CASIO

CASIO COMPUTER CO.,LTD.

6-1, Nishi-Shinjuku 2-chome
Shinjuku-ku, Tokyo 163-02, Japan

SA9510-001001A
Printed in Japan

U.S. Pat. 4,938,266/4,410,956

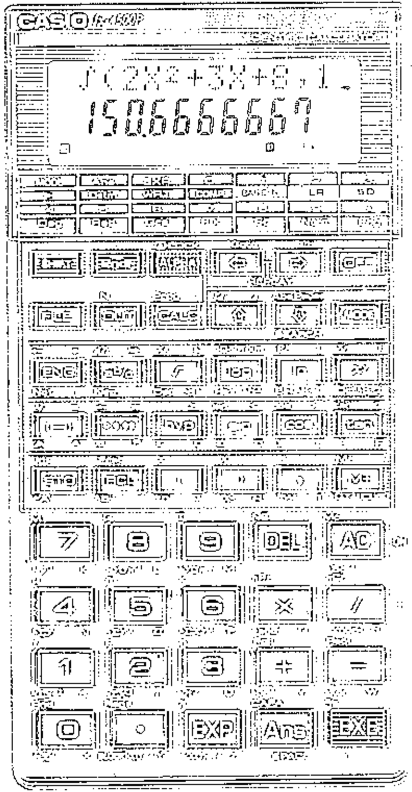
CASIO fx-4500P

CASIO

Scientific calculator

fx-4500P

Owner's manual



CASIO *fx-4500P*

Section 1 Configuration and Operation

Section 2 Manual Calculations

Section 3 Integration Calculation

Section 4 Program Calculation

PROGRAM LIBRARY

Introduction

Thank you for purchasing the Casio fx-4500P.
This unit is an advanced programmable scientific calculator which features a 2-tier display capable of displaying both formulas and results at the same time. The upper display features a 12-character dot matrix display capable of alphabetic and numeric display. The fx-4500P also features a large-volume program memory, and is capable of performing integration calculations. A built-in formula memory is handy when performing repeat calculations, and manual calculations can be easily performed by following written formulas.
Before using this unit, be sure to read these instructions thoroughly. When you're finished reading these instructions, be sure to keep this manual where you can refer to it often.

This manual is composed of four sections:

1. Configuration and Operation
2. Manual Calculations
3. Integration Calculation
4. Program Calculation

Section 1 should be read first to become familiar with the nomenclature, handling and cautions concerning this unit.
Section 2, 3 and 4 can then be read in order to master these types of computations through samples and explanations.

Section 1 Configuration and Operation

- **Key markings** 8
- **Modes** 9
  - Manual calculation modes 9
- **Display** 11
  - Two-tier display 11
  - Display symbols 12
  - Exponential display 12
  - Special display functions 13
- **Handling Precautions** 14
- **Power and Battery Replacement** 15
  - Replacing batteries 15
  - To replace the memory backup battery 15
  - To replace the main battery 16
  - Auto Power-OFF function 17
- **Nomenclature and Functions** 18
- **Before beginning calculations....** 27
  - Calculation priority sequence 27
  - Number of stacks 28
  - Number of input/output digits and calculation digits 28
  - Overflow and errors 29
  - Number of input characters 30
  - Corrections 30

Section 2 Manual Calculations

- **Basic calculations** 34
  - Arithmetic operations 34
  - Parenthesis calculations 35
  - Percentage calculations 36
  - Specifying the number of decimal places, the number of significant digits and the exponent display 37
- **Memory** 39
  - (1) Variable memory 39
  - Array-type memories 41
  - Deleting memory 43
  - (2) Independent memories 44
- **Special functions** 46
  - Answer function 46
  - Omitting the multiplication sign (×) 46
  - Continuous calculation function 47
  - Replay function 48
  - Error position display function 49
  - Multistatement function 50
- **Scientific function calculations** 52
  - Trigonometric functions and inverse trigonometric functions 52
  - Logarithmic and exponential functions 53
  - Performing hyperbolic and inverse hyperbolic functions 54
  - Coordinate transformation 55
  - Permutation and combination 56
  - Other functions ($\sqrt{\ }$, x^2, x^{-1}, $x!$, $\sqrt[3]{\ }$, Ran#) 57
  - Fractions 58
- **Engineering symbol calculations** 59
- **Binary, octal, decimal, hexadecimal calculations** 60
  - Binary and octal block display 61
  - Binary, octal, decimal, hexadecimal conversions 63
  - Negative expressions 64
  - Basic arithmetic operations using binary, octal, decimal and hexadecimal values 65
  - Logical operations 66
- **Statistical calculations** 67
  - Standard deviation 67
  - Regression calculation 70
- **Formula memory function** 77
  - Purpose of the formula memory function 77

Section 3 Integration Calculation

- **Input of function $f(x)$ and integration calculation** 84
  - Examples of operation 85
  - Notes on integration calculation 88

Section 4 Program Calculation

- **What is a program?** 90
  - Programming 90
  - Calculation formula 91
  - Registering filenames 91
  - Writing programs 92
  - Program execution 93
- **Program correction, addition and deletion** 95
  - Inserting lines 95
  - Inserting a line at the beginning 95

Editing programs 95
Program deletion 100
Program searchs 101
Filename sequential search 101
Sequential search of program lines 103
Direct search 104
Scrolling right and left in filenames and program lines 106
Program execution 107
Execution through filename search 107
Execution by pressing SHIFT Prog 108
Aborting execution 109
Program debugging (correcting errors) 109
Convenient program commands 109
Jump commands 109
Subroutines 114
Pause command 117
Variable input command 118
Fixm 118
Remaining program capacity 120
Determining the number of remaining steps 120
Using the unit as a data bank 121

PROGRAM LIBRARY
1. Prime factor analysis 126
2. Greatest common measure 128
3. Δ↔Y transformation 130
4. Minimum loss matching 132
5. Cantilever under concentrated load 134
6. Normal distribution 136
7. Numerical solution of an equation (Newton's law) 138
8. Quadratic equation 140
9. Complex numbers 144
Error messages at-a-glance 154
Input ranges of functions 155
Specifications 158

Section 1 Configuration and Operation

Key markings

Modes

Display

Handling Precautions

Power and Battery Replacement

Nomenclature and Functions

Before beginning calculations....

Section 1 Configuration and Operation

Before using this unit for the first time, be sure to press the ALL RESET button on the back of the unit.

•Flow of Operations (Be sure to read this!)

In contrast to standard electronic calculators, the keys on "scientific" calculators often perform more than one function. The following explains how to use these keys, so it's a good idea to read this section carefully before using your calculator for the first time.

Key markings

The fx-4500P uses any given key to perform a number of different functions. For example, the key shown below is used to perform the following 5 functions: ①: (−), ②: $\sqrt[3]{\ }$, ③: =, ④: A, ⑤: /A.

The function of this key differs depending on the operational mode the calculator is set to (see page 9), however if it is pressed directly, it performs the (−) function. If you press the [SHIFT] key and then press this key, it carries out the second function $\sqrt[3]{\ }$. If you press the [2ndF] key and then press the [(−)] key, it acts as the [=] key. And if you press it after pressing the [ALPHA] key, you can input the radical "A". Finally, you can use the [(−)] key while in the BASE-N (see page 60) "HEX" mode to input the hexadecimal "/A". You'll notice that the key shows marks for each of these functions, which are color coded for easy identification.

Referring back to the [(−)] key, the function marked in orange is carried out after pressing the [SHIFT] key. After pressing the [2ndF] key, the [(−)] key operates the function marked in light green. After pressing the [ALPHA] key, the function marked in red is carried out, and in the BASE-N mode, the [(−)] key operates the function marked in green.

Next, let's look at the [1] key. Note that the "Σx^2" mark is in blue brackets. The fx-4500P functions marked in these blue brackets are used for standard deviation (SD mode) and regression (LR mode) calculations.

Functions marked in ORANGE — Accessed by first pressing [SHIFT] key.
Functions marked in LIGHT GREEN — Accessed by first pressing [2ndF] key.
Functions marked in RED — Accessed by first pressing [ALPHA] key.
Functions marked in GREEN — Accessed in BASE-N mode.
Functions marked by BLUE brackets — Accessed in SD mode or LR mode.

Modes

When using the fx-4500P, it is necessary to select the proper mode to suit your calculation requirements. This can be done by using the [MODE] key in combination with the number keys. (Refer to plate below the display window.)

■Manual calculation modes

• Calculation modes

[MODE][0]: COMP mode

General calculations, including function calculations.

[MODE][1]: BASE-N mode

Binary, octal, decimal, hexadecimal conversion and calculations, as well as logical operations.

[MODE][2]: LR mode

Regression calculation. ("LR" symbol appears in display window when this mode is selected.)

[MODE][3]: SD mode

Standard deviation calculation. ("SD" symbol appears in display window when this mode is selected.)

*Modes [0] ~ [3] are totally independent, and cannot be used together.

[MODE][•]: Eng mode

Engineering symbol calculation. ("Eng" symbol appears in display window when this mode is selected.) (Refer to page 59.)

*The calculation mode last selected is retained in memory when the fx-4500P's power is switched OFF.

• Angular measurement modes

[MODE][4]: Deg mode

Specifies measurement in "degrees". ("D" symbol appears in display window when this mode is selected.)

[MODE][5]: Rad mode

Specifies measurement in "radians". ("R" symbol appears in display window when this mode is selected.)

[MODE][6]: Gra mode

Specifies measurement in "grads". ("G" symbol appears in display window when this mode is selected.)

*With the exception of the BASE-N mode, modes [4] ~ [6] can be used in combination with the manual calculation modes.

• Display modes

MODE 7: Fix mode

Specifies number of decimal places. ("Fix" symbol appears in display window when this mode is selected.)

MODE 8: Sci mode

Specifies number of significant digits. ("Sci" symbol appears in display window when this mode is selected.)

MODE 9: Norm mode

Cancels "Fix" and "Sci" specifications.

This operation also changes the range of the exponent display (see page 12).

*With the exception of the BASE-N mode, modes 7 ~ 9 can be used in combination with the manual calculation modes.

The mode last selected is retained in memory when the fx-4500P's power is switched OFF.

• Program calculation mode

MODE EXP: WRT mode

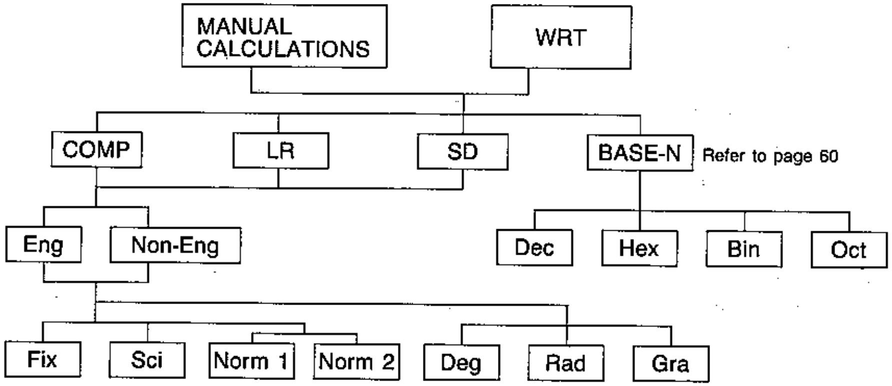
Specified when writing or correcting programs (files). ("WRT" symbol appears in display window when this mode is selected.) Press again to cancel WRT mode.

MODE Ans: Defm mode

Press to expand number of memories. ("Defm" appears in display window when this mode is selected.) After specifying this mode, input a value and press the EXE key to specify the number of useable memories (see page 41.)

Example MODE Ans 10 EXE — Number of memories expanded by 10.

