	(Sum of squares Σx^2) [FUNC][1](CAL)[4](Σx^2)[EXE]	22805

To calculate the deviation of the unbiased variance, the difference between each datum, and mean of the above data

(Continuing)

[FUNC][1](CAL)[3]($x\sigma_{n-1}$)[x^2][EXE]	1.982142857
55[−][FUNC][1](CAL)[1]($\bar{x}$)[EXE]	1.625
54[−][FUNC][1](CAL)[1]($\bar{x}$)[EXE]	0.625
51[−][FUNC][1](CAL)[1]($\bar{x}$)[EXE]	−2.375
⋮	⋮

To calculate x and σ_{n-1} for the following data

Class no.	Value	Frequency
1	110	10
2	130	31
3	150	24
4	170	2
5	190	3

[FUNC][6](CLEAR)[2](Scl)[EXE]	
110[SHIFT][:]10[DT]	110
130[SHIFT][:]31[DT]	130
150[SHIFT][:]24[DT]	150
170[DT][DT]	170
190[DT][DT][DT]	190
[FUNC][1](CAL)[6](n)[EXE]	70
[FUNC][1](CAL)[1]($\bar{x}$)[EXE]	137.7142857
[FUNC][1](CAL)[3]($x\sigma_{n-1}$)[EXE]	18.42898069

• Regression

The following are the formulas the unit uses to calculate constant term A and regression coefficient B for the regression formula $y = A + Bx$.

$$A = \frac{\Sigma y - B\cdot\Sigma x}{n} \qquad B = \frac{n\cdot\Sigma xy - \Sigma x\cdot\Sigma y}{n\cdot\Sigma x^2-(\Sigma x)^2}$$

The following is the formula the unit uses to calculate correlation coefficient r and estimated values of x and y.

$$r = \frac{n\cdot\Sigma xy - \Sigma x\cdot\Sigma y}{\sqrt{\{n\cdot\Sigma x^2-(\Sigma x)^2\}\{n\cdot\Sigma y^2-(\Sigma y)^2\}}}$$

$$\hat{y} = A + Bx \qquad \hat{x} = \frac{y-A}{B}$$

■Linear Regression

Example	Operation	Display
•Relationship between temperature and the length of a steel bar Temperature / Length 10°C / 1003mm 15°C / 1005mm 20°C / 1010mm 25°C / 1011mm 30°C / 1014mm The data in the above table can be used to obtain the terms of the regression formula and the correlation coefficient. Based on the regression formula, the estimated length of the steel bar at 18°C and the temperature when the bar is 1000 mm long can be calculated. The critical coefficient (r^2) and covariance $\left(\frac{\Sigma xy - n \cdot \bar{x} \cdot \bar{y}}{n-1}\right)$ can also be calculated.	[FUNC][6](CLEAR)[2](Scl)[EXE] (Clears memory)	
	10[,]1003[DT]	10
	15[,]1005[DT]	15
	20[,]1010[DT]	20
	25[,]1011[DT]	25
	30[,]1014[DT]	30
	(Constant term A) [FUNC][1](CAL)[3](REG)[1](A)[EXE]	997.4
	(Regression coefficient B) [FUNC][1](CAL)[3](REG)[2](B)[EXE]	0.56
	(Correlation coefficient r) [FUNC][1](CAL)[3](REG)[3](r)[EXE]	0.9826073689
	(Length at 18°C) 18[FUNC][1](CAL)[3](REG) [5]($\hat{y}$)[EXE]	1007.48
	(Temperature at 1000mm) 1000[FUNC][1](CAL)[3](REG) [4]($\hat{x}$)[EXE]	4.642857143
	(Critical coefficient) [FUNC][1](CAL)[3](REG) [3](r)[x^2][EXE]	0.9655172414
	(Covariance) [(][FUNC][1](CAL)[2](Σ)[6](Σxy) [−][FUNC][1](CAL)[2](Σ)[3](n)[×] [FUNC][1](CAL)[1](DEV)[1]($\bar{x}$)[×] [FUNC][1](CAL)[1](DEV)[4]($\bar{y}$)[)] [÷][(][FUNC][1](CAL)[2](Σ) [3](n)[−]1[)][EXE]	35

■Logarithmic Regression

•The logarithmic regression formula is $y = A + B \cdot \ln x$.
•Σx, Σx^2, and Σxy are obtained as $\Sigma \ln x$, $\Sigma (\ln x)^2$, and $\Sigma \ln x \cdot y$ respectively.

Example	Operation	Display
xi / yi 29 / 1.6 50 / 23.5 74 / 38.0 103 / 46.4 118 / 48.9 The data in the above table can be used to obtain the terms of the regression formula and the correlation coefficient. Based on the regression formula, estimated value $\hat{y}$ can be obtained for $xi = 80$, and estimated value $\hat{x}$ can be obtained for $yi = 73$.	[FUNC][6](CLEAR)[2](Scl)[EXE] (Clears memory)	
	[SHIFT][ln]29[,]1.6[DT]	3.36729583
	[SHIFT][ln]50[,]23.5[DT]	3.912023005
	[SHIFT][ln]74[,]38.0[DT]	4.304065093
	[SHIFT][ln]103[,]46.4[DT]	4.634728988
	[SHIFT][ln]118[,]48.9[DT]	4.770684624
	(Constant term A) [FUNC][1](CAL)[3](REG)[1](A)[EXE]	−111.1283976
	(Regression coefficient B) [FUNC][1](CAL)[3](REG)[2](B)[EXE]	34.0201475
	(Correlation coefficient r) [FUNC][1](CAL)[3](REG)[3](r)[EXE]	0.9940139466
	($\hat{y}$ when $xi = 80$) [SHIFT][ln]80[FUNC][1](CAL) [3](REG)[5]($\hat{y}$)[EXE]	37.94879482
	($\hat{x}$ when $yi = 73$) 73[FUNC][1](CAL)[3](REG) [4]($\hat{x}$)[EXE][SHIFT][e^x][SHIFT][Ans][EXE]	224.1541313

■Exponential Regression

- The exponential regression formula is $y = A \cdot e^{B \cdot x}$ ($\ln y = \ln A + Bx$).
- Σy is obtained as $\Sigma \ln y$, Σy^2 as $\Sigma(\ln y)^2$, and Σxy as $\Sigma x \cdot \ln y$.

Example	Operation	Display
xi | yi 6.9 | 21.4 12.9 | 15.7 19.8 | 12.1 26.7 | 8.5 35.1 | 5.2	[FUNC][6](CLEAR)[2](Scl)[EXE] (Clears memory)	
	6.9[,][SHIFT][ln]21.4[DT]	6.9
	12.9[,][SHIFT][ln]15.7[DT]	12.9
	19.8[,][SHIFT][ln]12.1[DT]	19.8
	26.7[,][SHIFT][ln]8.5[DT]	26.7
	35.1[,][SHIFT][ln]5.2[DT]	35.1
The data in the above table can be used to obtain the terms of the regression formula and the correlation coefficient. Based on the regression formula, estimated value $\hat{y}$ can be obtained for $xi = 16$, and estimated value $\hat{x}$ can be obtained for $yi = 20$.	(Constant term A) [SHIFT][e^{x2}][FUNC][1](CAL)[3](REG) [1](A)[EXE]	30.49758743
	(Regression coefficient B) [FUNC][1](CAL)[3](REG) [2](B)[EXE]	−0.0492037083
	(Correlation coefficient r) [FUNC][1](CAL)[3](REG) [3](r)[EXE]	−0.997247352
	($\hat{y}$ when $xi = 16$) 16[FUNC][1](CAL)[3](REG) [5]($\hat{y}$)[EXE][SHIFT][e^{x2}][SHIFT][Ans][EXE]	13.87915739
	($\hat{x}$ when $yi = 20$) [SHIFT][ln]20[FUNC][1](CAL) [3](REG)[4]($\hat{x}$)[EXE]	8.574868047

■Power Regression

- The power regression formula is $y = A \cdot x^B$ ($\ln y = \ln A + B \ln x$).
- Σx is obtained as $\Sigma \ln x$, Σx^2 as $\Sigma(\ln x)^2$, Σy as $\Sigma \ln y$, Σy^2 as $\Sigma(\ln y)^2$, and Σxy as $\Sigma \ln x \cdot \ln y$.

Example	Operation	Display
xi | yi 28 | 2410 30 | 3033 33 | 3895 35 | 4491 38 | 5717	[FUNC][6](CLEAR)[2](Scl)[EXE] (Clears memory)	
	[SHIFT][ln]28[,][SHIFT][ln]2410[DT]	3.33220451
	[SHIFT][ln]30[,][SHIFT][ln]3033[DT]	3.401197382
	[SHIFT][ln]33[,][SHIFT][ln]3895[DT]	3.496507561
	[SHIFT][ln]35[,][SHIFT][ln]4491[DT]	3.555348061
	[SHIFT][ln]38[,][SHIFT][ln]5717[DT]	3.63758616
The data in the above table can be used to obtain the terms of the regression formula and the correlation coefficient. Based on the regression formula, estimated value $\hat{y}$ can be obtained for $xi = 40$, and estimated value $\hat{x}$ can be obtained for $yi = 1000$.	(Constant term A) [SHIFT][e^{x2}][FUNC][1](CAL)[3](REG) [1](A)[EXE]	0.2388010685
	(Regression coefficient B) [FUNC][1](CAL)[3](REG) [2](B)[EXE]	2.771866158
	(Correlation coefficient r) [FUNC][1](CAL)[3](REG) [3](r)[EXE]	0.9989062551
	($\hat{y}$ when $xi = 40$) [SHIFT][ln]40[FUNC][1](CAL)[3](REG) [5]($\hat{y}$)[EXE][SHIFT][e^{x2}][SHIFT][Ans][EXE]	6587.674589
	($\hat{x}$ when $yi = 1000$) [SHIFT][ln]1000[FUNC][1](CAL) [3](REG)[4]($\hat{x}$)[EXE] [SHIFT][e^{x2}][SHIFT][Ans][EXE]	20.2622581

Chapter 4

Graphing

Chapter 4 Graphing

This chapter explains everything you need to know to fully use the versatile graphing capabilities of the unit.

4-1 About the Graphing Function

The large 80×48 dot display of the unit provides you with the capability to graph the following:

Rectangular coordinates
Inequalities
Single-variable statistics
Paired-variable statistics

These graphs can be produced using manual input or by programs.
You should enter the COMP, SD, LR or GRAPH Mode for drawing graphs. Here, we will start our explanation of graph drawing using the COMP Mode.

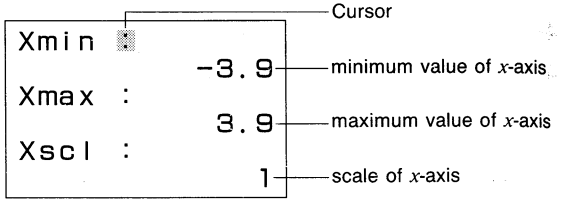
■Specifying the Range of a Graph

Before you draw a graph, you must first specify it range parameters.

• To display the range parameter of a graph

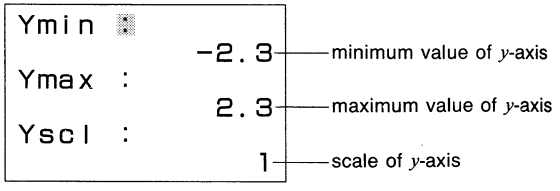
Press [Range] to display the parameters for the *x*-axis.

[Range]



Press [Range] again to display the parameters for the *y*-axis.

[Range]



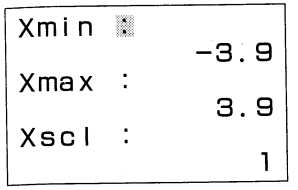
- The currently selected parameter in the above displays is the where the flashing cursor is located (for example, Xmin :). Each time you press [EXE] or [▼] the cursor moves to the next parameter in the following sequence.
  x-axis display: Xmin → Xmax → Xscl →
  y-axis display: Ymin → Ymax → Yscl
- To change a range parameter, select the item whose setting you want to change and input a value. Then press [EXE] to register the value.
- After you finish making all the parameter settings you want, press [Range] or [EXIT] to return to the display that was shown before you pressed [Range].

• To specify range parameters

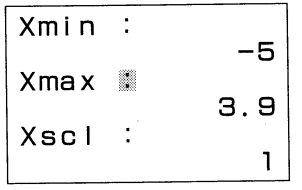
Example **To specify the following range parameters**

Xmin :	−5	Ymin :	−3
Xmax :	5	Ymax :	3
Xscl :	1	Yscl :	1

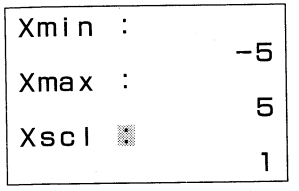
① [Range]



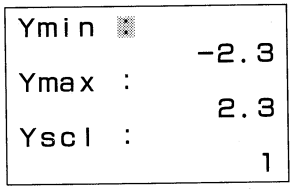
② [(−)] [5] [EXE]



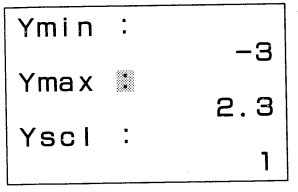
③ [5] [EXE]



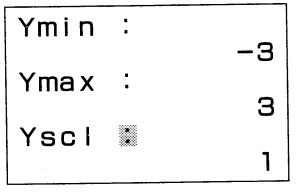
④ [EXE] (or [▼])



⑤ [(−)] [3] [EXE]



⑥ [3] [EXE]

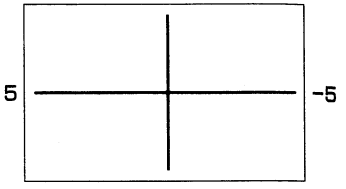


⑦ EXE (or ▼)

```
Ymin :
              -3
Ymax :
               3
Yscl :
               1
```

- Settings can be made within the following range:
  $-9.999999999E+97$ to $-9.999999999E-96$
  $9.999999999E-96$ to $9.999999999E+97$ And 0.
- If you specify an illegal value (such as outside the above range), an Ma ERROR occurs. When this happens, press ◀ or ▶ and then input a different value.
- If you specify zero for Xscl or Yscl, scale marks will not appear on the axis for which zero is specified.
- Do not specify the same value for the minimum and maximum.
- If you input an illegal value, the previous parameter is retained without change.
- If a minimum is greater than a maximum parameter, the axis is inverted.

Example **Xmin :5**
Xmax : −5



- You can input range parameters as expressions (such as 2π).
- When a range setting that does not allow display of the axes is used, 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 range values are changed, the graph display is cleared and the newly set axes only are displayed.
- Range setting may cause irregular scale spacing.
- If the range is set too wide, the graph produced may not fit on the display.
- The point of deflection sometimes exceeds the capabilities of the display with graphs that change drastically as they approach the point of deflection.
- A range that is too small can cause an Ma ERROR.

■Initializing the Range Parameters

There are two methods you can use to initialize range parameters. One is a general initialization procedure, and one initializes range parameters in accordance with the current unit of angular measurement setting. In both cases, you must start by pressing FUNC.