Mode Hierarchy Diagram



• Abbreviations

COMP	Compute	Dec	Decimal number
LR	Linear regression	Hex	Hexadecimal number
SD	Standard deviation	Bin	Binary number
Eng	Engineering	Oct	Octal number

*To return to standard operation (initialized state) press MODE 0 (COMP mode) — MODE 4 (Deg mode) — MODE 9 (Norm mode)

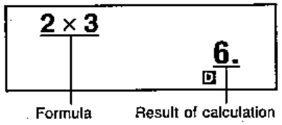
Display

Two-tier display

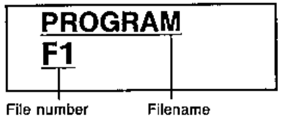
This unit features a two-tier display. The upper tier is a dot display which features an input buffer, for display of up to 12 characters. The lower display is capable of displaying 10 digits for a mantissa, as well as 2 digits for an exponent. When formulas are input, they are displayed on the upper display, and then results are shown on the lower display when the EXE is pressed to execute the calculation. This allows both the formula and the result to be displayed simultaneously.

In addition, when filenames are displayed, the file name is shown on the upper display, with the file number shown on the lower display. When programs are displayed, the program data is displayed on the upper display, with the program line number shown on the lower display.

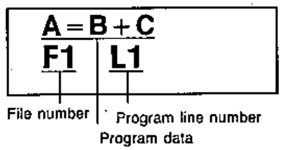
Example 2×3=6



Example Filename

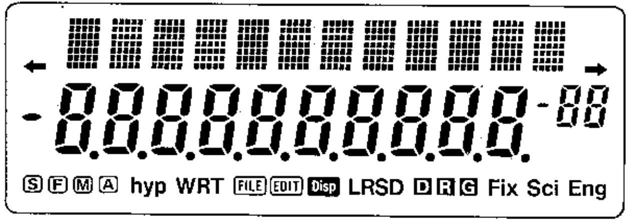


Example Program



■Display symbols

The display window features symbols which light to indicate the present operational status of the fx-4500P.



S:	Indicates SHIFT key has been pressed.
F:	Indicates 2ndF key has been pressed.
M:	Indicates MODE key has been pressed.
A:	Indicates ALPHA key has been pressed.
hyp:	Indicates hyp key has been pressed.
WRT:	Indicates calculator in the WRT mode.
FILE:	Indicates filename or program (file contents) is displayed.
EDIT:	Indicates program is being edited in WRT mode.
Disp:	Indicates intermediate result is displayed.
LR:	Indicates LR mode has been specified.
SD:	Indicates SD mode has been specified.
D:	Indicates angular measurement in units of "Degrees".
R:	Indicates angular measurement in units of "Radians".
G:	Indicates angular measurement in units of "Grads".
Fix:	Indicates specification of number of decimal places is being executed.
Sci:	Indicates specification of number of significant digits is being executed.
Eng:	Indicates Eng mode has been specified.
← →:	Indicates number of characters exceeds limitation of screen. Non-displayed characters can be viewed by "scrolling" right or left, as indicated by arrow(s).

■Exponential display

During normal calculation, this unit is capable of displaying up to 10 digits. However if calculation results exceed this limit, they are automatically displayed in exponential format. You can choose from two different types of exponential display formats:

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

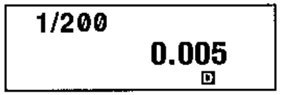
(B) 10^{-9}(0.000000001)> $|x|$, $|x| \geqq 10^{10}$: Norm 2 mode

Selection of these modes can be carried out by pressing MODE 9, when no specification has been made for the number of decimal places or significant digits.
The present status is not displayed, so it is necessary to perform the following procedure to specify either display format:

1 ◢ 200 EXE →

(Format A)

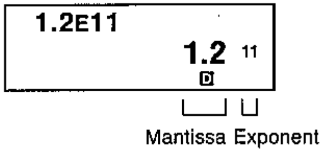
→



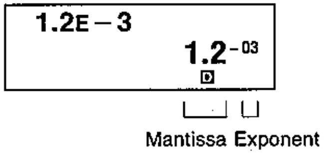
(Format B)

The examples given in this manual shows calculation results in exponential display format "A".

How to view the calculation results in exponential format.



→ 1.2×10^{11} → 120,000,000,000

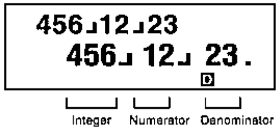


→ 1.2×10^{-3} → 0.0012

■Special display functions

For fractional, hexadecimal and other special calculations, results are shown on the display as follows:

•Fractions



[Indicates $456\frac{12}{23}$]

- **Hexadecimal numbers**

ABCDEF12
AbCdEF12 H [Indicates ABCDEF12$_{16}$ (= -1412567278_{10})]

- **Sexagesimal numbers**

12.58244
12▫34▫56.78 [Indicates 12°34'56.78"]
D

Degrees Minutes Seconds

Handling Precautions

- This unit is composed of precision electronic components, and should never be disassembled. Do not drop it or otherwise subject it to sudden impacts, or sudden changes in temperature. Be especially careful to avoid storing the unit or leaving it in areas exposed to high temperature, humidity or large amounts of dust. When exposed to low temperatures, the unit will require more time to display answers and may even fail to operate. The display will return to normal once normal temperature is attained.
- The display will appear blank while the unit is performing calculations. At this time most keys will be inoperative. Because of this, keys should normally be used while confirming proper operation by checking the display.
- Batteries should be replaced every 2 years, even if the unit is not used for extended periods. 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 a cloth that has been dipped in a neutral detergent solution and wrung out.
- Note that the manufacturer assumes no responsibility for any loss or claims by third parties which may arise from use of this product.
- Note that the manufacturer assumes no responsibility for any damage incurred as a result of data loss caused by malfunction, repairs or battery replacement. The user should prepare physical records of important data to protect against such data losses.
- If this unit should malfunction, be sure to contact your nearest Casio dealer or service center, explaining the problem in detail.

Power and Battery Replacement

Power is supplied to this unit by one CR2025 lithium battery, which is used for normal operations, as well as one CR1216 lithium battery used for memory backup.
If both of these batteries are removed at the same time, programs and data will be lost, so avoid replacing them at the same time.

***If both batteries have been removed from the unit for some reason, replace them and press the "All Reset" button after turning the power ON.**

■Replacing batteries

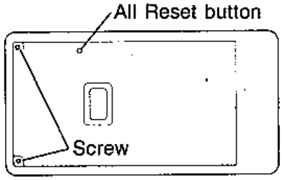
If batteries become weak, the "Low Battery" indicator appears on the display:

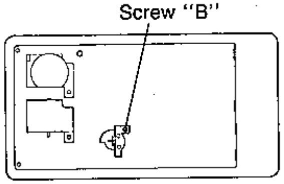
_Low battery

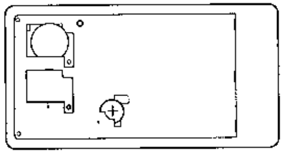
If you continue to use the unit after this display appears, power will turn OFF automatically and operation will become impossible even if you press the AC ON key. If this occurs, replace the CR2025 battery as soon as possible. Do not leave dead batteries in the unit. Doing so may result in damage or lost memory contents.

■To replace the memory backup battery

The battery used for memory backup should be replaced every two years.







① Press the OFF key. Then remove the two screws on the back of the unit and remove the back cover.

② Remove the screw holding the battery pressure plate (screw "B") and then remove the battery pressure plate.

③ Remove the old battery from the unit. (This can be done easily by turning the unit so that the battery compartment is facing downwards, and then lightly tapping the unit.)

④ Wipe the surfaces of the new battery with a soft, dry cloth and load them into the unit, making sure that the positive ⊕ side is facing upwards.

⑤ Fasten the battery pressure plate in place using the screw.

⑥ Replace the back cover and press the ON key. Memory contents are protected by the main battery in this case.

■To replace the main battery

①Press the OFF key. Then remove the two screws on the back of the unit and remove the back cover.

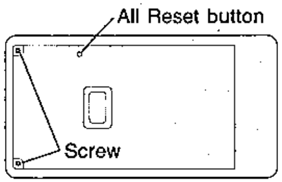
②Remove the screw holding the battery pressure plate (screw "A") and then remove the battery pressure plate.

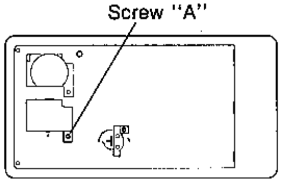
③Remove the old main battery from the unit. (This can be done easily by turning the unit so that the battery compartment is facing downwards, and then lightly tapping the unit.)

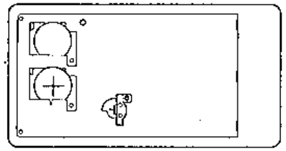
④Wipe the surfaces of the new battery with a soft, dry cloth and load them into the unit, making sure that the positive ⊕ side is facing upwards.

⑤Fasten the battery pressure plate in place using the screw. Then press the ON key.

⑥Replace the back cover. Memory contents are protected by the memory backup battery in this case.







Avoid changing both batteries at the same time as doing so may result in memory contents being lost.

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 the battery are facing in the proper direction.

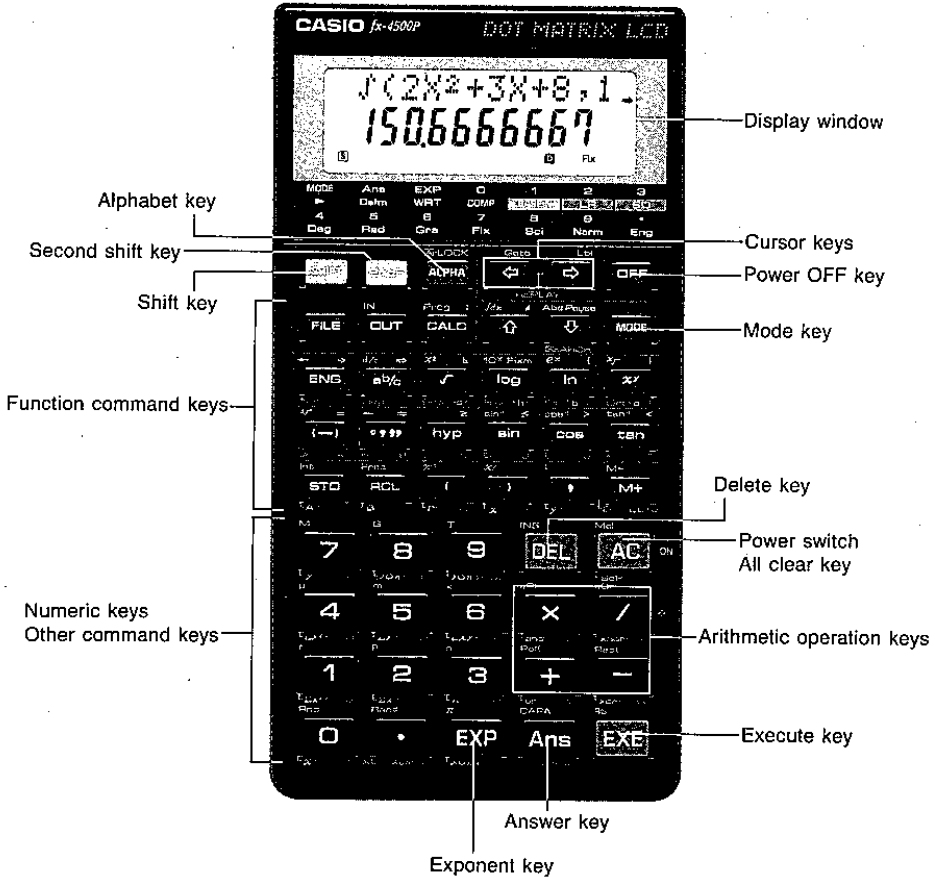
- Never leave a dead battery in the battery compartment.
- Remove the battery if you do not plan to use the unit for long periods.
- Replace the battery at least once every 2 years, no matter how much the unit is used during that period.
- Never try to recharge the battery supplied with the unit.
- Do not expose batteries to direct heat, let them become shorted, or try to take them apart.

Keep batteries out of the reach of small children. If swallowed, consult with a physician immediately.

■Auto Power-OFF function

To preserve battery life, this unit will turn OFF automatically if it is not used for approximately 6 minutes. To restore power, press the AC key. Note that memory contents are protected even when power goes OFF.