FUNC

```
1. INIT
2. TRIANGLE
```


• INIT

Pressing 1 (INIT) initializes range parameters to the following settings.

Xmin :	−3.9	Ymin :	−2.3
Xmax:	3.9	Ymax:	2.3
Xscl :	1	Yscl :	1

• TRIANGLE

Pressing 2 (TRIANGLE) initializes range parameters in accordance with the current unit of angular measurement setting (deg, rad, gra). This initialization procedure is helpful when drawing trigonometric graphs.

Deg

Xmin :	−360	Ymin :	−1.6
Xmax:	360	Ymax:	1.6
Xscl :	90	Yscl :	1

Rad

Xmin :	−6.283185307	Ymin :	−1.6
Xmax:	6.283185307	Ymax:	1.6
Xscl :	1.570796327	Yscl :	0.5

Gra

Xmin :	−400	Ymin :	−1.6
Xmax:	400	Ymax:	1.6
Xscl :	100	Yscl :	0.5

• To specify range parameters within a program

Use the following format to specify range parameters in a program.

Range (value of Xmin), (value of Xmax), (value of Xscl), (value of Ymin), (value of Ymax), (value of Yscl)

4-2 Rectangular Coordinate Graphs

To draw rectangular coordinate graphs, specify **RECT** as the GRAPH TYPE (page 18).

■Graphing Built-in Scientific Functions

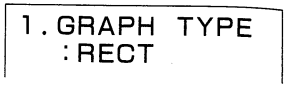
The following is a list of the built-in scientific functions that you can graph.

•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}	•$\sqrt[3]{x}$				

Use the RUN/COMP Mode to draw rectangular coordinate graphs. Do not use the BASE Mode. When you graph a built-in function, the range parameters are set by the unit automatically.

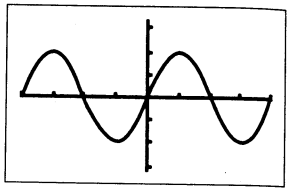
• To graph the sine function

[SHIFT] [SETUP] [1] (GRAPH TYPE)
[1] (RECT)



[EXIT]

[Graph] [sin] [EXE]



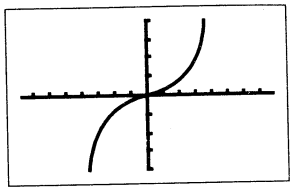
■Overdrawing Built-in Function Graphs

You can draw two or more built-in function graphs on the same screen. The range of first graph is set automatically, and the same range is applied for subsequent graphs. The important thing to note in the following example is the use of [X-var]. By pressing [X-var] before [EXE] to graph the second function, you are telling the unit to leave the previously drawn graphs on the display. If you do not press [X-var], the unit will clear the graphic display automatically and graph only the last function you entered.

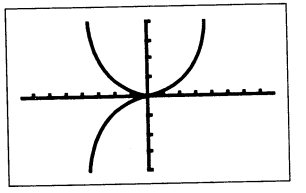
• To overdraw graphs

Example **To graph $y = \sinh x$ and overdraw it with $y = \cosh x$:**

[SHIFT] [Cls] [EXE]
[Graph] [FUNC] [4] [MATH] [1] (HYP)
[1] (sinh) [EXE]



[Graph] [FUNC] [4] (MATH) [1] (HYP)
[2] (cosh) [X-var] [EXE]



Note:
You cannot use built-in function graphs in multistatements (page 28) and programming.

■Graphing Manually Entered Functions

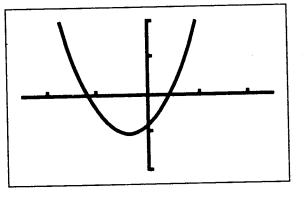
You can graph manually entered functions by simply pressing [Graph] and then entering the function. Remember that you also have to specify range parameters (page 76).

• To graph a manually entered function

Example **To graph $y = 2x^2 + 3x - 4$ using the following range parameters:**

Xmin :	−5	Ymin :	−10
Xmax :	5	Ymax :	10
Xscl :	2	Yscl :	5

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



■Overdrawing Manually Input Graphs

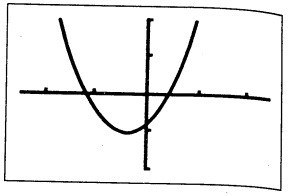
You can draw two or more manually input graphs on the same screen. This makes it possible to find points of intersection and solutions at a glance.

•You can also input value memory name X by pressing [ALPHA][X].

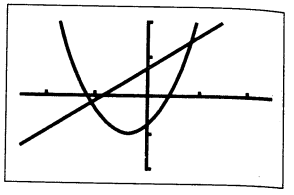
• To overdraw manually entered graphs

Example **To graph $y=2x^2+3x-4$ and overdraw it with $y=2x+3$:**

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



[Graph][2][X-var][+][3][EXE]



4-3 Inequality Graphs

To draw inequality graphs, specify **INEQ** as the GRAPH TYPE (page 18). Do not try to use the BASE Mode for graphing. The functions that can be graphed in the INEQ Mode are those that fit one of the following formats:

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

• To graph an inequality

Example **To graph $y<x^2-2x-6$ using the following range parameters:**

Xmin :	−6	Ymin :	−10
Xmax:	6	Ymax:	10
Xscl :	1	Yscl :	5

[SHIFT][SETUP][1](GRAPH TYPE)

```
GRAPH TYPE
   :RECT

1.RECT
2.INEQ
```

[2](INEQ)

```
1.GRAPH TYPE
   :INEQ
```

[EXIT]

Clear the graph.

[SHIFT][Cls][EXE]

Display the menu of inequality operators.

[Graph]

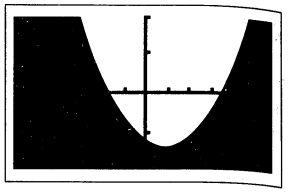
```
1.>
2.<
3.≥
4.≤
```

Input the inequality formula and draw the graph.

[2](<)[X-var][x^2][−]
[2][X-var][−][6]

```
Cls
                    0
Graph Y<X²-2X
-6_
```

[EXE]



■Overdrawing Inequality Graphs

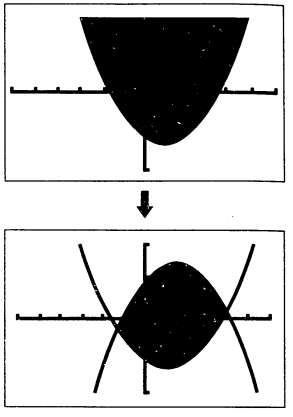
If you draw two or more inequality function graphs on the same screen, the area containing values that satisfy both functions is filled in.
In the following input sequence we will input two functions with a single operation. Note the [SHIFT][↵] operation that separates the two functions.

• To overdraw inequality graphs

Exampie **To graph $y>x^2-2x-6$ and overdraw it with $y<-x^2+3x+4$ using the following range parameters:**

Xmin :	−6	Ymin :	−10
Xmax:	6	Ymax:	10
Xscl :	1	Yscl :	5

[SHIFT][Cls][EXE]
[Graph][1](>)[X-var][x^2][−]
[2][X-var][−][6][SHIFT][↵]
[Graph][2](<)[(−)][X-var][x^2][+]
[3][X-var][+][-4][EXE]



4-4 Single-Variable Statistical Graphs

To draw single-variable statistical graphs, first enter the SD Mode and specify **DRAW** for the STAT-GRAPH setting. The unit lets you draw bar graphs, line graphs and normal distribution curves using data you input.

• To draw a bar graph

Example **To draw a bar graph of the following data:**

Rank	Value	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

First, specify the range parameters. Since the maximum data value for x is 100, we will set Xmax as 110. The maximum data value for y is 15, so set Ymax as 20.

Xmin :	0	Ymin :	0
Xmax:	110	Ymax:	20
Xscl :	10	Yscl :	2

Next, specify the number of bars by increasing the number of value memories. Since we have 11 ranks, we should increase the number of memories by 11. If you skip this step, an error occurs when you try to draw the graph.

[SHIFT][Defm][1][1][EXE]

```
MEMORY STATUS
MEMORY  :  37
```

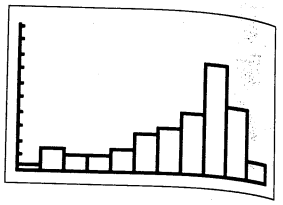
Now clear the statistical memory.
[FUNC][6](CLEAR)[2](Scl)[EXE]

Input the data. For full details on the techniques you can use to input statistical data, see page 60.

[0][DT][1][0][DT][DT][DT][2][0][DT][DT]
[3][0][DT][DT][4][0][DT][DT][DT]
[5][0][SHIFT][;][5][DT][6][0][SHIFT][;][6][DT][7][0][SHIFT][;][8][DT]
[8][0][SHIFT][;][1][5][DT][9][0][SHIFT][;][9][DT][1][0][0][DT][DT]

Now draw the graph.

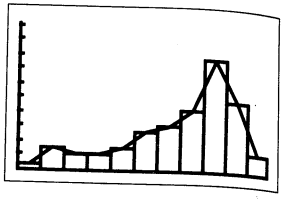
[Graph] [EXE]



• To superimpose a line graph on a bar graph

While a bar graph is displayed, perform the following key operation.

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



• To draw a normal distribution curve

Example **Using the data input above, with the following range parameters:**

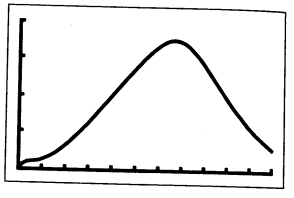
Xmin :	0	Ymin :	0
Xmax:	110	Ymax:	0.02
Xscl :	10	Yscl :	5^{-03}

This change in range parameters is necessary because the y values are so much smaller than the x values.

Draw the graph.

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

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



Notes:

- Be sure to expand the number of value memories to match the number of bars in a bar graph.
- If you change the number of value memories while you are inputting data, you will not be able to draw a graph correctly.
- If you input a value that is outside the minimum and maximum ranges you specify for the range parameters, the data is stored in statistical memory but not in graph memory.
- If you input data that is greater than the maximum you specify for the y-axis, the bar is drawn to the upper limit of the display, and the points outside the range cannot be connected.
- The following is the formula the unit uses to draw the normal distribution curve.

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

- For range parameter settings, Xmin must be less than Xmax.

4-5 Paired-Variable Statistical Graphs

To draw paired-variable statistical graphs (linear regression formula: $y=A+Bx$), first enter the LR Mode and specify **DRAW** for the STAT-GRAPH setting.

Example **Input the following data and draw a linear regression graph ($y=A+Bx$).**

xi	yi
−9	−2
−5	−1
−3	2
1	3
4	5
7	8

First, specify the range parameters as shown below.

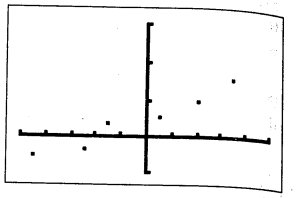
Xmin :	−10	Ymin :	−5
Xmax:	10	Ymax:	15
Xscl :	2	Yscl :	5

Now clear the statistical memory.

[FUNC] [6] (CLEAR) [2] (Scl) [EXE]

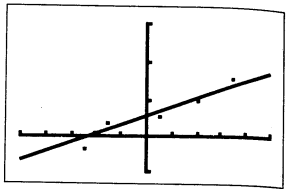
Input the data. For full details on the techniques you can use to input statistical data, see page 62.

(−) 9 , (−) 2 DT
(−) 5 , (−) 1 DT
(−) 3 , 2 DT
1 , 3 DT
4 , 5 DT
7 , 8 DT



Now draw the graph.

Graph SHIFT Line 1 EXE



Notes

- A point is not plotted if a set of data is outside the range parameter values you specify.
- The following key operation causes an error (Ma ERROR) if no paired-variable statistical data is present in memory.
  Graph SHIFT Line 1 EXE
- For range parameter settings, Xmin must be less than Xmax.

4-6 Storing Functions in Memory

You can store up to 10 functions and expressions in memory for later recall, editing, or graphing. Rectangular coordinate functions and inequalities can all be stored in memory. Note that the total amount of memory used for storage of each function or expression cannot exceed 127 bytes.

■To Access the Graphic Function Memory

Highlight the **GRAPH** icon on the Main Menu and press EXE to enter the GRAPH Mode.

Use ◀ and ▶, or input a number to move the pointer.
Memory locations

```
GRAPH
  ▼
Y-0123456789

500bytes free
Y:
```

• To store a rectangular coordinate function

Example **To store the following rectangular coordinate graph function in memory location Y1:**

$y = 2x^2 - 5$

Move the pointer to number of the memory area you want to specify.

▶ EXE

```
GRAPH
  ▼
Y-0123456789

Y1
_
```

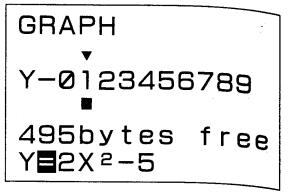
Input the function.

2 X-var x^2 − 5

```
GRAPH
  ▼
Y-0123456789
  ■
Y1
2X²-5_
```

Store the function.

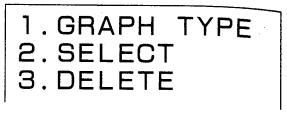
[EXE]



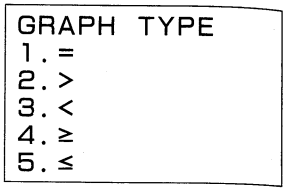
• To store an inequality

To store an inequality, you must first input a function and then use a graph type menu to change it to an inequality.

[FUNC]



[1](GRAPH TYPE)



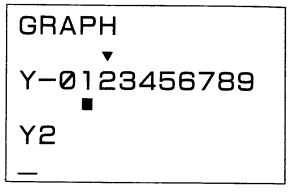
The following shows the items that are available in the graph type menu.

"1. =" ..... rectangular coordinate function
"2. >" ..... $y>f(x)$
"3. <" ..... $y<f(x)$
"4. ≥" ..... $y\geqq f(x)$
"5. ≤" ..... $y\leqq f(x)$

Example **To store the following inequality in graphic function memory location Y2:**
$y<x^2-2x-6$

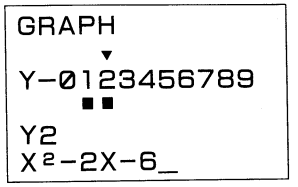
Move the pointer to the memory area you want to store to.

[▶][▶][EXE]



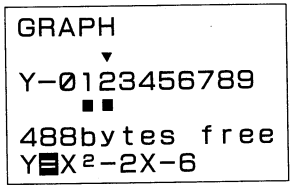
Input the function.

[X-var][x²][−][2][X-var][−][6]



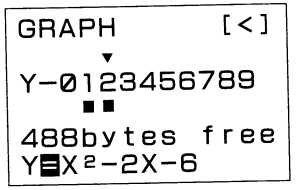
Store the function.

[EXE]



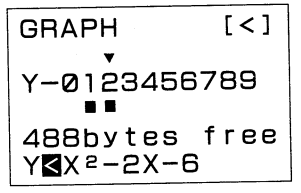
Display the graph type menu and specify the graph type.

[FUNC][1](GRAPH TYPE)
[3](<)



Store the function again as an inequality.

[EXE]



•Inputting [1](=) converts the inequality back to a rectangular coordinate function.

■Editing Functions in Memory

Use the following procedures to modify and delete functions that are stored in memory.

• To modify a function in memory

Example **To change the function in memory location Y1 ($y=2x^2-5$) to $y=2x^2-3$:**

Move the pointer to the memory area that contains the graph function you want to edit.

(▶)

```
GRAPH
▼
Y-0123456789
■■
488bytes free
Y■2X²-5
```

Display the graph function for editing.

[EXE]

```
GRAPH
▼
Y-0123456789
■■
Y1
2X²-5
```

Cursor

Move the cursor to the location of the change and then input the new value.

(▶)(▶)(▶)(▶)

```
2X²-5
```

[3]

```
2X²-3_
```

[EXE]

```
GRAPH
▼
Y-0123456789
■■
488bytes free
Y■2X²-3
```

•If you press [DEL] to delete all functions on the display and then press [EXE], the graph functons are deleted.

■Deleting Graph Functions

You can delete graph functions individually, or you can delete all graph functions currently stored in memory. In both cases, you must start by pressing [FUNC] and then [3] to select DELETE.

[FUNC]

```
1.GRAPH TYPE
2.SELECT
3.DELETE
```

[3](DELETE)

```
DELETE
1.ONE GRAPH
2.ALL GRAPH
```

The following describes the items that are available in the delete menu.

"**1. ONE GRAPH**" .... Deletes a specific graph function

"**2. ALL GRAPH**" ..... Deletes all graph functions

• To delete a specific graph function

Example **To delete the graph function stored in area Y1.**

While the delete menu is on the display, enter [1] to specify ONE GRAPH.

[1](ONE GRAPH)

Area specified by the pointer before you press [1].

```
GRAPH    [DEL]
▼
Y-0123456789
■■
488bytes free
Y:
```

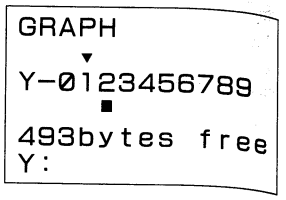
Move the pointer to the area that contains the graph function you want to delete and press [EXE].

(▶)[EXE]

```
DELETE
Y1?

PRESS [EXE]
```

Press [EXE] to delete the function.

[EXE]

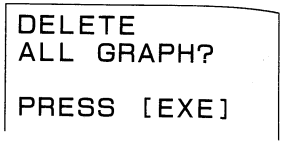


•You can press [EXIT] or [AC] to abort the delete operation without deleting anything.

• To delete all graph functions

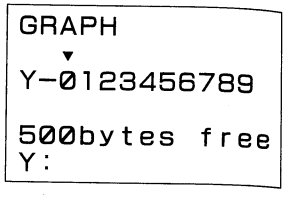
While the delete menu is on the display, enter [2] to specify ALL GRAPH.

[2](ALL GRAPH)



Press [EXE] to delete all the functions.

[EXE]



•You can press [EXIT] or [AC] to abort the delete operation without deleting anything.

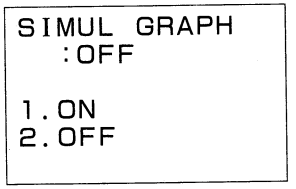
■Drawing Graphs from Memory

You can use either of the two following methods to draw graphs from memory.
•Drawing graphs from specific functions in memory
•Overlaying graphs for all the functions in memory

• To specify the overlaying method

Before drawing overlaid graphs, you should first use the set up screen to specify the SIMUL GRAPH setting you want to use.

[SHIFT][SET UP][2](SIMUL GRAPH)



"1. ON" ..... Simultaneous graphing of selected functions
"2. OFF" ..... One-by-one graphing of selected functions in memory number sequence

• To draw graphs from specific functions in memory

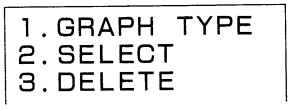
Example 1 **To draw a graph of the function in memory location Y1 ($y = 2x^2 - 3$):**

Use the following range parameters.

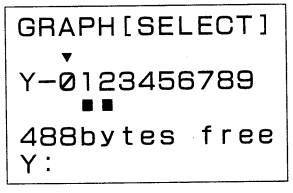
Xmin :	−5	Ymin :	−5
Xmax:	5	Ymax:	5
Xscl :	1	Yscl :	1

Display the graph select screen.

[FUNC]

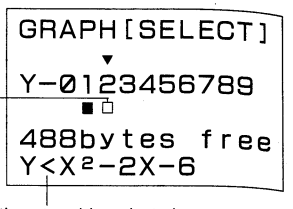


[2](SELECT)



Move the pointer to the functions you want to *omit*, and press [EXE] for each one.

[▶][▶][EXE]



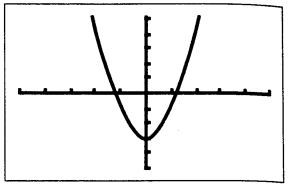
Indicates function stored in this memory area will not be drawn.

Function stored in selected memory area

•To change the status of a function from non-draw to draw, move the pointer to its memory area and press [EXE] again.

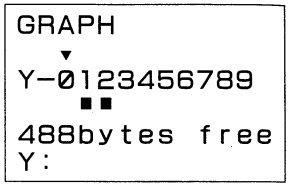
Draw the graph.

[RUN]

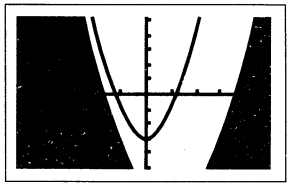


• To overlay graphs for all the functions in memory

Example 2 **To overlay graphs for all the functions using the same range parameters as in Example 1:**



[RUN]



Note

•If you do not want to display the functions on the graphic display, use the set up screen to change the FUNC DISP setting to OFF (page 19).

4-7 Other Graph Functions

Important

You should enter the COMP, SD, LR or GRAPH Mode to perform the operations described in this section. Here, we will explain all operations using the COMP Mode only.

■Setting the Type of Graphing Method

You can use the set up screen to specify either of the following two graphing methods by changing the DRAW TYPE setting (page 18).

"1. CONNECT" ..... Connects plotted points with lines

"2. PLOT" ..... Only points are plotted (without connection)

■Trace Function

The Trace Function lets you move a pointer along the line in a graph and display coordinate values at any point.

• To determine the values of points of intersection

Example **To determine the values of the points of intersection for the following equations:**

$y = x^2 - 3$

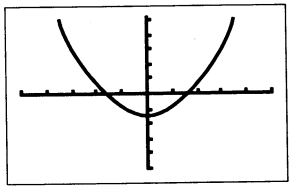
$y = -x + 2$

Use the following range parameters:

Xmin :	−5	Ymin :	−10
Xmax:	5	Ymax:	10
Xscl :	1	Yscl :	2

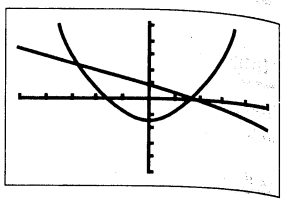
Draw the graph of the first equation.

[SHIFT][SETUP][1](GRAPH TYPE)
[1](RECT)[EXIT]
[SHIFT][Cls][EXE]
[Graph][X-var][x²][−][3][EXE]



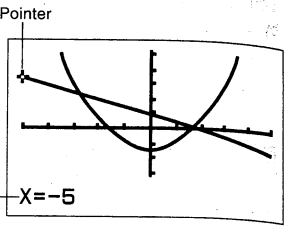
Overdraw the graph of the second equation.

[Graph] [(−)] [X-var] [+] [2] [EXE]



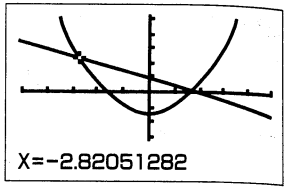
Press [Trace] to activate the Trace Function.

[Trace]



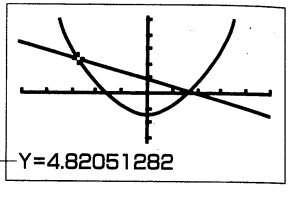
Move the pointer to the first intersection using ▶ and ◀.

▶ ~ ▶



•Press [SHIFT] [Coord] to switch between display of the x-coordinate and the y-coordinate.

[SHIFT] [Coord]

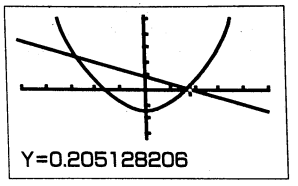


Important

The pointer does not move at fixed intervals. It follows the dots on the display. Because of this, the values provided for coordinates are approximate.

Move the pointer to the next intersection.

▶ ~ ▶



Finally, press [Trace] again to exit the Trace Function.

•To move the trace between two graphs

This operation can be used to trace multiple graphs on the same display. In the COMP, SD, or LR Mode this operation can be used with up to six graphs that are layered using multi-statements or programming. In the GRAPH Mode, all graphs that are drawn on the display can be traced.

Example **To trace points on the following equations (using a multistatement):**

$y=(x+2)(x-3)$

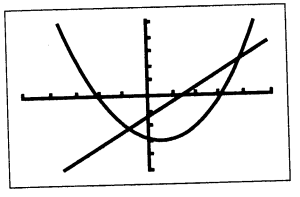
$y=2x-3$

Use the following range parameters:

Xmin :	−5	Ymin :	−10
Xmax :	5	Ymax :	10
Xscl :	1	Yscl :	2

Execute the multistatement that draws the two graphs.

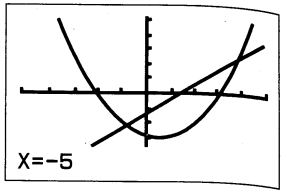
[SHIFT] [SET UP] [1] (GRAPH TYPE)
[1] (RECT) [EXIT]
[SHIFT] [Cls] [EXE]
[Graph] [(] [X-var] [+] [2] [)] [(] [X-var]
[−] [3] [)] [SHIFT] [:]
[Graph] [2] [X-var] [−] [3] [EXE]



Press [Trace] to activate the Trace Function.

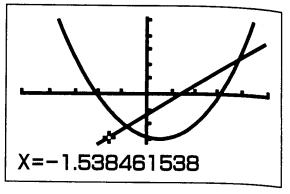
- The coordinates for the point that corresponds to the Xmin range parameter appear for the last graph (first graph in the GRAPH Mode) drawn ($y=2x-3$ in this example). The pointer also appears at this point on the graph.

[Trace]



Move the pointer along the line where it is located using ▶ and ◀.

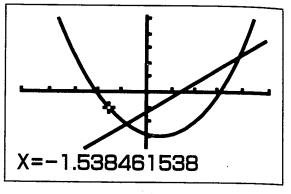
▶ ~ ▶



Pressing ▲ or ▼ moves the pointer to the point on other graph ($y=(x+2)(x-3)$ in this example) that has the same x-coordinate.

- You can use ▲ or ▼ to move the pointer between the two graphs.

▲(or ▼)



■Notes on Using the Trace Function

- You can use the Trace Function immediately after you draw a graph only. If you draw a graph and then perform a calculation or any other operation (besides [M]-Disp, Range, or G-T), the Trace Function will be unavailable.
- The coordinate values at the bottom of the display are shown with a 10-digit mantissa, or with a 9-digit mantissa and 2-digit exponent.
- You cannot use the Trace Function during program execution.
- Once program execution is suspended by a "◢" symbol, you can use the Trace Function on a graph produced at that point.

- If a display statement (◢) caused the first graph to be drawn (indicated when the message "—Disp—" is shown on the display), drawing the subsequent graph after activating the trace function causes the previous coordinates ("x =" and "y =") to be cleared from the display.

■Plot Function

The Plot Function makes it possible to plot points anywhere on a graph.

Note that there are two different plot operations: one for graphs in the COMP, SD, or LR Mode, and another for graphs in the GRAPH Mode.

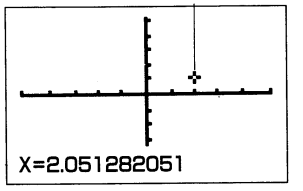
• To plot points in the COMP, SD or LR Mode

Example **To plot a point at $x=2$, $y=2$, with the following range parameters:**

Xmin :	−5	Ymin :	−10
Xmax:	5	Ymax:	10
Xscl :	1	Yscl :	2

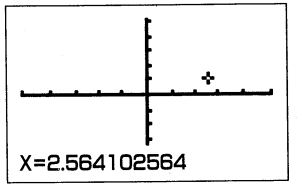
[SHIFT][Cls][EXE]
[SHIFT][Plot][2][,][2][EXE]

Pointer



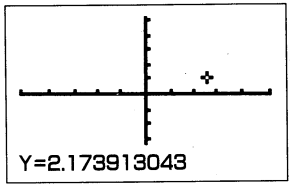
Move the pointer using ▶, ◀, ▲ and ▼.

▶▶▶▶



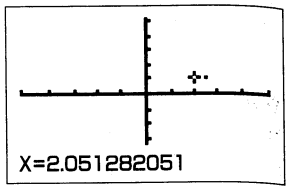
- Press [SHIFT][Coord] to switch between display of the x-coordinate and the y-coordinate.

[SHIFT][Coord]



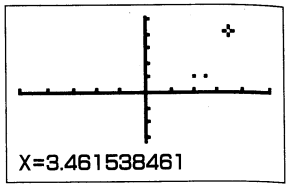
When the pointer is at the location you want, press [EXE] to plot a point. At this time, the pointer returns to the original point you specified (2, 2 in this example).

[EXE]



You can change the original point at any time by pressing [SHIFT] [Plot] and inputting new coordinates.

[SHIFT] [Plot] [3] [•] [5] [,]
[6] [•] [5] [EXE]



Notes

- If you activate the Plot Function without specifying an x-coordinate and y-coordinate, the pointer appears in the center of the screen.
- If you specify a point that is outside the range set up by the range parameters, the pointer does not appear on the display.
- The x-coordinate value of the current pointer location is stored in the X value memory. The y-coordinate value is stored in the Y value memory.

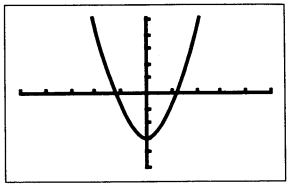
• To plot points in the GRAPH Mode

Example **To plot a point on the graph represented by $y = 2x^2 - 3$, with the following range parameters:**

Xmin :	−5	Ymin :	−5
Xmax:	5	Ymax:	5
Xscl :	1	Yscl :	1

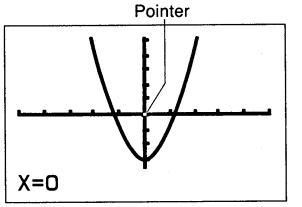
First plot the graph for $y = 2x^2 - 3$ using the procedures described on page 95.

[RUN]



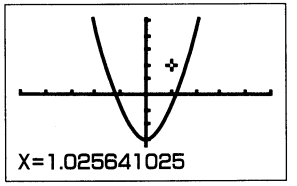
Activate the Plot Function, and the pointer appears flashing in the center of the display.