Nomenclature and Functions



[SHIFT]: Shift key

Press when using the function commands and functions marked in orange on the key panel. An "[S]" will appear on the display to indicate that [SHIFT] has been pressed. Pressing [SHIFT] again will cause the "[S]" to disappear from the display and the unit to return to the status it was in before [SHIFT] was originally pressed.

[2ndF]: Second shift key

Press when using the function commands and functions marked in light green on the key panel. An "[F]" will appear on the display to indicate that [2ndF] has been pressed. Pressing [2ndF] again will cause the "[F]" to disappear from the display and the unit to return to the status it was in before [2ndF] was originally pressed.

[MODE] Mode key

Press when setting the status of the unit or when specifying the unit of angular measurement. Refer to page 9 for details on modes.

A-LOCK [ALPHA] Alphabet key

Press to input alphabetic characters or special characters. Pressing [ALPHA] displays "[A]" and allows the input of only one character. After the character is input, the unit returns to the status it was in before the [ALPHA] key was originally pressed. Pressing [SHIFT] followed by [ALPHA] will lock the unit in this mode and allow consecutive input of alphabetic characters until [ALPHA] is pressed again.

☐	☐	☐	☐	☐	☐
☐	☐	☐	☐	☐	☐
”	☐	☐	☐	[	]
A	B	C	D	E	F
☐	☐	G	H	I	J

K	L	M	☐	☐
N	O	P	Q	R
S	T	U	V	W
X	Y	Z	SPACE	☐

Rnd [0] ~ T [9], Ran# [·] Numeric keys

$\lfloor\bar{x}\rfloor$ X $\lfloor y\sigma_{n-1}\rfloor$ M BLOCK $\lfloor x\sigma_n\rfloor$ Y

- When numeric values or calculation commands are input, they appear on the display window from the left. The [·] key is used to indicate the decimal point.
- Depending on the selected mode, the [SHIFT] and [2ndF] keys can be used in combination with the number keys to specify the following functions:

M [7]	G [8]	T [9]
μ [4]	m [5]	k [6]
f [1]	p [2]	n [3]
Rnd [0]	Ran# [·]	

COMP mode ([MODE][0])
LR mode ([MODE][2])
SD mode ([MODE][3])
} Used in combination with [SHIFT] key.

[7] ⌊$\bar{y}$⌋ [8] ⌊$y\sigma_n$⌋ [9] ⌊$y\sigma_{n-1}$⌋
[4] ⌊Σy^2⌋ [5] ⌊Σy⌋ [6] ⌊Σxy⌋
[1] ⌊Σx^2⌋ [2] ⌊Σx⌋ [3] ⌊n⌋
[0] ⌊$\bar{x}$⌋ [•] ⌊$x\sigma_n$⌋

LR mode ([MODE] [2])

Used in combination with [2ndF] key.

[7] [8] [9]
[4] [5] [6]
[1] ⌊Σx^2⌋ [2] ⌊Σx⌋ [3] ⌊n⌋
[0] ⌊$\bar{x}$⌋ [•] ⌊$x\sigma_n$⌋

SD mode ([MODE] [3])

- When the [SHIFT] key is pressed in the COMP mode, LR mode or SD mode, the following functions are specified:

[SHIFT] [0] (Rnd) .... Internal rounding
This key operation rounds the internal value (value stored in the Y register) to 10 digits. Note that this also rounds the result that is produced by the Ans function. In the FIX and SCI modes, this key operation changes the internal value to the form specified for value display.

[SHIFT] [•] (Ran#) .... Random number generation
Generates random numbers between 0.000 and 0.999.

For information on other functions, see "Engineering symbol calculations" on page 59.

- The following functions can be specified by pressing [2ndF] in the LR mode or SD mode (only some functions are available).

[2ndF] [0] ($\bar{x}$) .... $\bar{x}$ (Mean of x)
[2ndF] [1] (Σx^2) .... Σx^2 (Sum of squares of x)
[2ndF] [2] (Σx) .... Σx (Sum of x)
[2ndF] [3] (n) .... n (Number of data)
[2ndF] [4] (Σy^2) .... Σy^2 (Sum of squares of y)
[2ndF] [5] (Σy) .... Σy (Sum of y)
[2ndF] [6] (Σxy) .... Σxy (Sum of products of x and y)
[2ndF] [7] ($\bar{y}$) .... $\bar{y}$ (Mean of y)
[2ndF] [8] ($y\sigma_n$) .... $y\sigma_n$ (Standard deviation of y)
[2ndF] [9] ($y\sigma_{n-1}$) .... $y\sigma_{n-1}$ (Sample standard deviation of y)
[2ndF] [•] ($x\sigma_n$) .... $x\sigma_n$ (Standard deviation of x)

These functions are used in standard deviation and regression calculations. For details, see sections on "Standard deviation" (page 67) and "Regression calculation" (page 70).

π [EXP] ⌊$x\sigma_{n-1}$⌋ Z Exponent/Pi/Standard deviation calculation key

- When using exponents, the [EXP] key is pressed after the mantissa is input. For example, to input 2.56 × 10^{34}, press 2.56 [EXP] 34. When inputting exponents into a program, the [EXP] key is pressed after the value is input.
- When pressed following the [SHIFT] key, the value of pi (π) is input.
- When pressed following [2ndF] key in LR mode or SD mode, the sample standard deviation of x is calculated.

[2ndF] [EXP] ($x\sigma_{n-1}$) .... $x\sigma_{n-1}$ (Sample standard deviation of x) is calculated.

Pol([+] ⌊or⌋ V Rec([−] ⌊xor⌋ W $_nP_r$ [×] ⌊and⌋ Q $_nC_r$ [/] ÷ ⌊xnor⌋ R Arithmetic operation/Coordinate transformation/Permutation and combination/Logical operation keys

- When carrying out addition, subtraction multiplication and division, enter the calculation as it is written, from left to right.
- [+] and [−] keys can be used to indicate signs.
- [SHIFT] key combinations for the various modes are as follows:

COMP mode, SD mode or LR mode
$_nP_r$ [×] $_nC_r$ [/]
Pol([+] Rec([−]

[SHIFT] [+] (Pol() .... Coordinate transformation; press to transform polar coordinate into rectangular coordinate.
[SHIFT] [−] (Rec() .... Coordinate transformation; press to transform rectangular coordinate into polar coordinate.
[SHIFT] [×] ($_nP_r$) .... Permutation; press when making permutation calculations.
[SHIFT] [/] ($_nC_r$) .... Combination; press when making combination calculations.

BASE-N mode
[×] ⌊and⌋ [/] ⌊xnor⌋
[+] ⌊or⌋ [−] ⌊xor⌋

[SHIFT] [+] (or) .... or; press when calculating "or" of logical operation.
[SHIFT] [−] (xor) .... xor; press when calculating "xor" of logical operation.
[SHIFT] [×] (and) .... and; press when calculating "and" of logical operation.
[SHIFT] [/] (xnor) .... xnor; press when calculating "xnor" of logical operation.

*For division, the "/" (slash) key is used.

% [EXE] Execute/Percent key

- Press to obtain the result of a calculation. Pressed after data input for a program calculation or to advance to the next execution after a result is obtained.
- Press following [SHIFT] key for percentage calculations. Note that percentage calculations cannot be carried out in BASE-N mode.

CAPA
Ans Answer/CAPA/Space key
SPACE

- Press Ans followed by EXE to recall the last calculation result.
- Hold down following SHIFT key to display number of remaining steps in program.
- Press following ALPHA key to input a space.

INS
DEL Delete/Insert key

- Press DEL to delete character where cursor is flashing. Deletes character to left of cursor when cursor is to the right of the last input character.
- Press following SHIFT key to display the insert cursor ([ ]). Entering a value while the insert cursor is displayed inserts the value in the position immediately preceding the insert cursor location.

Mcl
AC ON All clear/Memory clear/Statistical data clear/Power On key
Scl

- Press to clear all input characters or formulas. Also, press to clear Error Check message on display.
- Pressing SHIFT followed by AC clears all data in unit's memory.
- Pressing 2ndF followed by AC clears contents of statistical calculation memory.
- Press when power is OFF to turn power ON.

Goto Lbl
⇦ ⇨ Cursor/Replay/Jump command keys
REPLAY

- Press to move the cursor to the left or right on the display to correct formulas or numeric values.
  Pressing ⇦ moves the cursor to the left, while pressing ⇨ moves it to the right. Pressing either key and holding it down will cause continuous movement of the cursor in the respective direction.
- Once a formula or numeric value is input and EXE is pressed, these keys become replay keys. Pressing ⇦ displays the formula or numeric value from the end, and pressing ⇨ displays it from the beginning. Pressing EXE again will re-execute (see page 48).
- These keys are also used to input "Jump" commands which alter program execution. Pressing 2ndF followed by ⇦ enters the "Goto" command. Pressing 2ndF followed by ⇨ enters the "Lbl" (Label) command. For details, refer to page 109.

OFF Power OFF key
Press to turn the unit's power OFF. Note that mode setting and memory contents are protected even when power is turned OFF.

FILE File key
Press to recall registered files. For details, refer to page 96.

IN
OUT Formula memory key
Used when making calculations using registered formulas. For details, refer to page 77.

Prog :
CALC Formula memory/Program/Multistatement key

- Press CALC to execute formulas in formula memory. For details, refer to page 77.
- Press SHIFT followed by CALC and EXE to execute programs. For details, refer to page 108.
- Press 2ndF followed by CALC to separate formulas or commands in programmed calculations or consecutive calculations. The result of such combinations is known as a "multistatement". For details, refer to page 50.

∫dx ◢
⇧ File line scroll up/Integration/Display key

- Press while file contents are displayed to scroll up to the previous file line.
- Press SHIFT followed by ⇧ when making integrations. For details, refer to page 84.
- Press 2ndF followed by ⇧ to display results of program calculations and consecutive calculations.

Abs Pause
⇩ File line scroll down/Absolute value/Pause command/Search key
SEARCH

- Press while file contents are displayed to scroll down to the next file line.
- Press SHIFT followed by ⇩ when making absolute value calculations.
- Press 2ndF followed by ⇩ to input "Pause" command. For details, refer to page 117.
- Press to search contents of file using "Search" function. For details, refer to page 105.

← ⇒
ENG Engineering/Judge command/Not key
Not ”

- Each press of this key shifts the decimal of the displayed value three decimal places to the right or left. This in effect results in conversion of the value from one metric unit to another, such as 10^{-3} milliseconds, 10^{-6} microseconds, 10^{-12} picoseconds, or 10^{3} kilohertz, 10^{6} megahertz, 10^{9} gigahertz.

Example

12.3456 EXE	12.3456		
1st time ENG is entered	12.3456	00	
2nd time ENG is entered	12345.6	-03	
3rd time ENG is entered	12345600.	-06	
4th time ENG is entered	12345600.	-06	(No change)
12.3456 EXE	12.3456		
1st time SHIFT ENG is entered	0.0123456	03	
2nd time SHIFT ENG is entered	0.000012345	06	
3rd time SHIFT ENG is entered	0.000000012	09	
4th time SHIFT ENG is entered	0.000000012	09	(No change)

- When pressed after pressing 2ndF key, "judge" symbol "⇒", used in executing Jump command, is input. For details, refer to page 112.
- When pressed in BASE-N mode, this key executes "Not" function used in logical operation.

[a b/c] Fractions/Judge command/Negative key

- Used when inputting fractions and mixed numbers.

Example To input $\frac{23}{45}$, press 23[SHIFT][a b/c]45: To input $2\frac{3}{4}$, press 2[a b/c]3[a b/c]4:

- By pressing [SHIFT][a b/c] in succession, the displayed value will be converted to the improper fraction.
- When pressed after pressing [2ndF] key, "judge" symbol "⇸", used in executing Jump command, is input. For details, refer to page 112.
- Press in the BASE-N mode prior to entering a value to obtain the negative of that value. The negative number is the two's complement of the value entered.