[SHIFT] [Plot]



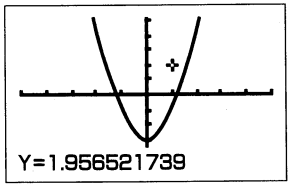
Use the cursor keys to move the pointer around the display.

[▶] ~ [▶]
[▲] ~ [▲]



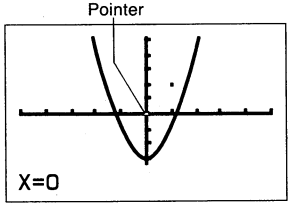
- Press [SHIFT] [Coord] to switch between display of the x-coordinate and the y-coordinate.

[SHIFT] [Coord]



When the pointer is at the location you want, press [EXE] to plot a point.

You can return the pointer to the center of the display at any time by pressing [SHIFT] [Plot].



Notes:

- You can switch the Plot Function off by pressing [SHIFT] [Cls]. When you do, the graph is cleared from the display and then redrawn, without the points that you plotted.
- Whenever you are using the Plot Function, the location of the pointer is maintained in value memory. The x-coordinate is stored in value memory X, while the y-coordinate is stored in value memory Y.

■Line Function

With the Line Function, you can link two points with a straight line.

Note that there are two different line operations: one for graphs in the COMP, SD, or LR Mode, and another for graphs in the GRAPH Mode.

• To draw a line in the COMP, SD or LR Mode

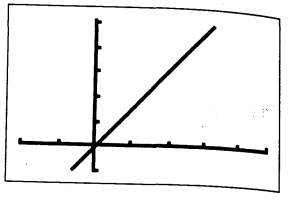
Example **To draw the graph for $y = 3x$, and then draw a line from the point on the graph where $x = 2$ and $y = 6$:**

Use the following range parameters:

Xmin :	−2	Ymin :	− 2
Xmax:	5	Ymax:	10
Xscl :	1	Yscl :	2

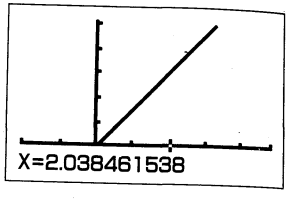
Draw the graph.

[SHIFT] [Cls] [EXE]
[Graph] [3] [X-var] [EXE]



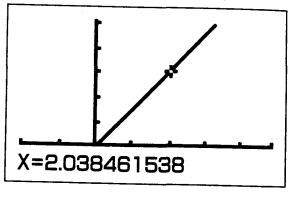
Use the Plot Function to locate the pointer at $x = 2$, $y = 0$.

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



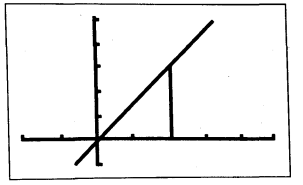
Move the pointer up to the graph line.

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



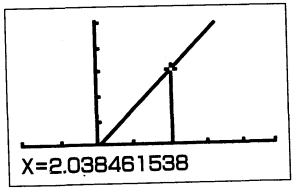
Draw the line.

[SHIFT] [Line] [EXE]



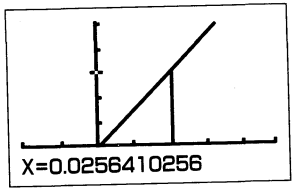
Now draw another line to the y-axis. Since the x- and y-coordinates of the point you last plotted are stored in X and Y value memories, you can easily move the pointer back to the point on the graph. Note the following operation.

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



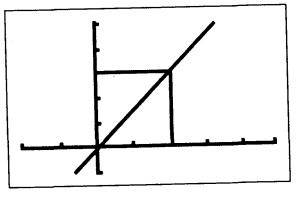
Move the pointer to the y-axis.

[◀] ~ [◀]



Draw the line.

[SHIFT] [Line] [EXE]



• To draw lines in the GRAPH Mode

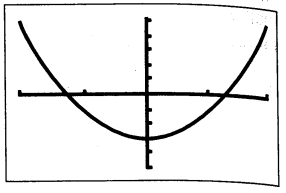
Example **To draw the graph for $y = 2x^2 - 3$ and then draw a line from the minimum point on the graph to the point where $x = 2$ and $y = 5$:**

Use the following range parameters:

Xmin :	−2	Ymin :	−5
Xmax:	2	Ymax:	5
Xscl :	1	Yscl :	1

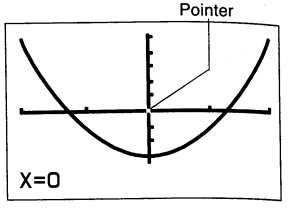
First draw the graph for $y = 2x^2 - 3$ using the procedures described on page 95.

[RUN]



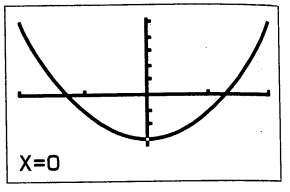
Activate the Plot Function, and the pointer appears flashing in the center of the display.

[SHIFT] [Plot]



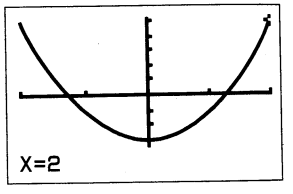
Use the cursor keys to move the pointer to the minimum point on the graph, and press [EXE].

[▼] ~ [▼] [EXE]



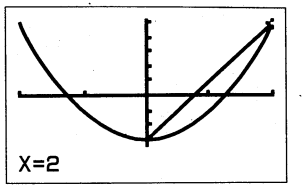
Use the cursor keys to move the pointer to the point where $x = 2$ and $y = 5$.

[▶] ~ [▶]
[▲] ~ [▲]



Press [SHIFT] [Line] [EXE] to connect the two points with a line.

[SHIFT] [Line] [EXE]



Note:

- You can switch the Line Function off by pressing [SHIFT] [Cls]. When you do, the graph is cleared from the display and then redrawn, without the lines you drew.

■ Graph Scroll Function

Immediately after you have drawn a graph, you can scroll it on the display. Use the cursor keys to scroll the graph left, right, up and down. The display is scrolled in increments of 12 dots, with the display being redrawn after each scroll operation.

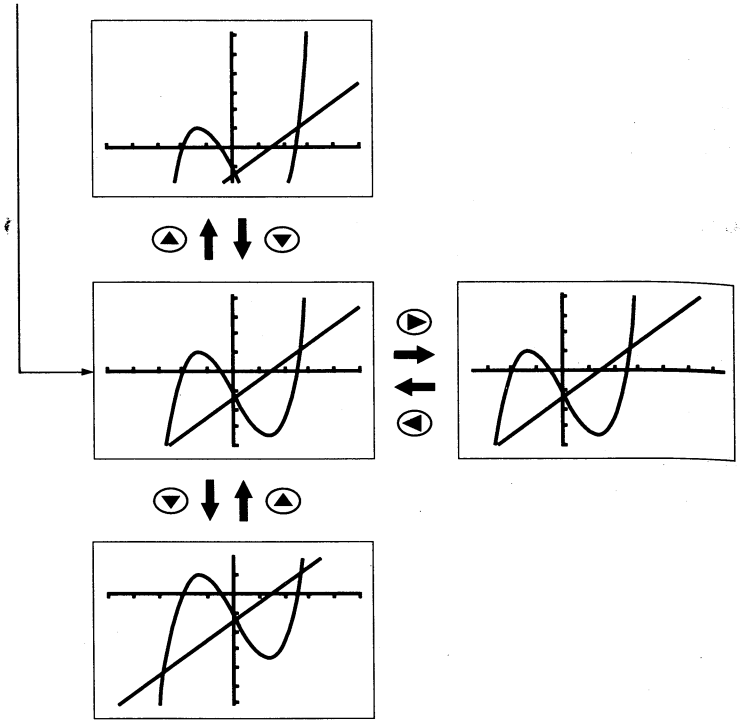
• To scroll the graph on the display

Example **To draw the graph for $y = 0.25(x + 2)(2x + 1)(2x - 5)$, $y = 2x - 3$, and then scroll it:**

Use the following range parameters:

Xmin :	−5	Ymin :	−8
Xmax:	5	Ymax:	8
Xscl :	1	Yscl :	2

[SHIFT][SETUP][1](GRAPH TYPE)[1](RECT)[EXIT]
[SHIFT][Cls][EXE]
[Graph][0][•][2][5][(][X-var][+][2][)]
[(][2][X-var][+][1][)][(][2][X-var][−]
[5][)][SHIFT][↵]
[Graph][2][X-var][−][3][EXE]



•You cannot scroll bar graphs and line graphs produced using single-variable statistical data.

■Zoom Functions

You can use Zoom to enlarge or reduce graphs on the display.

• Before using Zoom

Pressing [Zoom] immediately after drawing a graph displays the following menu of zoom functions.

[Zoom]

```
1. BOX
2. ×f
3. ×1/f
4. ORG
```

The following are the items that are available from this menu.

"**1. BOX**" ..... Box Function
"**2. ×f**" ..... Zooms in on the graph in accordance with the zoom factors
"**3. $\times 1/f$**" ..... Zooms out on the graph in accordance with the inverse of the zoom factors
"**4. ORG**" ..... Restores a graph zoomed using the Box Function or factor zooming to its original size.

■Box Zoom Function

The Box Zoom Function lets you cut out a specific section of a graph for zooming.

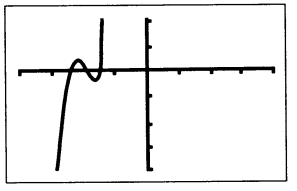
• To zoom in on a part of a graph

Example **To specify a box on the graph for $y=(x+5)(x+4)(x+3)$, with the following range parameters:**

Xmin :	−8	Ymin :	−4
Xmax:	8	Ymax:	2
Xscl :	2	Yscl :	1

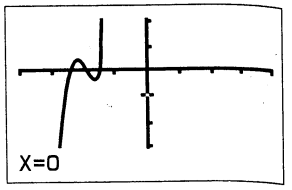
Draw the graph.

[SHIFT][SETUP][1](GRAPH TYPE)
[1](RECT)[EXIT]
[SHIFT][Cls][EXE]
[Graph][(][X-var][+][5][)][(][X-var][+]
[4][)][(][X-var][+][3][)][EXE]



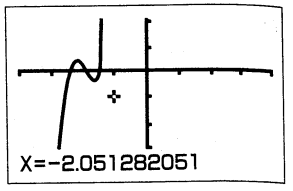
Press [Zoom] [1] (BOX) and a pointer appears flashing in the center of the display.

[Zoom] [1] (BOX)



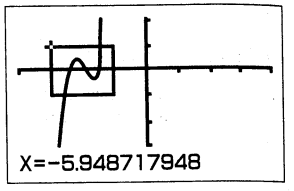
Move the pointer using the cursor keys.
Once the pointer is located where you want one corner of the box to be, press [EXE].

◀ ~ ◀ [EXE]



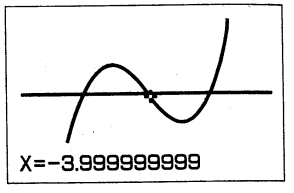
Move the pointer to the location of the corner diagonally opposite the one you have just set. Note that a box automatically appears on the display.

▲ ~ ▲ ◀ ~ ◀



When the pointer is located where you want the other corner of the box to be, press [EXE].

[EXE]



Note that the box you defined becomes the outline of the display, and the graph is enlarged to fit.
You can repeat the enlarge operation and make enlargements of part of an enlarged graph.

- To return the graph back to its original size, press [Zoom] [4] (ORG).
- If you locate the second corner of the box horizontally or vertically with the first corner, no box is formed, and so the graph is not enlarged.

- For graphs drawn in the COMP, SD, or LR Mode, the Box Zoom Function can be used to zoom only the most recently drawn six graphs. In the case of the GRAPH Mode, the Box Zoom Function can be used to zoom any graphs drawn.
- You cannot enlarge or reduce a single-variable bar or line graph.

■Using the Factor Function to Enlarge and Reduce the Entire Graph

The current pointer location is used as the center point of the enlargement or reduction. You can use the cursor keys to move the center point (pointer location) to the point you want.

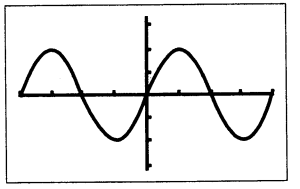
• To enlarge a graph

Example **To enlarge the graph for $y = \sin x$ by 1.5 times on the x-axis and 2 times on the y-axis, using the following range parameters:**

Xmin :	−360	Ymin :	−1.6
Xmax :	360	Ymax :	1.6
Xscl :	90	Yscl :	0.5

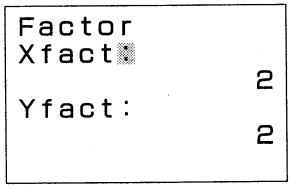
Draw the graph.

[SHIFT] [SET UP] [1] (GRAPH TYPE)
[1] (RECT) [EXIT]
[SHIFT] [Cls] [EXE]
[FUNC] [2] (DRG) [1] (Deg) [EXE]
[Graph] [sin] [X-var] [EXE]



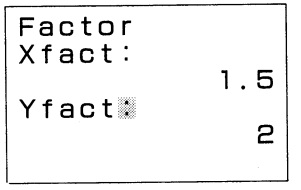
Press [SHIFT] [Factor] to display the Factor Input Screen.

[SHIFT] [Factor]



Input the zoom factors for the x-axis and y-axis.

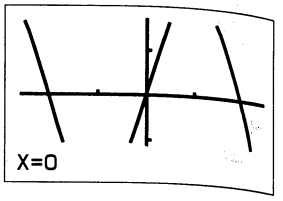
[1] [•] [5] [EXE]



[EXIT]

Press [Zoom][2](×f) to redraw the graph according to the factors you have specified.

[Zoom][2](×f)



At this time, the range parameters are changed as follows:

Xmin :	−240	Ymin :	−0.8
Xmax:	240	Ymax:	0.8
Xscl :	90	Yscl :	0.5

You can repeat the enlarge operation and enlarge the enlarged graph again.

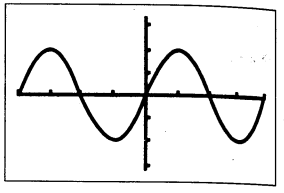
• To reduce a graph

Example **To reduce the graph for $y = \sin x$ by 1.5 times on the x-axis and 2.0 times on the y-axis, using the following range parameters:**

Xmin :	−360	Ymin :	−1.6
Xmax:	360	Ymax:	1.6
Xscl :	90	Yscl :	0.5

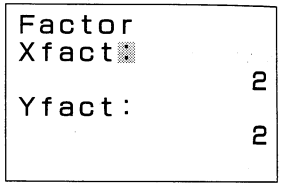
Draw the graph.

[SHIFT][SETUP][1](GRAPH TYPE)
[1](RECT)[EXIT]
[SHIFT][Cls][EXE]
[FUNC][2](DRG)[1](Deg)[EXE]
[Graph][sin][X-var][EXE]



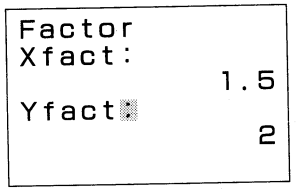
Press [SHIFT][Factor] to display the Factor Input Screen.

[SHIFT][Factor]



Input the zoom factors for the x-axis and y-axis.

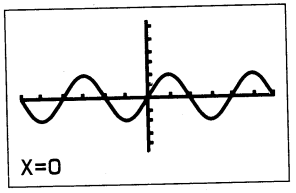
[1][•][5][EXE]



[EXIT]

Press [Zoom][3](×1/f) to redraw the graph according to the factors you have specified.

[Zoom][3](×1/f)



At this time, the range parameters are changed as follows:

Xmin :	−540	Ymin :	−3.2
Xmax:	540	Ymax:	3.2
Xscl :	90	Yscl :	0.5

You can repeat the reduce operation and reduce the reduced graph again.

• To return a graph to its original size

Use the following operation to return an enlarged or reduced graph to its original size.

[Zoom][4](ORG)

• To specify the zoom factors within a program

Use the following format to specify the zoom factors in a program.

Factor (Xfct), (Yfct)

- When you execute the program, range parameters are adjusted in accordance with the enlargement or reduction.

Notes:

- Yo can use only positive values as zoom factors. You can also use calculations (such as 2×3).
- For graphs drawn in the COMP, SD, or LR Mode, the Factor Zoom can be used to zoom only the most recently drawn six graphs. In the case of the GRAPH Mode, Factor Zoom can be used to zoom any graphs drawn.
- You cannot enlarge or reduce a single-variable bar or line graph.

■Using the Overwrite Function

You can use the following format, specifying your own values for the value memory where indicated, to draw more than one graph on the display at the same time.

[Graph] function [,] [SHIFT] [ALPHA] [(] value memory [=] [ALPHA] any value [,] any value [,] ... any value [ALPHA] [)] [EXE]

Notes:

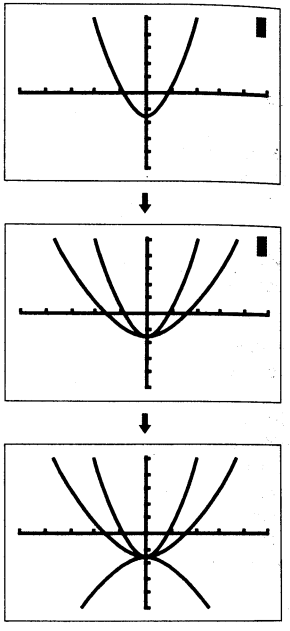
- Only one value for substitution of values can be used in the above format.
- X and Y cannot be specified as the value memory.
- If simultaneous graphing (SIMUL GRAPH) is ON, graphs for each of the variable values are drawn simultaneously (page 19).
- The above format can be used with rectangular coordinate, and with inequalities only.

• To overwrite graphs

Example **To draw graphs by substituting the values 3, 1, and −1 for A in the function $y = Ax^2 - 3$. Use the following range parameters:**

Xmin :	−5	Ymin :	−10
Xmax:	5	Ymax:	10
Xscl :	1	Yscl :	2

[SHIFT] [SET UP] [1] (GRAPH TYPE)
[1] (RECT) [EXIT]
[SHIFT] [Cls] [EXE]
[Graph] [ALPHA] [A] [X-var] [x^2] [−] [3]
[,] [SHIFT] [ALPHA] [(] [A] [=] [ALPHA]
[3] [,] [1] [,] [(−)] [1]
[ALPHA] [)] [EXE]



4-8 Some Graphing Examples

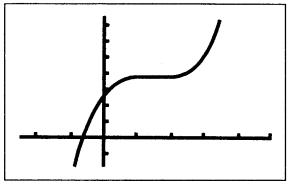
The following examples are presented to show you some ways that the graphing functions can be used effectively.
Note that all of these examples are performed in the COMP Mode.

Example 1 **To graph the function $y = x^3 - 9x^2 + 27x + 50$:**

Use the following range parameters.

Xmin :	−5	Ymin :	−30
Xmax:	10	Ymax:	150
Xscl :	2	Yscl :	20

[SHIFT] [SET UP] [1] (GRAPH TYPE)
[1] (RECT) [EXIT]
[SHIFT] [Cls] [EXE]
[Graph] [X-var] [^] [3] [−] [9] [X-var] [x^2]
[+] [2] [7] [X-var] [+] [5] [0] [EXE]

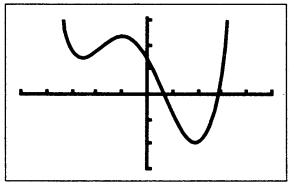


Example 2 **To graph the function $y = x^4 + 4x^3 - 36x^2 - 160x + 300$:**

Use the following range parameters.

Xmin :	−10	Ymin :	−600
Xmax:	10	Ymax:	600
Xscl :	2	Yscl :	200

[SHIFT] [Cls] [EXE]
[Graph] [X-var] [^] [4] [+] [4] [X-var] [^] [3]
[−] [3] [6] [X-var] [x^2] [−] [1] [6] [0] [X-var]
[+] [3] [0] [0] [EXE]



Chapter 5

Programming

Chapter 5 Programming

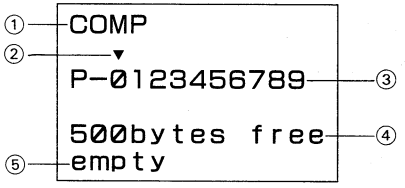
This chapter tells you how to use the versatile program memory of the unit. Once you program a calculation, you can call it up and execute it using any values you want at the touch of a key.

5-1 Introduction to Programming

The following explains the basics about programming the unit. We also provide a number of actual easy-to-understand examples for your reference. For full details on each of the programming operations, see the other sections in this chapter.

■To Enter the PRGM Mode

Highlight the **PRGM** icon on the Main Menu and press [EXE] to enter the PRGM Mode.



① Mode used when program is executed
A mode can be specified for each program.

② Pointer indicating currently selected program area
Use ◀ and ▶, or input a number to move the pointer.

③ Program area numbers

④ Amount of memory available for program storage
Total memory can be divided for storage of up to 10 programs.

⑤ First 13 characters of program
If a program is stored in the program area where the pointer is located, the first 13 characters of the program appear here. The message "empty" appears here is nothing is stored in the selected program area.

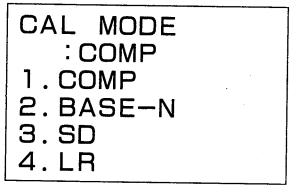
■Specifying the Calculation Mode

Before starting a programming operation, you should first specify the calculation mode (CAL MODE) that matches the calculation you plan to program.

• To specify the calculation mode

Select the program area that contains the program whose calculation mode you want to specify, and then perform the following procedure.

[SHIFT] [SETUP] [1] (CAL MODE)



Enter the number that corresponds to the mode settings you want to change.

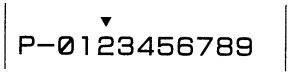
"1. COMP" ..... Computation Mode
"2. BASE-N" ..... BASE Mode
"3. SD" ..... Standard Deviation Mode
"4. LR" ..... Regression Mode

*Pressing [EXIT] returns to the PRGM Mode.

■Selecting a Program Area

You can select a program area by moving the cursor to it using the ▶ and ◀ keys, or by directly inputting the number that names the program area.

▶▶ (or [2])



■Checking How Much Memory Is Used by a Program

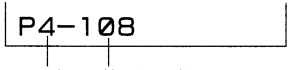
You can check how much memory is used by a program either while the program area list is displayed, or while you are inputting a program.

• To check memory from the program area list

Move the pointer to the number of the area whose memory status you want to check. Press [SHIFT] and then hold down [MEMO] to display the program area number along with the number of bytes it contains.

• To check memory while programming

Press [SHIFT] and then hold down [MEMO] to display the current program area number along with the number of bytes it contains.



Program area number Number of bytes

■Programming Example

The following example illustrates how to actually input a program into memory and execute it.

• To input a program

Example **To program the following formulas, which calculate the surface area (S) and volume (V) of a regular octahedron when the length of one side (A) is known. Store program in area P5.**

$S = 2\sqrt{3}A^2$ $V = \sqrt{2}/3A^3$

[▶][▶][▶][▶][▶]

```
COMP
▼
P-0123456789

500bytes free
empty
```

[EXE] (Starts programming)

```
_
```

[SHIFT][?][→][ALPHA][A][SHIFT][:]
[2][×][SHIFT][√][3][×][ALPHA][A][x²]
[SHIFT][◢]

```
?→A:2×√3×A²◢
_
```

[SHIFT][√][2][÷][3][×][ALPHA][A][^][3]

```
?→A:2×√3×A²◢
√2÷3×A^3_
```

[EXIT]

• The following table describes the four most commonly used commands.

?	Interrupts program execution and displays a question mark to prompt for data input. A value or calculation up to 127 bytes can be input in response to the prompt that appears. The syntax for this command is: ?→<value memory name>. No non-calculation command or multistatement can be performed while the calculator is waiting for input in response to a prompt command.
◢	Connects multi-statements, and interrupts program execution to display the last intermediate result that was calculated or an alphabetic character. In manual calculations, this command should be inserted at points where [EXE] key operation is desired. The display result command "◢" causes program execution to stop while the calculation result up to the display result command or a text message is displayed. To resume program execution, press [EXE]. The final result of the program execution is displayed regardless of whether or not this command is included at the end. Note, however, that this command should be used at the end of the BASE Mode program in order to return the unit to its original mode following the program.
:	Connects multi-statements. Execution of the multi-statements are performed without interruption when this command is used for connection.
↵	Connects multi-statements and performs a new-line operation. This command is the same as ":", except that it makes the program easier to read by putting each statement on a different line. Use [SHIFT][↵] to input this command.

• To execute a program stored in memory

Example **To execute the program stored by the operation described above, for A = 7, 10 and 15**

Length of one side	Surface area	Volume
7cm	(169.7409791) cm^2	(161.6917506) cm^3
10	(346.4101615)	(471.4045208)
15	(779.4228634)	(1590.990258)

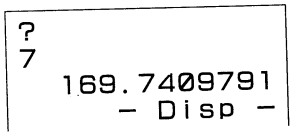
[▶][▶][▶][▶][▶]

```
COMP
▼
P-0123456789
■
480bytes free
?→A:2×√3×A²◢
```

[RUN]

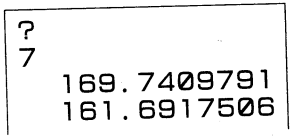
```
?
```

7 EXE (Value of A)

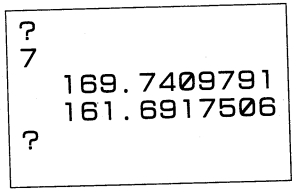


"– Disp –" pauses calculation for display of result

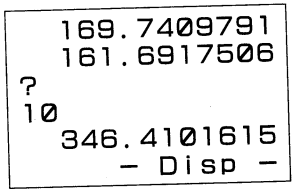
EXE



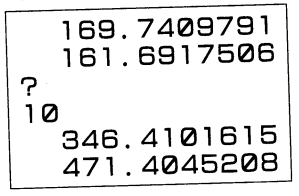
EXE



1 0 EXE (Value of A)



EXE



(The rest is omitted)

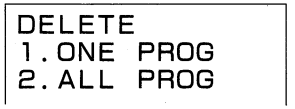
*If calculation is suspended to display a result, press EXE to resume the calculation.
*In the COMP Mode, you can also run a program by pressing Prog, inputting the program area number, and pressing EXE.
*When you execute a program, calculations are performed in the mode (COMP, BASE, SD, LR) that was selected when you input the program.

5-2 Deleting Programs

You can delete programs individually, or you can delete all programs currently stored in memory. In both cases, you must start by pressing FUNC and then 1 to select DELETE.

FUNC

1 (DELETE)



The following describes the items that are available in the delete menu.
"1. ONE PROG" ..... Deletes a specific program
"2. ALL PROG" ..... Deletes all programs

Important

The following procedures cannot be undone. Make sure you do not need data any more before you delete it.

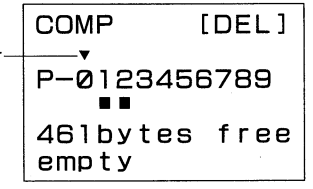
• To delete a specific program

Example **To delete the program stored in area P1.**

While the delete menu is on the display, enter 1 to specify ONE PROG.

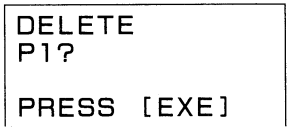
1 (ONE PROG)

Area specified by the pointer before you press 1.



Move the pointer to the area that contains the program you want to delete and press EXE.

▶ EXE



Press [EXE] to delete the program.

[EXE]

```
COMP
  ▼
P-0123456789
  ■
481bytes free
empty
```

•You can press [EXIT] or [AC] to abort the delete operation without deleting anything.

• To delete all programs

While the delete menu is on the display, enter [2] to specify ALL PROG.

[2](ALL PROG)

```
DELETE
ALL PROG?

PRESS [EXE]
```

Press [EXE] to delete all programs.

[EXE]

```
COMP
  ▼
P-0123456789

500bytes free
empty
```

•You can press [EXIT] or [AC] to abort the delete operation without deleting anything.

5-3 About Error Messages

Sometimes a program you enter causes an error message to appear when you execute it. This means that there is an error that needs to be corrected. The following shows a typical error message display

```
P0-Syn ERROR
```

Error type

Program area where error occurred

All of the possible error messages are listed in the Error Message Table on page 152. When you get an error message, look it up in the Error Message Table and take actions to correct it.

5-4 Counting the Number of Bytes

The memory of this unit can hold up to 500 bytes of data. Generally, one function in a program takes up one byte. Some functions, however, require two bytes each.

•1-byte functions

sin, cos, tan, log, (,), A, B, C, 1, 2, etc.

•2-byte functions

Lbl 1, Goto 2, Prog 3, etc.

You can count the bytes in a program by pressing the ◀ and ▶ keys. Each press of these keys causes the cursor to jump one byte.

When the number of bytes remaining drops to five or below, the cursor automatically changes from an underline to "■". If you need to input more than five bytes, try to increase the amount of memory available for program storage by deleting unnecessary programs or deleting expanded memory.

■Checking the Amount of Memory Remaining

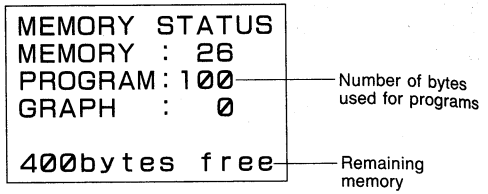
You can use either of the two following methods to check how much memory is available for storage.

• To check memory in the PRGM Mode

Highlight the PRGM icon on the Main Menu and press [EXE] to enter the PRGM Mode (page 118).

• To check memory in other modes

While in the COMP, BASE, SD, or LR Mode, press [SHIFT] [Defm] [EXE].



■Checking the Current Cursor Location

[SHIFT] [MI Disp]

P0-6

(Current location of cursor byte #6)

The above screen remains on the display as long as [SHIFT] [MI Disp] is depressed.

5-5 Program Commands

The unit provides you with special programming commands that let you perform conditional and unconditional jumps and loops.

• To display the program function menu

[FUNC] [5](PRGM)

1. JUMP
2. REL

The following are the items that are available from this menu.