[√] Square root/Square/Judge command/Decimal value key

- Press prior to entering a numeric value to obtain the square root of that value.
- Enter a value, and press this key following [SHIFT] to obtain the square of the value.
- When pressed after pressing [2ndF] key, the "judge" symbol "◣", used in executing Jump command, is input. For details, refer to page 112.
- Press in the BASE-N mode to specify the decimal calculation mode.
- When pressed following [SHIFT] in the BASE-N mode, the subsequently entered value is specified as a decimal value.

[log] Common logarithm/Exponent of 10/Variable fix command/ Hexadecimal key

- Press prior to entering a value to obtain the common logarithm of that value.
- When pressed following the [SHIFT] key, the subsequently entered value becomes an exponent of 10.
- When pressed following the [2ndF] key, "Fixm" is entered. For details, refer to page 118.
- Press in the BASE-N mode to specify the hexadecimal calculation mode.
- When pressed following [SHIFT] in the BASE-N mode, the subsequently entered value is specified as a hexadecimal value.

[ln] Natural logarithm/Exponential/Variable input command/Binary key

- Press prior to entering a value to obtain the natural logarithm of that value.
- When pressed following the [SHIFT] key, the subsequently entered value becomes an exponent of "*e*".
- When pressed following the [2ndF] key, the " { " symbol used in executing the variable input command is input. For details, refer to page 118.
- Press in the BASE-N mode to specify the binary calculation mode.
- When pressed following the [SHIFT] key in the BASE-N mode, the subsequently entered value is specified as a binary value.

[x^y] Power/Root/Variable input command/Octal key

- Enter x, press this key and then enter y (any number) to calculate x to the power of y.
- To calculate the xth root of y, press after pressing [SHIFT].
- When pressed following the [2ndF] key, the " } " symbol used in executing the variable input command is input. For details, refer to page 118.
- Press in the BASE-N mode to specify the octal calculation mode.
- When pressed following the [SHIFT] key in the BASE-N mode, the subsequently entered value is specified as an octal value.

[(−)] Negative/Cube root/Equal key

- Press prior to entering a numeric value to make that value negative.

Example –123 ➡ [(−)]123

- Press following the [SHIFT] key to obtain the cube root of a subsequently entered numeric value.
- Press following the [2ndF] key to enter the "=" sign.

[°'"] Decimal ↔ Sexagesimal/Not equal key

- Press to enter sexagesimal value. (degree/minute/second or hour/minute/second)

Example 78°45'12" ➡ 78[°'"]45[°'"]12[°'"]

- When pressed following the [SHIFT] key, a decimal based value can be displayed in degrees/minutes/seconds.
- Press following the [2ndF] key to input the "≠" sign.

[hyp] Hyperbolic/Relational operator key

- Pressing [hyp] and then [sin], [cos] or [tan] prior to entering a value produces the respective hyperbolic function (sinh, cosh, tanh) for the value.
- Pressing [SHIFT], then [hyp] and then [sin], [cos] or [tan] prior to entering a value produces the respective inverse hyperbolic function ($\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$) for the value.
- Press following the [2ndF] key to enter the "≥" sign.

[sin] [cos] [tan] Trigonometric function/Inverse trigonometric function/ Relational operator keys

- Press one of these keys prior to entering a value to obtain the respective trigonometric function for the value.
- Press [SHIFT] and then one of these keys prior to entering a value to obtain the respective inverse trigonometric function for the value.
- Press [2ndF] and then one of these keys to input the "≦", ">" and "<" signs, respectively.
- In the BASE-N mode, press [(−)] ~ [tan] to enter A ~ H (10_{10} ~ 15_{10}) of a hexadecimal number.

$\overset{\text{Int}}{\underset{[A]}{\boxed{\text{STO}}}}$ Store memory/Integer/Constant term key

- Press prior to inputting alphabet character when inputting calculation results to memory.
- Press SHIFT key followed by STO key prior to inputting number in order to obtain integer part of that number.
- Press following 2ndF key in LR mode to calculate constant term "A" in regression formula.

  2ndF $\underset{A}{\text{STO}}$ .... Calculation of A (Constant term of regression formula)

$\overset{\text{Frac}}{\underset{[B]}{\boxed{\text{RCL}}}}$ Recall memory/Fraction/Regression coefficient key

- Press prior to inputting alphabet characters to display value input into memory.
- Press SHIFT key followed by RCL key prior to inputting number in order to obtain fraction part of that number.
- Press following 2ndF key in LR mode to calculate regression coefficient "B" in regression formula.

  2ndF $\underset{B}{\text{RCL}}$ .... Calculation of B (Regression coefficient of regression formula)

$\overset{x^{-1}}{\underset{[r]\ G}{\boxed{(}}}$ $\overset{x!}{\underset{[\hat{x}]\ H}{\boxed{)}}}$ Parentheses/Reciprocal/Factorial/Correlation coefficient/Estimated value of *x* key

- Press the open parenthesis key and the closed parenthesis key at the position required in a formula.
- Press SHIFT followed by (prior to entering a value to obtain the reciprocal of that value.
- Press SHIFT followed by) after entering a value to obtain the factorial of that value.
- In the LR mode, press following the 2ndF key for coefficient of correlation calculation and estimated value of *x* in linear regression calculation, respectively.

  2ndF $\underset{r}{(}$ .... Calculation of r (correlation coefficient)

  2ndF $\underset{\hat{x}}{)}$ .... Calculation of $\hat{x}$ (estimate of value of x)

$\overset{;}{\underset{[\hat{y}]\ I}{\boxed{,}}}$ Comma/Semicolon/Estimated value of *y* key

- Press to enter comma in statistical and other formulas.
- Press following SHIFT to enter semicolon.
- In the LR mode, press following the 2ndF key for the estimated value of y in regression calculation.

$\overset{\text{M-}}{\underset{[DT][CL]\ J}{\boxed{\text{M+}}}}$ Memory plus/Memory minus/Data input/Clear key

- Press to add displayed value to memory. Note that when formula is displayed, results are first derived and then stored into memory.
- Press following SHIFT key to subtract displayed value from memory.
- In the LR and SD modes, press to input data.
- In the LR and SD modes, press following the SHIFT key to clear data which has been input incorrectly.

Before beginning calculations....

Calculation priority sequence

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

① Coordinate transformation/integration Pol (x, y), Rec (r, θ), $\int dx$

② Type A functions
These functions are those in which the value is entered and then the function key is pressed.
x^2, x^{-1}, $x!$, ° ' ", Eng symbols

③ Power/root x^y, $\sqrt[x]{\ }$

④ Fractions a^b/c

⑤ Abbreviated multiplication format in front of π, memory or parenthesis 2π, 4K1, 5A, πR, etc.

⑥ Type B functions
These functions are those in which 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-N mode only) d, H, b, o, Neg, Not

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

⑧ Permutation, combination nPr, nCr

⑨ ×, ÷

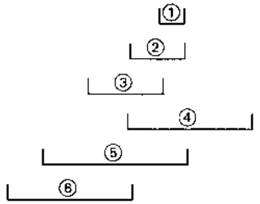
⑩ +, −

⑪ and
⑫ or, xor, xnor] In BASE-N mode only.

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

*Everything contained within parentheses receives highest priority.

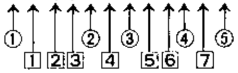
Example **2+3×(log sin2π^2 +6.8)=22.07101691 (in the "Rad" mode)**



■Number of stacks

This unit features a memory known as a "stack" for the temporary storage of low priority numeric values and commands (functions, etc.). The numeric value stack has nine levels, while the command stack has 24. If a complex formula is employed that exceeds the stack space available, a stack error (Stk ERROR) message will appear on the display.

Example 2 × ((3 + 4 × (5 + 4) ÷ 3) ÷ 5) + 8 =



Numeric stack value

①	2
②	3
③	4
④	5
⑤	4
⋮	

Command stack

1	×
2	(
3	(
4	+
5	×
6	(
7	+
⋮	

*Calculations are performed in the order of the highest calculation priority first. Once a calculation is executed, it is cleared from the stack.

■Number of input/output digits and calculation digits

The allowable input/output range (number of digits) of this unit is 10 digits for a mantissa, and 2 digits for an exponent. Calculations, however, are performed internally with a range of 12 digits for a mantissa and 2 digits for an exponent.

Example $3 \times 10^5 \div 7 =$

3 EXP 5 ÷ 7 EXE

3E5/7
42857.14286
D

3 EXP 5 ÷ 7 − 42857 EXE

3E5/7 − 42857
0.1428571
D

Once a calculation is completed, the mantissa is rounded off to 10 digits and displayed.

Example $3 \times 10^5 \div 7 =$

3 EXP 5 ÷ 7 EXE

3E5/7
42857.14286
D

− 42857 EXE

42857.14286 − →
0.14286
D

■Overflow and errors

If the operational range of the unit is exceeded, or incorrect inputs are made, an error message will appear on the display and subsequent operation will be impossible. This is carried out by the error check function. The following operations will result in errors:

(1) The answer, whether intermediate or final, or any value in memory exceeds the value of $\pm 9.999999999 \times 10^{99}$.
(2) An attempt is made to perform function calculations that exceed the input range. (See page 155.)
(3) Improper operation during statistical calculations. (Ex. Attempting to obtain $\bar{x}$ or $x\sigma n$ without data input.)
(4) Illegal argument.
(Ex. Negative value specified for Defm)
(5) The capacity of the numeric value stack or the command stack is exceeded.
(Ex. Entering 23 successive ('s followed by 2 + 3 × 4)
(6) Input errors are made. (Ex. 5 × × 3 EXE)
(7) Even though memory has not been expanded, a memory such as Z [2] is used. (See page 42 for details on memory.)
(8) When Prog command (see page 114) causes subroutine nesting overflow.
(9) When no Lbl corresponds to Goto command (see page 111), or when no filename corresponds to Prog command (see page 114).

When error messages appear, most keys will become inoperative. In this case, press the AC key to return to normal operation. You can also press the ⇦ key or ⇨ key, causing the cursor to show the position of the error (see "Error position display function" on page 49).

The following error messages will be displayed for the operations noted above:

(1)~(3) Ma ERROR
(4) Arg ERROR
(5) Stk ERROR
(6) Syn ERROR
(7) Mem ERROR
(8) Ne ERROR
(9) Go ERROR

Ne ERROR and Go ERROR messages mainly occur when using programs. (Refer to the Error Message Table on page 154.)

■Number of input characters

This unit features a 127-step area for calculation execution.

One function comprises one step. Each press of numeric or [+], [−], [×] and [÷] keys comprise one step. Though such operations as [SHIFT][x^2] ([x^2] key) require two key operations, they actually comprise only one function, and, therefore, only one step. These steps can be confirmed using the cursor. With each press of the [⇦] or [⇨] key, the cursor is moved one step.

Input characters are limited to 127 steps. Usually, the cursor is represented by a blinking "_", but once the 121st step is reached, the cursor changes to a blinking "■". If the "■" appears during a calculation, the calculation should be divided at some point and performed in two parts.

*When numeric values or calculation commands are input, they appear on the display from the left. Calculation results, however, are displayed from the right.

■Corrections

To make corrections in a formula that is being input, use the [⇦] and [⇨] keys to move to the position of the error and press the correct keys.

Example **To change an input of 122 to 123:**

[1][2][2]	122_
[⇦]	122
[3]	123_

Example **To change an input of cos60 to sin60:**

[cos][6][0]	cos 60_
[⇦][⇦][⇦]	cos 60
[sin]	sin 60

*If, after making corrections, input of the formula is complete, the answer can be obtained by pressing [EXE]. If, however, more is to be added to the formula, advance the cursor using the [⇨] key to the end of the formula for input.

•If an unnecessary character has been included in a formula, use the [⇦] and [⇨] keys to move to the position of the error and press the [DEL] key. Each press of [DEL] will delete one command (one step).

Example **To correct an input of 369 × × 2 to 369 × 2:**

[3][6][9][×][×][2]	369 × × 2_
[⇦][⇦][DEL]	369 × 2

If a character has been omitted from a formula, use the [⇦] and [⇨] keys to move to the position where the character should have been input, and press [SHIFT] followed by the [INS] key. Each press of [SHIFT] [INS] will create a space for input of one command.

Example **To correct an input of 2.36^2 to $\sin 2.36^2$:**

[2][•][3][6][SHIFT][x^2]	2.36^2_
[⇦][⇦][⇦][⇦][⇦]	2.36^2
[SHIFT][INS]	[2].36^2
[sin]	sin [2].36^2

*When [SHIFT][INS] are pressed, the space that is opened is displayed as "[ ]". The function or value assigned to the next key you press will be inserted in the [ ]. To exit from the insertion mode, move the cursors, press [SHIFT][INS], or press [EXE].

Even after the [EXE] key has been pressed to calculate a result, it is possible to use this procedure for correction. Press the [⇦] key to move the cursor to the place where the correction is to be made.

Section 2

Manual Calculations

Basic calculations
Memory
Special functions
Scientific function calculations
Engineering symbol calculations
Binary, octal, decimal, hexadecimal calculations
Statistical calculations
Formula memory function

Section 2 Manual Calculations

Basic calculations

Arithmetic operations

- Arithmetic operations are performed by pressing the keys in the same order as noted in the formula.
- For negative values, press (−) before entering the value.

Example	Operation	Display (Lower)
$23+4.5-53=-25.5$	23 + 4.5 − 53 EXE	−25.5
$56\times(-12)\div(-2.5)=268.8$	56 × (−) 12 ÷ (−) 2.5 EXE	268.8
$12369\times7532\times74103=$ 6.903680613×10^{12} (6903680613000)	12369 × 7532 × 74103 EXE	$6.903680613\ ^{12}$
$(4.5\times10^{75})\times(-2.3\times10^{-79})$ $=-1.035\times10^{-3}$ (-0.001035)	4.5 EXP 75 × (−) 2.3 EXP (−) 79 EXE	-1.035^{-03}
$(2+3)\times10^{2}=500$	(2 + 3) × 1 EXP 2 EXE	500.
*The correct answer cannot be derived by entering (2 + 3) EXP 2. Be sure to enter × 1 between the) and EXP in the above example.		
$(1\times10^{5})\div7=14285.71429$	1 EXP 5 ÷ 7 EXE	14285.71429
$(1\times10^{5})\div7-14285$ $=0.7142857$	1 EXP 5 ÷ 7 − 14285 EXE	0.7142857
*Internal calculations are calculated in 12 digits for a mantissa, and the result is displayed rounded off to 10 digits. Internally, however, the mantissa is calculated to 12 digits.		

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

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

Parenthesis calculations

Example	Operation	Display (Lower)
$100-(2+3)\times4=80$	100 − (2 + 3) × 4 EXE	80.
$2+3\times(4+5)=29$	2 + 3 × (4 + 5 EXE	29.
*Closed parentheses occurring 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 × occurring immediately before an open parenthesis can be omitted.		
$10-\{2+7\times(3+6)\}=-55$	10 − (2 + 7 (3 + 6 EXE	−55.
*Henceforth, abbreviated style will not be used in this manual.		
$\frac{2\times3+4}{5}=(2\times3+4)\div5=2$	(2 × 3 + 4) ÷ 5 EXE	2.
$\frac{5\times6+6\times8}{15\times4+12\times3}=0.8125$	(5 × 6 + 6 × 8) ÷ (15 × 4 + 12 × 3) EXE	0.8125
$(1.2\times10^{19})-\{(2.5\times10^{20})$ $\times\frac{3}{100}\}=4.5\times10^{18}$	1.2 EXP 19 − (2.5 EXP 20 × 3 ÷ 100) EXE	$4.5\ ^{18}$
$\frac{6}{4\times5}=0.3$	6 ÷ (4 × 5) EXE	0.3
*The above is the same as 6 ÷ 4 ÷ 5 EXE.		

■Percentage calculations

Example	Operation	Display (Lower)
•Percentage 26% of $15.00	**15×26** SHIFT %	**3.9**
•Premium 15% increase from $36.20	**36.2×15** SHIFT % +	**41.63**
•Discount 4% discount from $47.50	**47.5×4** SHIFT % −	**45.6**
•Ratio 75 is what % of 250?	**75÷250** SHIFT %	**30. (%)**
•Rate of change 141 is an increase of what % from 120?	**141−120** SHIFT %	**17.5 (%)**
240 is a decrease of what % from 300?	**240−300** SHIFT %	**−20. (%)**

■Specifying the number of decimal places, the number of significant digits and the exponent display

- •To specify the number of decimal places (Fix), press MODE followed by 7, and then a value indicating the number of places (0~9). (The "Fix" indicator will appear on the display.)
- •To specify the number of significant digits (Sci), press MODE followed by 8, and then a value indicating the number of significant digits (0~9 to set from 1 to 10 digits with "0" indicating 10 digits). (The "Sci" indicator will appear on the display.)
- •Pressing the ENG key or SHIFT followed by ENG will cause the exponent display for the number being displayed to change in multiples of 3.
- •The specified number of decimal places or number of significant digits will not be cancelled until another value or MODE 9 is specified. (Specified values are not cancelled even if power is switched OFF or another mode (besides MODE 9) is specified.)
- •MODE 9 cancels Fix and Sci specifications, however the range of the exponent display can be set.

  Each time MODE 9 is input, operation switches between Norm1 and Norm2.

  Norm 1 : All values less than 10^{-2} or greater than 10^9 are automatically expressed as exponents.

  Norm 2 : All values less than 10^{-9} or greater than 10^9 are automatically expressed as exponents.
- •Even if the number of decimal places and number of significant digits are specified, internal calculations are performed in 12 digits for a mantissa, and the displayed value is stored in 10 digits. To convert these to the specified number of decimal places and significant digits, press SHIFT followed by Rnd.
- •This operation is invalid in the BASE-N mode. To make this specification in the BASE-N mode, first press MODE followed by 0.

Example	Operation	Display (Lower)
100÷6=16.66666666...	**100÷6** EXE	**16.66666667**
	(Four decimal places specified.) MODE 7 4	**16.6667** Fix
	(Specification cancelled.) MODE 9	**16.66666667**
	(Five significant digits specified.) MODE 8 5	**1.6667** ^{01} Sci
	(Specification cancelled.) MODE 9	**16.66666667**
*Values are displayed rounded off to the place specified.		
1÷1000=0.001	(With Norm1 specified.) **1÷1000** EXE	**1.** $^{-03}$
$=1\times10^{-3}$	(Norm2 specified) MODE 9	**0.001**

200÷7×14=400	200[÷]7[×]14[EXE]	400.
	(Three decimal places specified.) [MODE][7][3]	400.000 Fix
	(Calculation continues with 10 digits.) 200[÷]7[EXE]	28.571 Fix
	[×]	(Upper) ←8.57142857×_ Fix
	14[EXE]	400.000 Fix
	If the same calculation is performed with the specified number of digits:	
	200[÷]7[EXE]	28.571 Fix
	(Value stored internally cut off at specified decimal place.) [SHIFT][Rnd]	28.571 Fix
	[×]	(Upper) 28.571×_ Fix
	14[EXE]	399.994 Fix
	(Specification cancelled.) [MODE][9]	399.994
123m×456=56088m	123[×]456[EXE]	56088.
=56.088km	[ENG]	56.088 03
78g×0.96=74.88g	78[×]0.96[EXE]	74.88
=0.07488kg	[SHIFT][ENG]	0.07488 03

Memory

This unit contains 26 standard memories. There are two basic types of memories, the <Variable> memories, which are accessed by using the [STO] and [RCL] keys in combination with the 26 letters of the alphabet, and the <Independent> memories, which are accessed by using the [M+], [SHIFT][M−], [RCL] and [M] keys. The variable memory and independent memory utilize the same memory area.
Contents of both of the variable and independent memories are protected even when the power is turned OFF.

(1) Variable memories

Up to 26 values can be retained in memory at the same time, and can be recalled when desired.

Example **Inputting 123 into memory "A":**

[AC]123	123_
[STO][A]	A= 123.
[AC]	_
[RCL][A]	A= 123.

When formulas are input, the result of the formula's calculation is retained in memory.

Example **Inputting the result of 123 × 456 into memory "B":**

[AC]123[×]456	123×456_
[STO][B]	B= 56088
[AC]	_

RCL B

```
B=
        56088
```

If a variable expression is entered, the expression is first calculated according to the values stored in the variable memories used in the expression. The result is then stored in the variable memory specified for the result.

Example **Inputting the results of A × B into memory "C":**

AC ALPHA A × ALPHA B

```
A × B_
```

STO C

```
C=
     6898824.
```

AC

```
_
```

RCL C

```
C=
     6898824.
```

*Syn ERROR is generated when an attempt is made to input a substitution formula (such as C = A × B) or multistatements (such as A × B : C × D), and the existing memory contents are retained.

When input is made in a format such as "S = log2", where the variable is equal to the formula, the results of the calculation are input into the specified memory.

Example **Executing "S = log2":**

AC ALPHA S 2ndF = log 2

```
S=log 2_
```

EXE

```
S=log 2
 0.301029995
```

AC

```
_
```

RCL S

```
S=
 0.301029995
```

*In the SD mode, variable memories S,T and U are used as statistical memories. In the LR mode, variable memories N, O, P, S, T, and U are used as statistical memories. In addition, G, H, I, J, K, L, and X can be used as integral memories. These variable memories cannot be used simultaneously while making statistical or integral calculations.

■Array-type memories

Up to this point, all of the memories used have been referred to by single alphabetic characters such as A, B, X, or Y.

With the array-type memory introduced here, a memory name (one alphabetic character from A through Z) is appended with a subscript such as [1] or [2]. *Brackets input by ALPHA ln, ALPHA x².

Standard memory	Array memory
A	A[0]
B	A[1]
C	A[2]
D	A[3]

Proper use of the subscripts shortens programs and makes them easier to use.

• Memory expansion

Although there are 26 standard memories (A ~ Z), they can be expanded by changing program storage steps to memory. Memory expansion is performed by converting the 8 steps to one memory.

*See page 90 for information on the number of program steps.

Number of memories	26	27	28	....	36	....	100	....	163
Number of steps	1103	1095	1087	....	1023	....	511	....	7

Memory is expanded in units of one. A maximum of 137 memories can be added for a maximum total of 163. Expansion is performed by pressing MODE followed by Ans, a value representing the size of the expansion, and then EXE.

Example **To expand the number of memories by 30 to bring the total to 56:**

MODE Ans 30

```
Defm 30_
```

EXE

```
Defm 30
          30.
```

To check the current number of expanded memories, press MODE followed by Ans and EXE.

MODE Ans EXE

```
Defm
             30.
```

To initialize the number of memories (to return the number to 26) enter a zero for the value in the memory expansion sequence outlined above.

MODE Ans 0 EXE

```
Defm 0
              0.
```

*Though a maximum of 137 memories can be added, if a program has already been stored and the number of remaining steps is less than the desired expansion, an error (Mem ERROR) will be generated and expansion will be impossible.

*The expansion procedure (MODE Ans expansion value) can also be stored as a program.

● Using expanded memories

Expanded memories are used in the same manner as standard memories, and are referred to as variable Z[*n*] through variable A[*n*+25], etc., as shown below:

Z[1]=Y[2]=X[3]= ..... =A[26]　(Defm 1)
Z[2]=Y[3]=X[4]= ..... =A[27]　(Defm 2)
⋮
Z[*n*]=Y[*n*+1]=X[*n*+2]= ..... =A[*n*+25]　(Defm *n*)

**n* is the number of expanded memories.

For example, when two memories are added:

Z[1]=Y[2]=X[3]= ..... =A[26]
Z[2]=Y[3]=X[4]= ..... =A[27]

These memories are used in the same way as array-type memories, with a subscript being appended to the name.

Example **Inputting 123 in Z[2]:**

MODE Ans 2 EXE

```
Defm 2
              2.
```

ALPHA Z ALPHA [2 ALPHA] 2ndF = 123

```
Z[2]=123_
```

EXE

```
Z[2]=123
            123.
```

Recall memory data.