"**1. JUMP**" ..... Displays jump command menu
"**2. REL**" ..... Displays relational operator menu

• To display the jump command menu

[1](JUMP)

1. ⇒
2. Goto
3. Lbl
4. Dsz
5. Isz

The following are the items that are available from this menu.

"**1. ⇒**" ..... Indicates conditional jump destination
"**2. Goto**" ..... Indicates unconditional jump destination
"**3. Lbl**" ..... Indicates label
"**4. Dsz**" ..... Decrements value memory
"**5. Isz**" ..... Increments value memory

• To display the relational operator menu

[2](REL)

1. =
2. ≠
3. >
4. <
5. ≥
6. ≤

The following are the items that are available from this menu.

"1. =" ..... Equal
"2. ≠" ..... Not equal
"3. >" ..... Greater than
"4. <" ..... Less than
"5. ≥" ..... Greater than or equal to
"6. ≤" ..... Less than or equal to

•The following symbols can also be used inside of programs.

","	This symbol indicates the start of a non-executable remark. Everything from "," up until the next ",", ":", "◢" or "↵" symbol is treated as a remark. You can use this symbol to include the name of your program in the first line.
"„"	This symbol indicates text to be shown on the display. Display text should start and end with double quotation marks (page 137).

5-6 Using Jump Commands

Generally, programs are executed from beginning to end, in the order that they are input into memory. This can cause problems when you want to repeat an operation a number of times or when you want to execute a formula in a different location. Jump commands make it possible to accomplish such operations very easily.

■About Unconditional Jumps

An unconditional jump is one that is performed no matter what circumstances exist. To use an unconditional jump with the unit, you first identify the destination of the jump with a label. Then you tell the unit at some point to go to the label and continue execution of the program.
With an unconditional jump however, once we start program execution, it repeats until we tell it to stop.

Example **To program the formula $y = A + Bx$, so that for each execution the values of A and B remain constant, but the value of x varies.**

Program

?, →, A, :, ?, →, B, :, Lbl, 1, :, ?, →, X, :, A, +, B, ×, X, ◢, Goto, 1 23 bytes

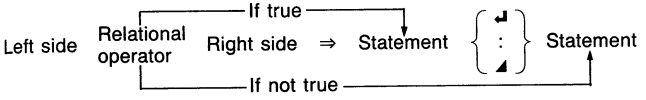
With this program, a prompt appears once for A and B. A prompt for X appears with each execution, of the loop back to label 1 (Lbl 1).

Note

*If your program tells the calculator to go to a label that does not exist, an error message (Go ERROR) appears on the display.

■About Conditional Jumps

With a conditional jump you set up certain criteria and control whether or not the jump is actually performed. Look at the following format.



As shown above, if the condition defined by the relational operator is true, the statement following "⇒" is executed, and then the next statement is executed. If the condition is false, the statement following "⇒" is skipped.
The following are the conditions that you can define using the relational operators.

L=R ..... True when L and R are equal; false when L and R are not equal
L≠R ..... True when L and R are not equal; false when L and R are equal
L>R ..... True when L is greater than R; false when L is less than or equal to R
L<R ..... True when L is less than R; false when L is greater than or equal to R
L≥R ..... True when L is greater than or equal to R; false when L is less than R
L≤R ..... True when L is less than or equal to R; false when L is greater than R

• To use a conditional jump

Example 1 **To write a program that calculates the square root of any input value that is greater than or equal to zero. If a value that is less than zero is input, the program ignores it and prompts further input.**

Program

Lbl, 1, :, ?, →, A, :, A, ≥, 0, ⇒, √‾, A, ◢, Goto, 1 16 bytes

This program starts out by prompting input for A. The next statement tests the input by saying: "if the value of A is greater than or equal to 0, then calculate the square root of A". This is followed by a display result command. After the result is displayed, pressing [EXE] continues with the Goto 1 unconditional jump to label 1 (Lbl 1) at the beginning of the program. For values that are less than 0, the square root calculation statement is skipped and execution jumps directly to the Goto 1 statement.

Example 2 **To write a program that accumulates input values, but displays the total of the values any time zero is entered.**

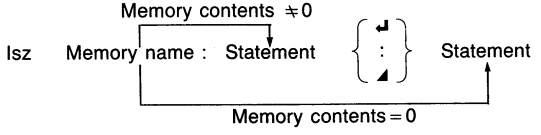
Program

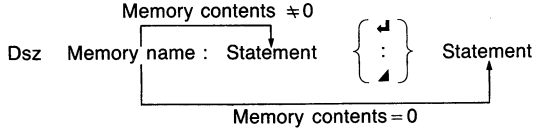
0, →, B, :,
Lbl, 1, :, ?, →, A, :, A, =, 0, ⇒, Goto, 2, :,
A, +, B, →, B, :, Goto, 1, :,
Lbl, 2, :, B 31 bytes

With this program, 0 is assigned to value memory B to clear it. The next statement prompts for input of a value to value memory A. The next statement is a conditional jump that says: "if the value input for A equals 0, then go to label 2". The statement following label 2 (Lbl 2) ends program execution with a display of the value memory B contents. For other values, the next statement adds value memories A and B, and then stores the result in value memory B again. After this, program execution returns to the statement following label 1 (Lbl 1), where the next input for A is prompted.

■ About Count Jumps

There are two count jumps: one that increments a value memory (Isz) and one that decrements a value memory (Dsz). Look at the following format.





As shown above, if the increment or decrement operation does not cause the content of the value memory to become 0, the statement following the value memory name is executed. If the content of the value memory becomes 0, the next statement is skipped.

• To use a count jump

Example 1 **To write a program that accepts input of 10 values, and then calculates the average of the values.**

Program

1, 0, →, A, :, 0, →, C, :,
Lbl, 1, :, ?, →, B, :, B, +, C, →, C, :,
Dsz, A, :, Goto, 1, :, C, ÷, 1, 0 32 bytes

This program starts out by assigning a value of 10 to A. This is because value memory A will be used as a control variable. The next statement clears C to zero. After defining the location of label 1 (Lbl 1), the program then prompts for input of a value for B. The next statement adds the value of B to value memory C, and then stores the result in C. The next three statements say: "decrement the value in A, and if it is still greater than 0, jump back to label 1; otherwise divide the contents of C by 10".

Example 2 **To write a program that calculates at 1-second intervals the altitude of a ball thrown into the air at an initial velocity of Vm/sec and an angle of S°. The formula is expressed as: $h = V \cdot \sin St - \frac{1}{2}gt^2$, with $g = 9.8$. The effects of air resistance should be disregarded.**

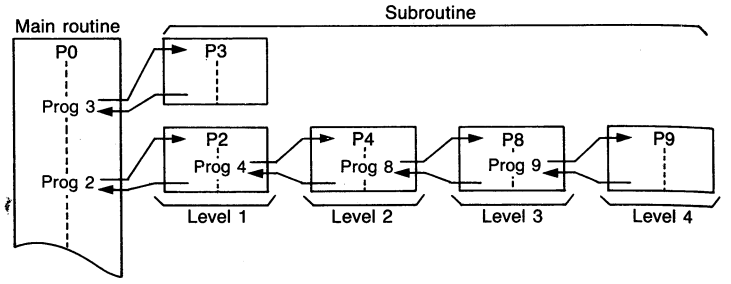
Program

Deg, :, 0, →, T, :, ?, →, V, :, ?, →, S, :,
Lbl, 1, :, Isz, T, :, V, ×, sin, S, ×, T, −,
9, •, 8, ×, T, x^2, ÷, 2, ◢, Goto, 1 38 bytes

With this program, the first statements specify the unit of angular measurement and clear T to 0. Then the initial velocity is prompted for V and the angle is prompted for S. Lbl 1 identifies the beginning of the repeat calculation.
The value stored in T is incremented by Isz T, and in this program the Isz command is used only for incrementation, without any comparison or decision being performed. Each time T is incremented, the formula is calculated and the altitude is displayed.

5-7 Using Subroutines

Up to this point, all of the programs we have seen were contained in a single program area. You can also jump between program areas, so that the resulting execution is made up of pieces in different areas. In such a case, the central program from which other areas are jumped to is called a "main routine". The areas jumped to from the main routine are called "subroutines".



To input the command to jump to another program area, press [Prog], followed by the name of the program area you want to jump to.

Example **Prog 2 — Jumps to program area 2**

After the jump to the program area you specify, execution continues from the beginning of the subroutine stored in the specified program area. When end of the subroutine is reached, execution returns to the statement following the Prog command that initiated the subroutine.

You can jump from one subroutine to another, a procedure that is called "nesting". You can nest up to a maximum of 10 levels, and an error will occur (Ne ERROR) if you try to nest an 11th time. If you try to jump to a program area that does not contain a program, an error message (Go ERROR) will appear on the display.

Important

- The Goto command does not jump between program areas. A Goto command jumps to the label (Lbl) located inside the same program area.

■Subroutines Save Memory

Note the following two programs.

P0 Fix, 3, :, ?, →, A, :, 2, ×, √, 3, ×, A, x^2, ◢,
√, 2, ÷, 3, ×, A, ^, 3 — 23 bytes

P1 Fix, 3, :, ?, →, A, :, √, 3, ×, A, x^2, ◢,
√, 2, ÷, 1, 2, ×, A, ^, 3 — 22 bytes

If we input these two programs separately, they require a total of 45 bytes. But note that the underlined portions of these two programs are identical. This means that these parts can be stored as subroutines and called by both of the programs.
If we use subroutines, we get the following results.

Subroutines

P9 Fix, 3, :, ?, →, A, :, √, 3, ×, A, x^2 — 12 bytes
P8 √, 2, ÷, 3, ×, A, ^, 3 — 8 bytes

Main routines

P0 Prog, 9, :, Ans, ×, 2, ◢, Prog, 8 — 9 bytes
P1 Prog, 9, ◢, Prog, 8, :, Ans, ÷, 4 — 9 bytes

As you can see, the number of bytes required to store the two programs and the subroutines is 38, for a saving of 7 bytes.
When you execute the program in program area P0, it immediately jumps to P9 and executes the contents of that program area. At the end of P9, execution returns to P0 where the result produced by the subroutine in P9 is multiplied by 2 and then displayed. After you press the [EXE] key, execution jumps to P8, where the remainder of the program is executed.
With the main routine in program area P1, execution jumps immediately to program area P9. At the end of P9 execution returns to P1 where the P9 result is displayed. When you press [EXE], execution jumps again to P8. At the end of P8, execution returns to P1, where the result produced by P8 is divided by 4 and displayed.

5-8 Using Array Memory

In addition to the individual value memories, the unit gives you array memory capabilities. Note the following.

Value Memories	Array Memories
A	A[0] B[−1]
B	A[1] B[0]
C	A[2] B[1]

As you can see, array memory names consist of an alphabetic character, followed by a *subscript* enclosed in brackets. The subscript is a value, either positive or negative, or a value memory that represents a value. If the value of 5 is assigned to value memory X, for example, the array memory A[X] would be equivalent to A[5].

■Array Memories Simplify Programming

Since the subscript of an array memory can be a value memory name, programming becomes more economical. Note the following.

Example **To write a program that assigns the values from 1 through 10 to memories A through J**

Using value memories

```
1, →, A, :, 2, →, B, :, 3, →, C, :, 4, →, D, :,
5, →, E, :, 6, →, F, :, 7, →, G, :, 8, →, H, :,
9, →, I, :, 1, 0, →, J                          40 bytes
```

Using array memories

```
0, →, Z, :, Lbl, 1, :, Z, +, 1, →, A, [, Z, ], :,
Isz, Z, :, Z, <, 1, 0, ⇒, Goto, 1               26 bytes
```

As you can see, using array memories uses 14 fewer bytes. You get even more economy with the following program.

Example **To write a program that displays the contents of a memory specified by input**

Using value memories

```
Lbl, 1, :, ?, →, Z, :,
Z, =, 1, ⇒, A, ◢, Z, =, 2, ⇒, B, ◢,
Z, =, 3, ⇒, C, ◢, Z, =, 4, ⇒, D, ◢,
Z, =, 5, ⇒, E, ◢, Z, =, 6, ⇒, F, ◢,
Z, =, 7, ⇒, G, ◢, Z, =, 8, ⇒, H, ◢,
Z, =, 9, ⇒, I, ◢, Z, =, 1, 0, ⇒, J, ◢,
Goto, 1                                         70 bytes
```

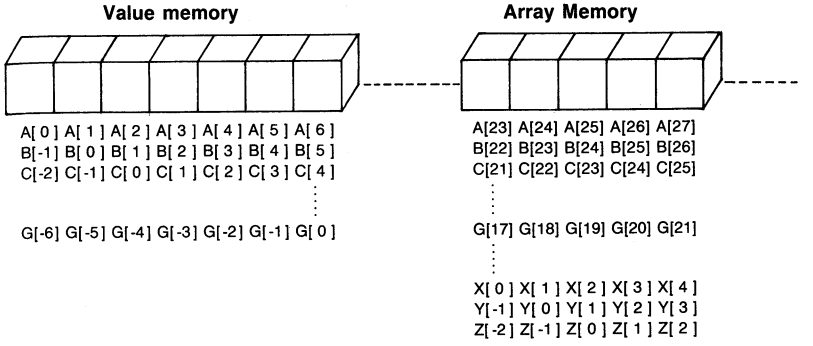
Using array memories

```
Lbl, 1, :, ?, →, Z, :, A, [, Z, −, 1, ], ◢,
Goto, 1                                         16 bytes
```


With value memories, logical operations are used to test the input until the proper memory is found. With array memories, on the other hand, the specified memory is found immediately.

■Cautions When Using Array Memories

You should remember that array memories are actually based on value memories. Note the following relationship.



This means that you must be careful when using array memories that you do not overlap.

■Sample Programs That Use Array Memory

The following programs store x and y data in array memories. Whenever an x value is input, the corresponding y value is displayed. You can input a total of 15 sets of data.

Example 1 **With this version of the program, value memory A is used as a data control memory, while memory B is used for temporary storage of x data. The x data is stored in memories C[1] (value memory D) through C[15] (value memory R), while the y data is stored in memories C[16] (value memory S) through C[30] (value memory Z[7]).**

```
1, →, A, :, Defm, 7, :,
Lbl, 1, :, ?, →, C, [, A, ], :,
?, →, C, [, A, +, 1, 5, ], :,
Isz, A, :, A, =, 1, 6, ⇒, Goto, 2, :, Goto, 1, :,
Lbl, 2, :, 1, 5, →, A, :, ?, →, B, :,
B, =, 0, ⇒, Goto, 5, :,
Lbl, 3, :, B, =, C, [, A, ], ⇒, Goto, 4, :,
Dsz, A, :, Goto, 3, :, Goto, 2, :,
Lbl, 4, :, C, [, A, +, 1, 5, ], ◢, Goto, 2, :,
Lbl, 5                                          98 bytes
```

The above program uses value memories as follows:

***x* data**

C[1]	C[2]	C[3]	C[4]	C[5]	C[6]	C[7]	C[8]	C[9]	C[10]
D	E	F	G	H	I	J	K	L	M
C[11]	C[12]	C[13]	C[14]	C[15]					
N	O	P	Q	R					

***y* data**

C[16]	C[17]	C[18]	C[19]	C[20]	C[21]	C[22]	C[23]	C[24]	C[25]
S	T	U	V	W	X	Y	Z	Z(1)	Z(2)
C[26]	C[27]	C[28]	C[29]	C[30]					
Z(3)	Z(4)	Z(5)	Z(6)	Z(7)					

Example 2 **This version is identical to Example 1, except that a different letter is used for the *x* and *y* data names.**

```
1, ⁻¹, A, :, Defm, 7, :,
Lbl, 1, :, ?, →, C, [, A, ], :,
?, →, R, [, A, ], :,
Isz, A, :, A, =, 1, 6, ⇒, Goto, 2, :, Goto, 1, :,
Lbl, 2, :, 1, 5, →, A, :, ?, →, B, :,
B, =, 0, ⇒, Goto, 5, :,
Lbl, 3, :, B, =, C, [, A, ], ⇒, Goto, 4, :,
Dsz, A, :, Goto, 3, :, Goto, 2, :,
Lbl, 4, :, R, [, A, ], ◢, Goto, 2, :,
Lbl, 5                                          92 bytes
```

This above program uses value memories as follows:

***x* data**

C[1]	C[2]	C[3]	C[4]	C[5]	C[6]	C[7]	C[8]	C[9]	C[10]
D	E	F	G	H	I	J	K	L	M
C[11]	C[12]	C[13]	C[14]	C[15]					
N	O	P	Q	R					

***y* data**

R[1]	R[2]	R[3]	R[4]	R[5]	R[6]	R[7]	R[8]	R[9]	R[10]
S	T	U	V	W	X	Y	Z	Z(1)	Z(2)
R[11]	R[12]	R[13]	R[14]	R[15]					
Z(3)	Z(4)	Z(5)	Z(6)	Z(7)					

Note that in the above two programs the Defm command was necessary to increase the number of value memories.

5-9 Displaying Text Messages

Text, numbers, and symbols can be displayed by programs as messages that prompt input or other actions. You can tell the program to display the name of the variable that will be assigned an input value so the operator can better understand what is required. Note the following example.

Statement	**Display**
Without text ? → X	?
With text "X=" ? → X	X=?

As you can see, the text prompt makes it much easier to understand what input is required by the program.

Messages can also be used to explain the meaning of a displayed result.

Example

```
Lbl, 0, :, '', N, =, '', ?, →, B, ~, C, :,
0, →, A, :,
Lbl, 1, :, C, ÷, 2, →, C, :, Frac, C, ≠, 0, ⇒, Goto, 3, :,
Isz, A, :, C, =, 1, ⇒, Goto, 2, :, Goto, 1, :,
Lbl, 2, :, '', X, =, '', ◢, A, ◢, Goto, 0, :,
Lbl, 3, :, '', N, O, '', ◢, Goto, 0                    70 bytes
```

This program prompts for input of a value. If the input value is equivalent to 2^x, it displays the value of x. If the input value is not equivalent to 2^x, it displays the message "NO".

Important

Be sure to follow the message with a display result command if there is another statement following the message.

Assuming that the program is stored in P2:

RUN	N=?
4 0 9 6 EXE	X=
EXE	12
EXE	N=?
3 1 2 4 EXE	NO

Text that is longer than 14 characters is displayed in two lines. When text is at the bottom of the display, the entire screen scrolls upwards.

```
ABCDEFGHIJKLM
```

↓ After a while

```
ABCDEFGHIJKLM
NOPQRSTU
```


5-10 Using the Graph Function in Programs

By using the graph function in programs, you can graphically represent long, complex equations or overdraw graphs a number of times. All graph commands (except the Trace Function) can be used in programs. You can also specify range parameters in programs.

Example **To graphically represent the number of solutions (real roots) that satisfy both of the following equations**

$$y = x^4 - x^3 - 24x^2 + 4x + 80$$
$$y = 10x - 30$$

Use the following range parameters.

Xmin :	−10	Ymin :	−120
Xmax:	10	Ymax:	150
Xscl :	2	Yscl :	50

First, program the range parameters. Note that parameters are separated by commas. Press [EXE] at the end.

Range, (−), 1, 0, ', 1, 0, ', 2, ', (−), 1, 2, 0, ', 1, 5, 0, ', 5, 0

Next, program the equation for the first graph. Press [EXE] at the end.

Graph, X, ^, 4, −, X, ^, 3, −, 2, 4, X, x^2, +, 4, X, +, 8, 0

Finally, program the equation for the second graph.

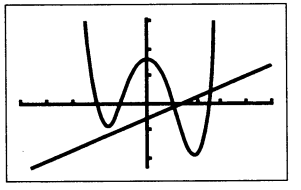
Graph, 1, 0, X, −, 3, 0

Total: 49 bytes

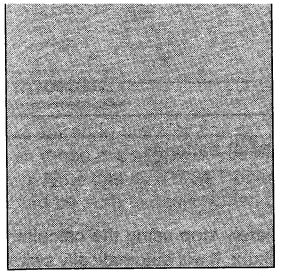
```
↵
Graph Y=X^4-X
^3-24X²+4X+80
↵
Graph Y=10X-3
0_
```

The above program should produce this graph when you execute it.

[EXIT] [RUN]



You could use a display result command (◢) in place of the [EXE] operation at the end of the first equation. This will cause execution to stop after the first graph is drawn. To resume execution, press [EXE].



Appendix

The appendix contains information on battery replacement, error messages, specifications, and other details.

Appendix A Power Supply

This unit is powered by two AAA-size (LR03 (AM4) or UM-4) batteries.

■When to Replace Batteries

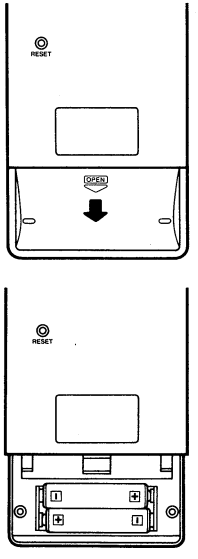
If the following message appears on the display, immediately stop using the calculator and replace batteries. If you try to continue using the calculator, it will automatically switch power off, in order to protect memory contents.
You will not be able to switch power back on until you replace batteries.

```
Low battery!
```

- Be sure to replace batteries at least once every two years, no matter how much you use the calculator during that time.
- All data stored in memory is cleared whenever you replace batteries or if battery power drops below a certain level. Be sure to keep written copies of all important data to avoid losing it due to low battery power.

The batteries that come installed in this unit when you purchase it are for factory test purposes, so they will probably not provide normal service life.

■Replacing Batteries



① Switch the power of the calculator off.

② Slide the battery compartment cover on the back of the unit in the direction indicated by the arrow.

③ Remove the two old batteries.

④ Load two new batteries into the calculator so that their positive ⊕ and negative ⊖ ends are facing properly. Be sure to replace all two batteries with new ones.

⑤ Replace the battery compartment cover, sliding it in the direction opposite that indicated by the arrow.

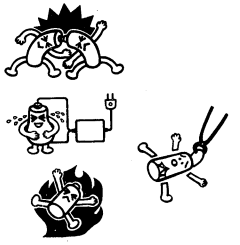
⑥ Perform the RESET operation described on page 144.

Important

Data stored in memory can be corrupted or lost if battery power drops below a certain level. When this happens, you must perform the RESET operation to restore normal operation. Note that the RESET operation clears all data from memory. Because of this, you should be sure to keep written copies of all important data to avoid losing it due to low battery power.

Precautions:
Incorrectly using batteries can cause them to burst or leak, possibly damaging the interior of the unit. Note the following precautions:

- Be sure that the positive ⊕ and negative ⊖ poles of each battery are facing in the proper directions.
- Never mix batteries of different types.
- Never mix old batteries and new ones.
- Never leave dead batteries in the battery compartment.
- Remove the batteries if you do not plan to use the unit for long periods.
- Never try to recharge the batteries supplied with the unit.
- Do not expose batteries to direct heat, let them become shorted, or try to take them apart.



(Should a battery leak, clean out the battery compartment of the unit immediately, taking care to avoid letting the battery fluid come into direct contact with your skin.)

Keep batteries out of the reach of small children. If swallowed, consult with a physician immediately.

■About the Auto Power Off Function

The calculator switches power off automatically if you do not perform any key operation for about 6 minutes. To restore power, press AC/ON.

Appendix B To Reset the Calculator

You should perform the RESET operation whenever you want to initialize the calculator.

Warning!
The procedure described here clears all memory contents. Never perform this operation unless you want to totally clear the memory of the calculator.
If you need the data currently stored in memory, be sure to write it down somewhere before performing the RESET operation.

• To reset the calculator
Press [MENU] to display the Main Menu, and use the cursor keys to highlight the **RESET** icon. And then press [EXE].

```
RESET OK?

YES:
 PRESS [EXE]
NO :
 PRESS [EXIT]
```

Press [EXE] to reset the calculator, or [EXIT] to abort the reset operation.

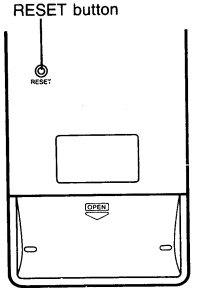
[EXE]

```
**********

 MEMORY
 ALL CLEARED!

**********
```


Resetting the calculator initializes the unit to the following settings.

Item	Initial Setting
Mode	COMP
Unit of Angular Measurement	Deg
Norm	Norm 1
BASE-N	Dec
Value Memories	Clear
Expanded Memory	Clear
Ans Memory	Clear
Graphic Display	Clear
Text Display	Clear
Graphic Function Memory	Clear
Program	Clear
Input Buffer	Clear
Replay Memory	Clear

*If the calculator stops operating correctly for some reason, use a thin, pointed object to press the RESET button on the back of the calculator. This should make the RESET confirmation screen appear on the display. Perform the procedure described above to complete the RESET operation.



Appendix C Function Reference

■Manual Calculations

Mode specification	COMP Mode (see page 16)	Arithmetic and function calculations
	BASE Mode (see page 16)	Binary, octal, decimal, hexadecimal conversions and calculations, logical operations
	SD Mode (see page 16)	Standard deviation calculations (1-variable statistical)
	LR Mode (see page 16)	Regression calculations (paired variable statistical)
Statistical graph	SD Mode (see page 60, 85)	For production of single variable statistical graphs (bar graphs, line graphs, normal distribution curves)
	LR Mode (see page 62, 87)	For production of paired variable statistical graphs (regression lines)
Functions	Type A functions	Function command input immediately after numeric value [x^2, x^{-1}, $x!$, ° ' "]
	Type B functions	Function command input immediately before numeric value (sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, log, ln, e^x, 10^x, $\sqrt{}$, $\sqrt[3]{}$, etc.)
	Paired variable functions	Function command input between two numeric values, numeric value enclosed in parentheses input immediately after function command (A ^ B (A to the Bth power), B $\sqrt[]{}$ A (A to the 1/Bth power), Pol (A, B), Rec (A, B)) **A and B are numeric values.*
	Immediately executed functions	Displayed value changed with each press of a key. [ENG, $\overleftarrow{\text{ENG}}$, $\overleftarrow{\text{°}}$ ' "]

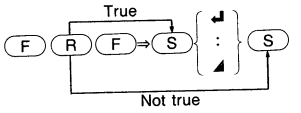
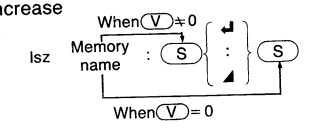
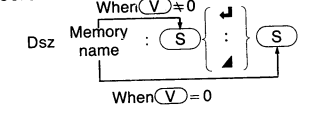
Binary, octal, decimal, hexadecimal calculations (see page 37, 38)	Setting number system	Decimal ..... [1](Dec)[EXE] Hexadecimal ..... [2](Hex)[EXE] Binary ..... [3](Bin)[EXE] Octal ..... [4](Oct)[EXE]
	Number system specification	Number system for the numeric value entered immediately after can be specified regardless of the currently set number system. To specify: Decimal ..... [6](d~o)[1](d) Hexadecimal ..... [6](d~o)[2](h) Binary ..... [6](d~o)[3](b) Octal ..... [6](d~o)[4](o)
	Logical operations	Input numeric values are converted to binary and each bit is tested. Result is converted back to number system used for input, and then displayed. Not ..... Reverse of each bit and ..... Logical product of each bit or ..... Logical sum of each bit xor ..... Exclusive logical sum of each bit xnor ..... Exclusive negative logical sum of each bit
Standard deviation calculations (see page 60)	Data clear	[FUNC][6](CLEAR)[2](Scl)[EXE]
	Data input	Data [;frequency] [DT] **Frequency can be omitted.*
	Data deletion	Data [;frequency] [CL] **Frequency can be omitted.*
	Result display	Number of data (n) ..... [FUNC][1](CAL)[6](n)[EXE] Sum (Σx) ..... [FUNC][1](CAL)[5](Σx)[EXE] Sum of squares (Σx^2) . [FUNC][1](CAL)[4](Σx^2)[EXE] Mean ($\bar{x}$) ..... [FUNC][1](CAL)[1]($\bar{x}$)[EXE] Population standard deviation ($x\sigma_n$) ..... [FUNC][1](CAL)[2]($x\sigma_n$)[EXE] Sample standard deviation ($x\sigma_{n-1}$) ..... [FUNC][1](CAL)[3]($x\sigma_{n-1}$)[EXE]

Regression calculations (see page 62)	Data clear	FUNC 6 (CLEAR) 2 (Scl) EXE
	Data input	x data, y data [;frequency] DT **Frequency can be omitted.*
	Data deletion	x data, y data [;frequency] CL **Frequency can be omitted.*
	Result display	Number of data (n) ..... FUNC 1 (CAL) 2 (Σ) 3 (n) EXE Sum of x (Σx) ..... FUNC 1 (CAL) 2 (Σ) 2 (Σx) EXE Sum of y (Σy) ..... FUNC 1 (CAL) 2 (Σ) 5 (Σy) EXE Sum of squares of x (Σx^2) ..... FUNC 1 (CAL) 2 (Σ) 1 (Σx^2) EXE Sum of squares of y (Σy^2) ..... FUNC 1 (CAL) 2 (Σ) 4 (Σy^2) EXE Sum of products of x and y (Σxy) ..... FUNC 1 (CAL) 2 (Σ) 6 (Σxy) EXE Mean of x ($\bar{x}$) ..... FUNC 1 (CAL) 1 (DEV) 1 ($\bar{x}$) EXE Mean of y ($\bar{y}$) ..... FUNC 1 (CAL) 1 (DEV) 4 ($\bar{y}$) EXE Population standard deviation of x ($x\sigma_n$) ..... FUNC 1 (CAL) 1 (DEV) 2 ($x\sigma_n$) EXE Population standard deviation of y ($y\sigma_n$) ..... FUNC 1 (CAL) 1 (DEV) 5 ($y\sigma_n$) EXE Sample standard deviation of x ($x\sigma_{n-1}$) ..... FUNC 1 (CAL) 1 (DEV) 3 ($x\sigma_{n-1}$) EXE Sample standard deviation of y ($y\sigma_{n-1}$) ..... FUNC 1 (CAL) 1 (DEV) 6 ($y\sigma_{n-1}$) EXE Constant term of regression formula (A) ..... FUNC 1 (CAL) 3 (REG) 1 (A) EXE Regression coefficient (B) ..... FUNC 1 (CAL) 3 (REG) 2 (B) EXE Correlation coefficient (r) ..... FUNC 1 (CAL) 3 (REG) 3 (r) EXE Estimated value of x ($\hat{x}$) ..... FUNC 1 (CAL) 3 (REG) 4 ($\hat{x}$) EXE Estimated value of y ($\hat{y}$) ..... FUNC 1 (CAL) 3 (REG) 5 ($\hat{y}$) EXE

Special functions	Ans	The latest result obtained in manual or program calculations is stored in memory. It is recalled by pressing SHIFT Ans. **Mantissa of numeric value is 15 digits.*
	Replay	•After calculation results are obtained, the formula can be recalled by pressing either ◀ or ▶. •If an error is generated, pressing either ◀ or ▶ will cancel the error and the point where the error was generated will be indicated by a blinking cursor.
	Multistatement	Colons are used to join a series of statements or calculation formulas. If joined using "◢", the calculation result to that point is displayed.
	Memory	The number of memories can be expanded from the standard 26. Memories can be expanded in units of one up to 24 (for a total of 50). Ten bytes are required for one memory. SHIFT Defm number of memories EXE.
Graph function	Range	Graph range settings Xmin ..... Minimum value of x Xmax ..... Maximum value of x Xscl ..... Scale of X-axis (space between points) Ymin ..... Minimum value of y Ymax ..... Maximum value of y Yscl ..... Scale of Y-axis (space between points)
	Trace	Moves pointer on graph. Current coordinate location is displayed.
	Plot	Marks pointer (blinking dot) at any coordinate on the graph display.
	Line	Connects with a straight line two points created with plot function.
	Box	Defines area for zoom in.
	Factor	Defines factor for zoom in/zoom out.
	Original	Returns graph to original dimensions after zoom operation.
	Scroll	Scrolls screen to view parts of graphs that are off the display.