AC

```
_
```

ALPHA Z ALPHA [2 ALPHA]

```
Z[2]_
```

EXE

```
Z[2]
            123.
```

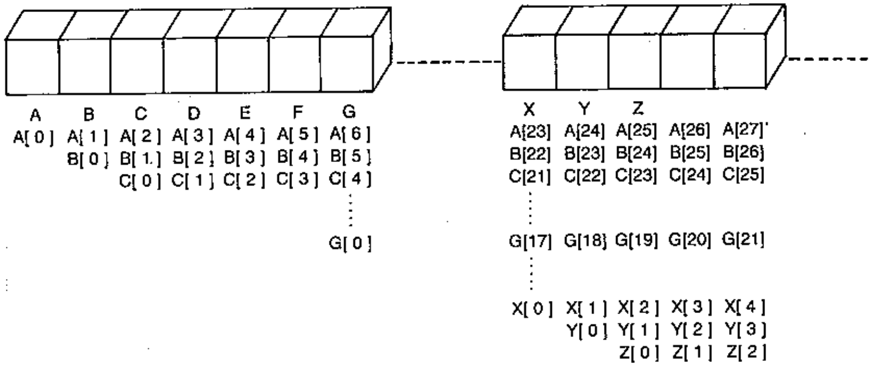
● Cautions when using array-type memories

When using array-type memories, a subscript is appended to an alphabetic character that represents a standard memory from A through Z.

Therefore, care must be taken to prevent overlap of memories.

*The following shows a case in which array-type memories overlap with standard format memories. This situation should always be avoided.

The relation is as follows:



■Deleting memories

To delete all contents of variable memories (including expanded memories), press SHIFT followed by Mcl EXE.

(2) Independent memories

Addition and subtraction (to and from sum) results can be stored directly in memory. Results can also be totalized in memory, making it easy to calculate sums.

Example **Inputting 123 to independent memory:**

AC 123	123_
M+	123 123.

Recall memory data.

AC	–
RCL M	M = 123.

Add 25, subtract 12

25 M+ 12 SHIFT M– (Pressing 25 – 12 M+ provides same result.)	12 12.

Recall memory data.

AC	–
RCL M	M = 136.

*To clear memory contents, press 0 STO M.

*Addition/subtraction to or from sum in memory cannot be carried out with M+, SHIFT and M– keys in SD mode and LR mode.

- **Difference between STO M and M+, SHIFT M–.**

Both STO M and M+, SHIFT M– can be used to input results into memory, however when the STO M operation is used, previous memory contents are cleared. When M+, SHIFT M– is used, value is added or subtracted to or from present sum in memory.

Example **Inputting 456 into memory "M" using STO M procedure. Memory already contains value of 123:**

AC 123 STO M	M = 123.
AC 456 STO M	M = 456.
AC	–
RCL M	M = 456.

Example **Inputting 456 into memory "M" using M+. Memory already contains value of 123:**

AC 123 STO M	M = 123.
AC 456 M+	456 456.
AC	–
RCL M	M = 579.

Special functions

Answer function

This unit has an answer function that stores the result of the most recent calculation. Once a numeric value or numeric expression is entered and EXE is pressed, the result (the answer in the case of numeric formulas) is stored by this function.
To recall the stored value, press the Ans key. When Ans is pressed, "Ans" will appear on the display, and the value can be used in subsequent calculations.

*As the "Ans" function works just like any other memory, it will be referred to as "Ans memory" in subsequent sections of this manual.

Example 123 + 456 = <u>579</u>
789 − <u>579</u> = 210

AC 1 2 3 + 4 5 6 EXE	123+456 579.
7 8 9 − Ans	789 − Ans_
EXE	789 − Ans 210.

Numeric values with 12 digits for a mantissa and 2 digits for an exponent can be stored in the Ans memory. The Ans memory is not erased even if the power of the unit is turned OFF. Each time EXE, %, M+, SHIFT M− and STO α (α = A ~ Z) is pressed, the value in the Ans memory is replaced with the new value produced by the calculation execution. When execution of a calculation results in an error, however, the Ans memory retains its current value.

*Contents of Ans memory are not altered when RCL α (α = A ~ Z) is used to recall contents of variable memory. Also, contents of Ans memory are not altered when variables are input when the variable input prompt is displayed.

Omitting the multiplication sign (×)

When inputting a formula as it is written, from left to right, it is possible to omit the multiplication sign (×) in the following cases:

1) Before the following functions:
   sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, log, ln, 10^x, e^x, $\sqrt{\ }$, $\sqrt[3]{\ }$, Pol (x, y), Rec (r, θ)
   Ex. 2sin30, 10log1.2, $2\sqrt{3}$, 2Pol(5,12), etc.

2) Before fixed numbers, variables and memories:
   Ex. 2π, 2AB, 3Ans, etc.

3) Before parentheses:
   Ex. 3(5+6), (A+1)(B−1), etc.

Continuous calculation function

Even if calculations are concluded with the EXE key, the result obtained can be used for further calculations. In this case, calculations are performed with 10 digits for the mantissa which is displayed.

Example **To calculate ÷ 3.14 continuing after 3 × 4 = 12:**

AC 3 × 4 EXE	3×4 12.
(Continuing) / 3.14	12./3.14_
EXE	12./3.14 3.821656051

Example **To calculate 1 ÷ 3 × 3 = :**

AC 1 / 3 × 3 EXE	1/3×3 1.
1 / 3 EXE	1/3 0.333333333
(Continuing) × 3 EXE	0.333333333 × → 0.999999999

Calculations performed with 10 digits for mantissa.

This function can be used with Type A functions (x^2, x^{-1}, $x!$, see page 27), +, −, x^y, $\sqrt[x]{\ }$, and ° ' ".

Example **Squaring the result of 78 ÷ 6 = 13:**

AC 78 / 6 EXE	78/6 13.

(Continuing) SHIFT x²	13.²_
EXE	13.² 169.

■Replay function

This function stores formulas that have been executed. After execution is complete, pressing either the ⇨ or ⇦ key will display the formula executed.

Pressing ⇨ will display the formula from the beginning, with the cursor located under the first character.

Pressing ⇦ will display the formula from the end, with the cursor located at the space following the last character. After this, using the ⇨ and ⇦ to move the cursor, the formula can be checked and numeric values or commands can be changed for subsequent execution.

Example

AC 123 × 456 EXE	123 × 456 56088.
⇨	1̲23 × 456
EXE	123 × 456 56088.
⇦	123 × 456_

Example 4.12 × 3.58 + 6̲.̲4̲ = 21.1496
4.12 × 3.58 − 7̲.̲1̲ = 7.6496

AC 4.12 × 3.58 + 6.4 EXE	4.12 × 3.58 + 6. → 21.1496
⇦	← 12 × 3.58 + 6.4_
⇦⇦⇦⇦	← 4.12 × 3.58 +̲ 6. →
− 7.1	← 12 × 3.58 − 7.1_
EXE	4.12 × 3.58 − 7. → 7.6496

*As with the number of input characters (see page 30), the replay function can accept input of up to 127 steps.

*The replay function is not cleared even when AC is pressed or when power is turned OFF, so contents can be recalled even after AC is pressed.

Example

AC 123 × 456 EXE	123 × 456 56088.
AC	_
⇦	123 × 456_

*Replay function is cleared when mode or operation is switched.

■Error position display function

When an ERROR message appears during operation execution, the error can be cleared by pressing the AC key and the values or formula can be re-entered from the beginning. However, by pressing the ⇨ or ⇦ key, the ERROR message is cancelled and the cursor moves to the point where the error was generated.

Example 14 ÷ 0 × 2.3 mistakenly input instead of 14 ÷ 10 × 2.3:

AC 14 ÷ 0 × 2.3 EXE	Ma ERROR
⇨ (or ⇦)	14/0 ×̲ 2.3

Cursor indicates where error is generated

⇐ SHIFT INS 1	14/10×2.3
EXE	14/10×2.3 3.22

■Multistatement function

- The multistatement function (using colons to separate formulas or statements) available in program calculations can also be used for manual calculations.
- The multistatement function allows formulas to be separated by colons (2ndF :) to make consecutive, multiple statement calculations possible.
- When EXE is pressed to execute a formula input using the multistatement format, the formula is executed in order from the beginning.
- Inputting "◢" (2ndF ◢) in place of the colon (2ndF :) will display the calculation result up to that point during execution.

Example 6.9×123=848.7
123÷3.2=38.4375

AC 123 STO A 6.9 × ALPHA A 2ndF ◢ ALPHA A ÷ 3.2 EXE	6.9×A 848.7 Disp

↑
Appears on display when "◢" is used.

EXE	A/3.2 38.4375

*Even if "◢" is not input at the end of a formula, the final result will be displayed.
*Consecutive calculations containing multistatements cannot be performed.

123×456 : ×5
└── Invalid

- Calculations can be performed while an intermediate result is displayed during execution interrupted by "◢".

Example

MODE 4 5 × 6 2ndF ◢ 7 × 8	5×6◢7×8_ D
EXE	5×6 30. Disp D

sin Ans	sin Ans_ Disp D
EXE	sin Ans 0.5 Disp D

When interrupt operation is completed, press EXE once again to execute.

EXE	7×8 56. D

Scientific function calculations

Trigonometric functions and inverse trigonometric functions

- Be sure to set the unit of angular measurement before performing trigonometric function and inverse trigonometric function calculations.
- The unit of angular measurement (degrees, radians, grads) is set by pressing $\boxed{\text{MODE}}$ followed by a value from $\boxed{4}$ to $\boxed{6}$.

$(90° = \frac{\pi}{2}$ radians $= 100$ grads$)$

- Once a unit of angular measurement is set, it remains in effect until a new unit is set. Settings are not cleared when power is switched OFF.
- This operation is invalid in the BASE-N mode. When in the BASE-N mode, make setting after pressing $\boxed{\text{MODE}}$ followed by $\boxed{0}$.

Example	Operation	Display (Lower)
sin 63°52′41″ = 0.897859012	$\boxed{\text{MODE}}\boxed{4}$ → " D " $\boxed{\sin}$ **63** $\boxed{{}^{\circ\,\prime\,\prime\prime}}$ **52** $\boxed{{}^{\circ\,\prime\,\prime\prime}}$ **41** $\boxed{{}^{\circ\,\prime\,\prime\prime}}\boxed{\text{EXE}}$	**0.897859012**
$\cos\left(\frac{\pi}{3}\text{ rad}\right) = 0.5$	$\boxed{\text{MODE}}\boxed{5}$ → " R " $\boxed{\cos}\boxed{(}\boxed{\text{SHIFT}}\boxed{\pi}\boxed{/}$ **3** $\boxed{)}\boxed{\text{EXE}}$	**0.5**
tan(−35gra) = −0.612800788	$\boxed{\text{MODE}}\boxed{6}$ → " G " $\boxed{\tan}\boxed{(-)}$ **35** $\boxed{\text{EXE}}$	**−0.612800788**
2·sin 45° × cos 65° = 0.597672477	$\boxed{\text{MODE}}\boxed{4}$ → " D " **2** $\boxed{\times}\boxed{\sin}$ **45** $\boxed{\times}\boxed{\cos}$ **65** $\boxed{\text{EXE}}$ ↑ ↑ Can be omitted.	**0.597672477**
$\sin^{-1}0.5 = 30°$ (Determines x for $\sin x = 0.5$)	$\boxed{\text{SHIFT}}\boxed{\sin^{-1}}$ **0.5** $\boxed{\text{EXE}}$ ↑ Can be entered as .5	**30.**
$\cos^{-1}\frac{\sqrt{2}}{2} = 0.785398163$ rad $= \frac{\pi}{4}$ rad	$\boxed{\text{MODE}}\boxed{5}$ → " R " $\boxed{\text{SHIFT}}\boxed{\cos^{-1}}\boxed{(}\boxed{\sqrt{\ }}$ **2** $\boxed{/}$ **2** $\boxed{)}\boxed{\text{EXE}}$ $\boxed{/}\boxed{\text{SHIFT}}\boxed{\pi}\boxed{\text{EXE}}$	**0.785398163** **0.249999999**

$\tan^{-1}0.741 = 36.53844577°$ = 36°32′18.4″	$\boxed{\text{MODE}}\boxed{4}$ → " D " $\boxed{\text{SHIFT}}\boxed{\tan^{-1}}$ **0.741** $\boxed{\text{EXE}}$ $\boxed{\text{SHIFT}}\boxed{\leftarrow}$	**36.53844577** **36°32°18.4**
$2.5 \times (\sin^{-1}0.8 - \cos^{-1}0.9)$ = 68°13′13.53″	**2.5** $\boxed{\times}\boxed{(}\boxed{\text{SHIFT}}\boxed{\sin^{-1}}$ **0.8** $\boxed{-}$ $\boxed{\text{SHIFT}}\boxed{\cos^{-1}}$ **0.9** $\boxed{)}\boxed{\text{EXE}}\boxed{\text{SHIFT}}\boxed{\leftarrow}$	**68°13°13.53**

*If the total number of digits for degrees/minutes/seconds exceeds 11 digits, the high-order values (degrees and minutes) are given display priority, and any lower-order values are not displayed. However, the entire value is stored within the unit as a decimal value.

Logarithmic and exponential functions

- The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out calculation after pressing $\boxed{\text{MODE}}$ followed by $\boxed{0}$.

Example	Operation	Display
log 1.23 ($\log_{10}1.23$) = 8.9905111×10^{-2}	$\boxed{\log}$ **1.23** $\boxed{\text{EXE}}$	**0.089905111**
In90 (log90) = 4.49980967	$\boxed{\ln}$ **90** $\boxed{\text{EXE}}$	**4.49980967**
log456 ÷ In456 = 0.434294481 (log/In ratio = constant M)	$\boxed{\log}$ **456** $\boxed{/}\boxed{\ln}$ **456** $\boxed{\text{EXE}}$	**0.434294481**
$10^{1.23} = 16.98243652$ (To obtain the anti-logarithm of common logarithm 1.23)	$\boxed{\text{SHIFT}}\boxed{10^{x}}$ **1.23** $\boxed{\text{EXE}}$	**16.98243652**
$e^{4.5} = 90.0171313$ (To obtain the anti-logarithm of natural logarithm 4.5)	$\boxed{\text{SHIFT}}\boxed{e^{x}}$ **4.5** $\boxed{\text{EXE}}$	**90.0171313**
$10^{4} \cdot e^{-4} + 1.2 \cdot 10^{2.3}$ = 422.5878667	$\boxed{\text{SHIFT}}\boxed{10^{x}}$ **4** $\boxed{\times}\boxed{\text{SHIFT}}\boxed{e^{x}}\boxed{(-)}$ **4** $\boxed{+}$ **1.2** $\boxed{\times}\boxed{\text{SHIFT}}\boxed{10^{x}}$ **2.3** $\boxed{\text{EXE}}$	**422.5878667**
$(-3)^{4} = (-3) \times (-3) \times (-3) \times (-3)$ = 81	$\boxed{(}\boxed{(-)}$ **3** $\boxed{)}\boxed{x^{y}}$ **4** $\boxed{\text{EXE}}$	**81.**
$-3^{4} = -(3 \times 3 \times 3 \times 3) = -81$	$\boxed{(-)}$ **3** $\boxed{x^{y}}$ **4** $\boxed{\text{EXE}}$	**−81.**
$5.6^{2.3} = 52.58143837$	**5.6** $\boxed{x^{y}}$ **2.3** $\boxed{\text{EXE}}$	**52.58143837**
$\sqrt[7]{123}$ $(= 123^{\frac{1}{7}})$ = 1.988647795	**7** $\boxed{\text{SHIFT}}\boxed{\sqrt[x]{\ }}$ **123** $\boxed{\text{EXE}}$	**1.988647795**

$(78-23)^{-12}$ $=1.305111829\times10^{-21}$	[(] 78 [−] 23 [)] [x^y] [(−)] 12 [EXE]	1.305111829^{-21}
$2+3\times\sqrt[3]{64}-4=10$	2 [+] 3 [×] 3 [SHIFT] [$\sqrt[x]{\ }$] 64 [−] 4 [EXE]	10.
*x^y and $\sqrt[x]{\ }$ given calculation priority over × and /.		
$2\times3.4^{(5+6.7)}=3306232.001$	2 [×] 3.4 [x^y] [(] 5 [+] 6.7 [)] [EXE]	3306232.001

■Performing hyperbolic and inverse hyperbolic functions

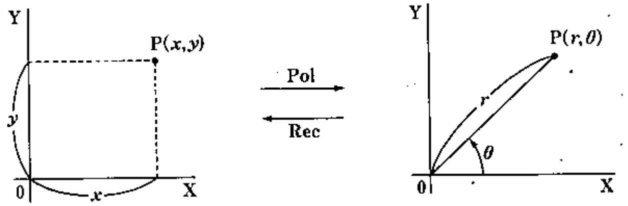
- The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out calculation after pressing [MODE] followed by [0].

Example	Operation	Display (Lower)
$\sinh 3.6=18.28545536$	[hyp] [sin] 3.6 [EXE]	18.28545536
$\cosh 1.23=1.856761057$	[hyp] [cos] 1.23 [EXE]	1.856761057
$\tanh 2.5=0.986614298$	[hyp] [tan] 2.5 [EXE]	0.986614298
$\cosh 1.5-\sinh 1.5$ $=0.22313016$ $=e^{-1.5}$ (Proof of $\cosh x \pm \sinh x = e^{\pm x}$)	[hyp] [cos] 1.5 [−] [hyp] [sin] 1.5 [EXE] (Continuing) [ln] [Ans] [EXE]	0.22313016 −1.5
$\sinh^{-1}30=4.094622224$	[hyp] [SHIFT] [sin] 30 [EXE]	4.094622224
$\cosh^{-1}\left(\frac{20}{15}\right)=0.795365461$	[hyp] [SHIFT] [cos] [(] 20 [÷] 15 [)] [EXE]	0.795365461
Determine the value of x when $\tanh 4x=0.88$		
$x=\frac{\tanh^{-1}0.88}{4}$ $=0.343941914$	[hyp] [SHIFT] [tan] 0.88 [÷] 4 [EXE]	0.343941914
$\sinh^{-1}2\times\cosh^{-1}1.5$ $=1.389388923$	[hyp] [SHIFT] [sin] 2 [×] [hyp] [SHIFT] [cos] 1.5 [EXE]	1.389388923
$\sinh^{-1}\left(\frac{2}{3}\right)+\tanh^{-1}\left(\frac{4}{5}\right)$ $=1.723757406$	[hyp] [SHIFT] [sin] [(] 2 [÷] 3 [)] [+] [hyp] [SHIFT] [tan] [(] 4 [÷] 5 [)] [EXE]	1.723757406

■Coordinate transformation

- Your scientific calculator lets you convert between rectangular coordinates and polar coordinates.

•Rectangular coordinates **•Polar coordinates**



- Calculation results are stored in variable memory V and variable memory W. Contents of variable memory V are displayed initially. To display contents of memory W, press [RCL] [W].

	V	W
Pol	r	θ
Rec	x	y

- With polar coordinates, θ can be calculated within a range of $-180° < \theta \leq 180°$. (Calculation range is the same with radians or grads.)
- The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out calculation after pressing [MODE] followed by [0].

Example	Operation	Display (Lower)
If $x=14$ and $y=20.7$, what are r and θ°?	[MODE] [4] → “D” [SHIFT] [Pol(] 14 [,] 20.7 [)] [EXE] (Continuing) [RCL] [W] [SHIFT] [←°'"]	24.98979792 (r) 55°55°42.2 (θ)
If $x=7.5$ and $y=-10$, what are r and θ rad?	[MODE] [5] → “R” [SHIFT] [Pol(] 7.5 [,] [(−)] 10 [)] [EXE] (Continuing) [RCL] [W]	12.5 (r) −0.927295218 (θ)
If $r=25$ and $\theta=56°$, what are x and y?	[MODE] [4] → “D” [SHIFT] [Rec(] 25 [,] 56 [)] [EXE] (Continuing) [RCL] [W]	13.97982259 (x) 20.72593931 (y)
If $r=4.5$ and $\theta=\frac{2}{3}\pi$rad, what are x and y?	[MODE] [5] → “R” [SHIFT] [Rec(] 4.5 [,] [(] 2 [÷] 3 [×] [SHIFT] [π] [)] [)] [EXE] (Continuing) [RCL] [W]	−2.25 (x) 3.897114317 (y)

■Permutation and combination

•Total number of permutations

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

•Total number of combinations

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

•The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out calculation after pressing MODE followed by 0.

Example	Operation	Display (Lower)
Taking any four out of ten items and arranging them in a row, how many different arrangements are possible? $_{10}P_4 = 5040$	10 SHIFT nPr 4 EXE	5040.
Using any four numbers from 1 to 7, how many four-digit even numbers can be formed if none of the four digits consist of the same number? ($\frac{3}{7}$ of the total number of permutations will be even.) $_7P_4 \times \frac{3}{7} = 360$	7 SHIFT nPr 4 × 3 ÷ 7 EXE	360.
If any four items are removed from a total of 10 items, how many different combinations of four items are possible? $_{10}C_4 = 210$	10 SHIFT nCr 4 EXE	210.
If 5 class officers are being selected for a class of 15 boys and 10 girls, how many combinations are possible? At least one girl must be included in each group. $_{25}C_5 - {}_{15}C_5 = 50127$	25 SHIFT nCr 5 − 15 SHIFT nCr 5 EXE	50127.

■Other functions ($\sqrt{\ }$, x^2, x^{-1}, $x!$, $\sqrt[3]{\ }$, Ran#)

•The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out calculation after pressing MODE followed by 0.

Example	Operation	Display
$\sqrt{2}+\sqrt{5}=3.65028154$	√ 2 + √ 5 EXE	3.65028154
$2^2+3^2+4^2+5^2=54$	2 SHIFT x^2 + 3 SHIFT x^2 + 4 SHIFT x^2 + 5 SHIFT x^2 EXE	54.
$(-3)^2=(-3)\times(-3)=9$	((−) 3) SHIFT x^2 EXE	9.
$-3^2=-(3\times3)=-9$	(−) 3 SHIFT x^2 EXE	−9.
$\dfrac{1}{\frac{1}{3}-\frac{1}{4}}=12$	(3 SHIFT x^{-1} − 4 SHIFT x^{-1}) SHIFT x^{-1} EXE	12.
$8!(=1\times2\times3\times\ldots\ldots\times8)$ $=40320$	8 SHIFT $x!$ EXE	40320.
$\sqrt[3]{36\times42\times49}=42$	SHIFT ∛ (36 × 42 × 49) EXE	42.
Random number generation (pseudorandom number from 0.000 to 0.999)	SHIFT Ran# EXE	(Ex.) 0.792
$\sqrt{13^2-5^2}+\sqrt{3^2+4^2}=17$	√ (13 SHIFT x^2 − 5 SHIFT x^2) + √ (3 SHIFT x^2 + 4 SHIFT x^2) EXE	17.
$\sqrt{1-\sin^2 40°}=0.766044443$ $=\cos 40°$ (Proof of $\cos\theta=\sqrt{1-\sin^2\theta}$)	MODE 4 → " D " √ (1 − (sin 40) SHIFT x^2) EXE (Continuing) SHIFT cos Ans EXE	0.766044443 40.
$\frac{1}{2!}+\frac{1}{4!}+\frac{1}{6!}+\frac{1}{8!}$ $=0.543080357$	2 SHIFT $x!$ SHIFT x^{-1} + 4 SHIFT $x!$ SHIFT x^{-1} + 6 SHIFT $x!$ SHIFT x^{-1} + 8 SHIFT $x!$ SHIFT x^{-1} EXE	0.543080357

■ Fractions

- Fractions are input and displayed in the following order: integer, numerator, denominator.