■Program Calculations

Program input	Calculation mode	Mode that conforms with program specified by: SHIFT SETUP 1(CAL MODE)1(COMP), (2(BASE-N), 3(SD), 4(LR))
	Program area specification	Cursor is moved to the desired program area name (P0 through P9) using ◀ or ▶, and EXE is pressed.
Program execution	Program area specification	Execution starts with Prog program area name EXE. Program area name: P0 through P9
Program editing	Program area specification	Cursor is moved to the desired program area name (P0 through P9) using ◀ or ▶, and EXE is pressed.
	Editing	Cursor is moved to position to be edited using ◀ or ▶. •Press correct key for corrections. •Press DEL for deletions. •Press SHIFT INS to specify insert mode for insertion.
Program delete	Deletes specific program	Press FUNC 1(DELETE)1(ONE PROG). Then move the cursor to the desired program area name (P0 through P9) using ◀ and ▶, and press EXE EXE.
	Clears all programs	Press FUNC 1(DELETE)2(ALL PROG)EXE.

Program commands	Unconditional jump	Program execution jumps to the Lbl *n* which corresponds to Goto *n*. **n = 0 through 9*
	Conditional jumps	If conditional expression is true, the statement after "⇒" is executed. If not true, execution jumps to the statement following next "↵", ":" or "◢".  (F): Formula (R): Relational operator (S): Statement **The relational operator is:* =, ≠, >, <, ≥, ≤.
	Count jumps	The value in a memory is increased or decreased. If the value does not equal 0, the next statement is executed. If it is 0, a jump is performed to the statement following the next "↵", ":" or "◢". Increase  Decrease  (S): Statement (V): Value in memory
	Subroutines	Program execution jumps from main routine to subroutine indicated by Prog *n* (*n* = 0 through 9). After execution of the subroutine, execution returns to the point following Prog *n* in the original program area.

Appendix D Error Message Table

Message	Meaning	Countermeasure
Syn ERROR	①Calculation formula contains an error. ②Formula in a program contains an error.	①Use ◀ or ▶ to display the point where the error was generated and correct it. ②Use ◀ or ▶ to display the point where the error was generated and then correct the program.
Ma ERROR	①Calculation result exceeds calculation range. ②Calculation is performed outside the input range of a function. ③Illogical operation (division by zero, etc.)	①②③ Check the input numeric value and correct it. When using memories, check that the numeric values stored in memories are correct.
Go ERROR	①No corresponding Lbl *n* for Goto *n*. ②No program stored in program area Prog *n*.	①Correctly input a Lbl *n* to correspond to the Goto *n*, or delete the Goto *n* if not required. ②Store a program in program area Prog *n*, or delete the Prog *n* if not required.
Ne ERROR	•Nesting of subroutines by Prog *n* exceeds 10 levels.	•Ensure that Prog *n* is not used to return from subroutines to main routine. If used, delete any unnecessary Prog *n*. •Trace the subroutine jump destinations and ensure that no jumps are made back to the original program area. Ensure that returns are made correctly.
Stk ERROR	•Execution of calculations that exceed the capacity of the stack for numeric values or stack for calculations.	•Simplify the formulas to keep stacks within 10 levels for the numeric values and 26 levels for the calculations. •Divide the formula into two or more parts.
Mem ERROR	①Specified expanded value memory does not exist. ②Not enough memory to expand value memories specified number. ③Not enough memory to store statistical data. ④Not enough memory to hold function input in the Graph Mode for graph drawing.	①Use SHIFT Defm to correctly expand the number of value memories. ②③④ •Keep the number of value memories you use for the operation within the number of value memories currently available. •Simplify the data you are trying to store to keep it within the available memory capacity. •Delete no longer needed data to make room for the new data.
Arg ERROR	Incorrect argument specification for a command that requires an argument.	Correct the argument. •Sci *n*, Fix *n*: *n* = integer from 0 through 9. •Lbl *n*, Goto *n*: *n* = integer from 0 through 9, or alpha character from A through Z. •Prog *n*: *n* = 0 through 9. •Defm *n*: *n* = integer from 0 up to the number of remaining bytes.

Appendix E Input Ranges

Function	Input range	Internal digits	Accuracy	Notes
$\sin x$ $\cos x$ $\tan x$	(DEG) $\|x\| < 9 \times 10^{9}$° (RAD) $\|x\| < 5 \times 10^{7}\pi$rad (GRA) $\|x\| < 1 \times 10^{10}$grad	15 digits	As a rule, accuracy is ±1 at the 10th digit.	However, for $\tan x$: $\|x\| \neq 90(2n+1)$:DEG $\|x\| \neq \pi/2(2n+1)$:RAD $\|x\| \neq 100(2n+1)$:GRA
$\sin^{-1}x$ $\cos^{-1}x$	$\|x\| \leqq 1$	〃	〃	
$\tan^{-1}x$	$\|x\| < 1 \times 10^{100}$			
$\sinh x$ $\cosh x$	$\|x\| \leqq 230.2585092$	〃	〃	Note: For sinh and tanh, when $x = 0$, errors are cumulative and accuracy is affected at a certain point.
$\tanh x$	$\|x\| < 1 \times 10^{100}$			
$\sinh^{-1}x$	$\|x\| < 5 \times 10^{99}$	〃	〃	
$\cosh^{-1}x$	$1 \leqq x < 5 \times 10^{99}$			
$\tanh^{-1}x$	$\|x\| < 1$			
$\log x$ $\ln x$	$1 \times 10^{-99} \leqq x < 1 \times 10^{100}$	〃	〃	
10^{x}	$-1 \times 10^{100} < x < 100$	〃	〃	
e^{x}	$-1 \times 10^{100} < x \leqq 230.2585092$			
$\sqrt{x}$	$0 \leqq x < 1 \times 10^{100}$	〃	〃	
x^2	$\|x\| < 1 \times 10^{50}$			
$1/x$	$\|x\| < 1 \times 10^{100}$, $x \neq 0$	〃	〃	
$\sqrt[3]{x}$	$\|x\| < 1 \times 10^{100}$			
$x!$	$0 \leqq x \leqq 69$ (x is an integer)	〃	〃	
nPr nCr	Result $< 1 \times 10^{100}$ n, r (n and r are integers) $0 \leqq r \leqq n$, $n < 1 \times 10^{10}$	〃	〃	
Pol (x, y)	$\sqrt{x^2+y^2} < 1 \times 10^{100}$	〃	〃	

Function	Input range	Internal digits	Accuracy	Notes
Rec (r, θ)	$0 \leqq r < 1 \times 10^{100}$ (DEG) $\|\theta\| < 9 \times 10^{9}$° (RAD) $\|\theta\| < 5 \times 10^{7}\ \pi$rad (GRA) $\|\theta\| < 1 \times 10^{10}$grad	15 digits	As a rule, accuracy is ±1 at the 10th digit.	However, for $\tan\theta$: $\|\theta\| \neq 90(2n+1)$:DEG $\|\theta\| \neq \pi/2(2n+1)$:RAD $\|\theta\| \neq 100(2n+1)$:GRA
°’ ”	$\|a\|$, b, $c < 1 \times 10^{100}$ $0 \leqq$ b, c	〃	〃	
$\overleftarrow{\text{°’ ”}}$	$\|x\| < 1 \times 10^{100}$ Hexadecimal display: $\|x\| \leqq 2777777.777$			
^ (x^y)	$x > 0$: $-1 \times 10^{100} < y\log x < 100$ $x = 0$:$y > 0$ $x < 0$: $y = n, \frac{1}{2n+1}$ (n is an integer) However; $-1 \times 10^{100} < \frac{1}{y}\log\|x\| < 100$	〃	〃	
$\sqrt[x]{y}$	$y > 0$:$x \neq 0$ $-1 \times 10^{100} < \frac{1}{x}\log y < 100$ $y = 0$:$x > 0$ $y < 0$:$x = 2n+1, \frac{1}{n}$ ($n \neq 0$, n is an integer) However; $-1 \times 10^{100} < \frac{1}{x}\log\|y\| < 100$	〃	〃	
$a^{b}/_{c}$	•Results Total of integer, numerator and denominator must be within 10 digits (includes division marks). •Input Result displayed as a fraction for integer when integer, numerator and denominator are less than 1×10^{10}.	〃	〃	
SD (LR)	$\|x\| < 1 \times 10^{50}$ $\|y\| < 1 \times 10^{50}$ $\|n\| < 1 \times 10^{100}$ $x\sigma n$, $y\sigma n$, $\bar{x}$, $\bar{y}$, A, B, r: $n \neq 0$ $x\sigma n-1$, $y\sigma n-1$:$n \neq 0$, 1	〃	〃	

Function	Input range
BASE-N	Values after variable within following range: DEC: $-2147483648 \leqq x \leqq 2147483647$ BIN: $1000000000 \leqq x$ $\leqq 1111111111$ (negative) $0 \leqq x \leqq 01111111111$ (0, positive) OCT: $20000000000 \leqq x \leqq 37777777777$ (negative) $0 \leqq x \leqq 17777777777$ (0, positive) HEX: $80000000 \leqq x \leqq$ FFFFFFFF (negative) $0 \leqq x \leqq$ 7FFFFFFF (0, positive)

*Errors may be cumulative with internal continuous calculations such as x^y, $\sqrt[x]{y}$, $x!$, $\sqrt[3]{x}$ sometimes affecting accuracy.

Appendix F Specifications

Model: fx-7300G

Calculations

Basic calculation functions:
Negative numbers, exponents, parenthetical addition/subtraction/multiplication/division (with priority sequence judgement function — true algebraic logic).

Built-in scientific functions:
Trigonometric/inverse trigonometric functions (units of angular measurement: degrees, radians, grads); hyperbolic/inverse hyperbolic functions; logarithmic/exponential functions; reciprocals; factorials; square roots; cube roots; powers; roots; squares; decimal-sexagesimal conversions; permutations/combinations; π; random numbers; internal rounding; fraction functions; engineering calculations; negative signing; exponential notation input; parenthetical calculations; coordinate transformations; number of decimal place and significant digit specification

Binary, octal, decimal, hexadesimal calculations:
Binary, octal, decimal, hexadesimal arithmetic operations, conversions, negation (two's complement), logical operations

Statistics:
Standard deviation: number of data; mean; standard deviation (two types); sum; sum of squares.
Regression: number of data; mean of x; mean of y; standard deviation of x (two types); standard deviation of y (two types); sum of x; sum of y; sum of squares of x; sum of squares of y; sum of square of x and y; fixed term; regression coefficient; correlation coefficient; estimated value of x; estimated value of y

Value memories: 26 standard, expandable up to 50

Calculation range:
1×10^{-99} to $9.999999999 \times 10^{99}$ and 0. Internal operation uses 15-digit mantissa.

Exponential display: Norm 1: $10^{-2} > |x|, |x| \geq 10^{10}$
Norm 2: $10^{-9} > |x|, |x| \geq 10^{10}$

Rounding:
Performed according to the specified number of significant digits and number of specified decimal places.

Graph functions

Built-in function graphs (rectangular coordinates):
(20 types) sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, log, ln, 10^x, e^x, x^2, $\sqrt{\ }$, $\sqrt[3]{\ }$, x^{-1}

Graph types: Rectangular coordinate graphs: $y=f(x)$
Inequality graphs: ($y>f(x)$, $y<f(x)$, $y\geqq f(x)$, $y\leqq f(x)$)
Single-variable statistical graphs (bar histograms, line graphs, normal distribution curves)
Paired-variable statistical graphs (regression line)

Graph memory: Graph function storage, editing, selection, drawing

Graph functions:
Range specification; overwrite, trace, plot, line, scroll, zoom, box and factor zoom (× f, × 1/f, ORG) capabilities

Programming

Program commands: Unconditional jumps: Goto, Lbl
Conditional jumps: ⇒, ◢, logical operators (=, ≠, >, <, ≥, ≤)
Jumps with count: Isz, Dsz
Subroutine calls: Prog, up to 10 levels of nesting

Number of stored programs: 10 maximum (P0 to P9)

Check functions: Program checking, debugging

Program area: 500 bytes maximum

General

Display system:
13-character × 6-line liquid crystal display; 10-digit mantissa and 2-digit exponent for calculations; displays binary, octal, hexadecimal, sexagesimal values, fraction

Power supply: Two AAA-size batteries (LR03 (AM4) or R03 (UM-4))

Power consumption: 0.05W

Battery life: Approximately 2,000 hours (continuous display of initial screen) type LR03 (AM4)
Approximately 1,000 hours (continuous display of initial screen) type R03 (UM-4)
Approximately 2 years (power switch off) with LR03 (AM4)/R03 (UM-4)

Auto power off:
Power is automatically switched off approximately six minutes after last operation.

Ambient temperature range: 0°C ~ 40°C (32°F ~ 104°F)

Dimensions: 17.5mmH × 77mmW × 157.5mmD (3/4"H × 3"W × 6 1/4"D)

Weight: 120g (4.2oz) including batteries

Accessories: Hard Case