Example	Operation	Display (Lower)
$\frac{2}{5}+3\frac{1}{4}=3\frac{13}{20}$	2[a b/c]5[+]3[a b/c]1[a b/c]4[EXE]	3⌟13⌟20.
$=3.65$	(Conversion to decimal) [a b/c]	3.65
*Fractions can be converted to decimals, and then converted back to fractions.		
$3\frac{456}{78}=8\frac{11}{13}$ (Reduced)	3[a b/c]456[a b/c]78[EXE]	8⌟11⌟13.
	(Continuing) [SHIFT][d/c]	115⌟13.
*Fractions and improper fractions which can be reduced become reduced fractions when the calculation command key is pressed. Press [SHIFT][d/c] to convert to improper fraction.		
$\frac{1}{2578}+\frac{1}{4572}$ $=6.066202547\times10^{-4}$	1[a b/c]2578[+]1[a b/c]4572[EXE]	6.066202547^{-04} (Norm mode)
*When the total number of characters, including integer, numerator, denominator and delimiter mark exceeds 10, the input fraction is automatically displayed in decimal format.		
$\frac{1}{2}\times0.5=0.25$	1[a b/c]2[×][•]5[EXE]	0.25
*Calculations containing both fractions and decimals are calculated in decimal format.		
$\frac{1}{3}\times(-\frac{4}{5})-\frac{5}{6}=-1\frac{1}{10}$	1[a b/c]3[×][(-)]4[a b/c]5[-]5[a b/c]6[EXE]	−1⌟1⌟10.
$\frac{1}{2}\times\frac{1}{3}+\frac{1}{4}\times\frac{1}{5}=\frac{13}{60}$	1[a b/c]2[×]1[a b/c]3[+]1[a b/c]4[×] 1[a b/c]5[EXE]	13⌟60.
$\frac{\frac{1}{2}}{3}=\frac{1}{6}$	[(]1[a b/c]2[)][a b/c]3[EXE]	1⌟6
$\frac{1}{\frac{1}{3}+\frac{1}{4}}=1\frac{5}{7}$	1[a b/c][(]1[a b/c]3[+]1[a b/c]4[)][EXE]	1⌟5⌟7
*When parentheses are used in numerators or denominators, it is possible to carry out fractional calculations.		

Engineering symbol calculations

- This unit allows engineering calculations utilizing engineering symbols.
- The Eng mode is specified by pressing [MODE][•] in the COMP mode ([MODE][0]), LR mode ([MODE][2]), SD mode ([MODE][3]) ("Eng" symbol appears on display). To exit from this mode, press [MODE][•] once again.

Operation	Unit	Unit symbol
[SHIFT][k] (=[6])	10^{3}	k (kilo)
[SHIFT][M] (=[7])	10^{6}	M (mega)
[SHIFT][G] (=[8])	10^{9}	G (giga)
[SHIFT][T] (=[9])	10^{12}	T (tera)
[SHIFT][m] (=[5])	10^{-3}	m (milli)
[SHIFT][μ] (=[4])	10^{-6}	μ (micro)
[SHIFT][n] (=[3])	10^{-9}	n (nano)
[SHIFT][p] (=[2])	10^{-12}	p (pico)
[SHIFT][f] (=[1])	10^{-15}	f (femto)

Example	Operation	Display (Lower)
	[MODE][•] → "Eng"	
999k (kilo) + 25k (kilo) = 1.024M (mega)	999[SHIFT][k][+]25[SHIFT][k][EXE]	1.024^{M}
100m (milli) × 5μ (micro) = 500n (nano)	100[SHIFT][m][×]5[SHIFT][μ][EXE]	500.^{n}
9 ÷ 10 = 0.9 = 900m (milli)	9[÷]10[EXE]	900.^{m}
	[SHIFT][ENG]	0.9
	[ENG]	900.^{m}

Binary, octal, decimal, hexadecimal calculations

- Binary, octal, decimal and hexadecimal calculations, conversions and logical operations are performed in the BASE-N mode (press [MODE][1]).
- The number system (2, 8, 10, 16) is set by respectively pressing [BIN], [OCT], [DEC] or [HEX]. A corresponding symbol — "b", "o", "d" or "H" appears on the display.
- Number systems are specified for specific values by pressing [SHIFT], then the number system designator (b, o, d, or h), immediately followed by the value.
- General function calculations cannot be performed in the BASE-N mode.
- Only integers can be handled in the BASE-N mode. If a calculation produces a result that includes a decimal value, the decimal portion is cut off.
- If values not valid for the particular number system are used, attach the corresponding designator (b, o, d or h), or an error message will appear.

Number system	Valid values
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

- To distinguish the A, B, C, D, E and F used in the hexadecimal system from standard letters, they appear as shown in the chart below.

Key	Display (Upper)
[A] (= [(-)])	A
[B] (= [°'''])	B
[C] (= [hyp])	C
[D] (= [sin])	D
[E] (= [cos])	E
[F] (= [tan])	F

- Negative numbers in binary, octal and hexadecimal are expressed as two's complements.
- Number of digits displayed in each number system

Number system	Number of digits displayed
Binary	Up to 32 digits (8 digits × 4 blocks)
Octal	Up to 11 digits (8 digits + 3 digits)
Decimal	Up to 10 digits
Hexadecimal	Up to 8 digits

- Calculation range (in BASE-N mode)

Binary
Positive : $01111111111111111111111111111111 \geqq x \geqq 0$
Negative : $11111111111111111111111111111111 \geqq x \geqq 10000000000000000000000000000000$

Octal
Positive : $17777777777 \geqq x \geqq 0$
Negative : $37777777777 \geqq x \geqq 20000000000$

Decimal
Positive : $2147483647 \geqq x \geqq 0$
Negative : $-1 \geqq x \geqq -2147483648$

Hexadecimal
Positive : $7FFFFFFF \geqq x \geqq 0$
Negative : $FFFFFFFF \geqq x \geqq 80000000$

■Binary and octal block display

In the binary mode, a maximum of 32 digits are displayed in 4 blocks of 8 digits. In the octal mode, a maximum of 11 digits are displayed in one block of 8 digits, and a second block of 3 digits.

Example **In binary mode:**

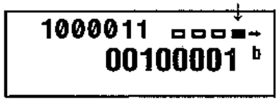
Block 4	Block 3	Block 2	Block 1
10000111	01100101	01000011	00100001
←8 digits→	←8 digits→	←8 digits→	←8 digits→
←32 digits→			

In octal mode:

Block 2	Block 1
012	34567012
←3 digits→	←8 digits→
←11 digits→	

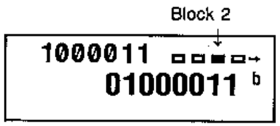
- In the binary mode, Block 1 is displayed immediately after calculation. Other blocks are displayed by pressing the [BLOCK] key. The block number increments each time you press the [BLOCK] key. The 4-digit symbol display at the upper right indicates the block presently being displayed. To reverse the order (shift from Block 4 to Block 3, etc.), press [SHIFT][BLOCK].

Indicates Block 1 presently displayed



(Block 1)

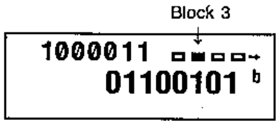
BLOCK



1000011 □□■□→
01000011 b

(Block 2)

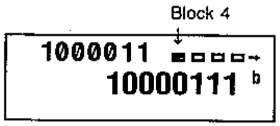
BLOCK



1000011 □■□□→
01100101 b

(Block 3)

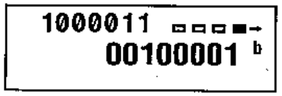
BLOCK



1000011 ■□□□→
10000111 b

(Block 4)

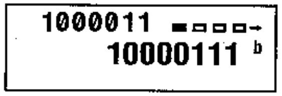
BLOCK



1000011 □□□■→
00100001 b

(Returns to Block 1)

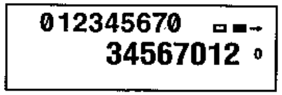
SHIFT BLOCK



1000011 ■□□□→
10000111 b

(Returns to Block 4)

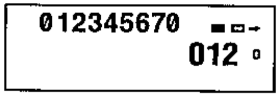
- In the octal mode, Block 1 is displayed immediately after calculation. Block 2 displayed by pressing the BLOCK key. The block display switches between Block 1 and Block 2 each time you press the BLOCK key. The 2-digit symbol display at the upper right indicates the block presently being displayed.



012345670 □■→
34567012 o

(Block 1)

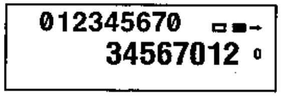
BLOCK



012345670 ■□→
012 o

(Block 2)

BLOCK



012345670 □■→
34567012 o

(Returns to Block 1)

■Binary, octal, decimal, hexadecimal conversions

There are two ways to perform reciprocal binary, octal, decimal and hexadecimal conversions.

● Conversion using number system specification key

Value from a different number system input when a specific number system mode is being used.

Example	Operation	Display (Lower)
What are the decimal values for $2A_{16}$ and 274_8?	MODE 1	
	Dec → "d"	d
	SHIFT h 2A EXE	42 d
	SHIFT o 274 EXE	188 d
What are the hexadecimal values for 123_{10} and 1010_2?	Hex → "H"	
	SHIFT d 123 EXE	0000007b H
	SHIFT b 1010 EXE	0000000A H
What are the octal values for 15_{16} and 1100_2?	Oct → "o"	
	SHIFT h 15 EXE	□■ 00000025 o
	SHIFT b 1100 EXE	□■ 00000014 o
What are the binary values for 36_{10} and $2C_{16}$?	Bin → "b"	
	SHIFT d 36 EXE	□□□■ 00100100 b
	SHIFT h 2C EXE	□□□■ 00101100 b

● Conversion using number system mode key

Calculation results can be converted to any specified number system by using the corresponding number system mode key.

Example	Operation	Display (Lower)
How is 22_{10} expressed in binary, octal and hexadecimal number systems?	MODE 1	
	Dec → "d"	
	22 EXE	22 d
	Bin	□□□■ 00010110 b
	Oct	□■ 00000026 o
	Hex	00000016 H

■Negative expressions

Example	Operation	Display (Lower)
	MODE 1	
How is 110010_2 expressed as a negative?	Bin → “b”	
	Neg 110010 EXE	□□□■ 11001110 b
	BLOCK	□□■□ 11111111 b
	BLOCK	□■□□ 11111111 b
	BLOCK	■□□□ 11111111 b
How is 72_8 expressed as a negative?	Oct → “o”	
	Neg 72 EXE	□■ 77777706 o
	BLOCK	■□ 377 o
How is $3A_{16}$ expressed as a negative?	Hex → “H”	
	Neg 3A EXE	FFFFFFC6 H

■Basic arithmetic operations using binary, octal, decimal and hexadecimal values

Example	Operation	Display (Lower)
	MODE 1	
$10111_2+11010_2=110001_2$	Bin → “b”	
	10111 + 11010 EXE	□□□■ 00110001 b
$B47_{16}-DF_{16}=A68_{16}$	Hex → “H”	
	B47 − DF EXE	00000A68 H
$123_8\times ABC_{16}=37AF4_{16}$	SHIFT o 123 × ABC EXE	00037AF4 H
$=228084_{10}$	Dec	228084 d
$1F2D_{16}-100_{10}=7881_{10}$	SHIFT h 1F2D − 100 EXE	7881 d
$=1EC9_{16}$	Hex	00001EC9 H
$7654_8\div 12_{10}=334.3333333_{10}$	Dec → “d”	
$=516_8$	SHIFT o 7654 ÷ 12 EXE	334 d
	Oct	□■ 00000516 o
*Calculation results are displayed with the decimal portion cut off.		
$1234_{10}+1EF_{16}\div 24_8$	SHIFT d 1234 + SHIFT h	
$=2352_8$	1EF ÷ 24 EXE	□■ 00002352 o
$=1258_{10}$	Dec	1258 d
*For mixed basic arithmetic operations, multiplication and division are given priority over addition and subtraction.		

■Logical operations

Logical operations are performed through logical products (and), logical sums (or), negation (Not), exclusive logic sums (xor), and negation of exclusive logical sums (xnor).

Example	Operation	Display (Lower)
	[MODE][1]	
19_{16} AND $1A_{16} = 18_{16}$	[Hex] → "H" 19[SHIFT][and]1A[EXE]	00000018 H
1110_2 AND $36_8 = 1110_2$	[Bin] → "b" 1110[SHIFT][and][SHIFT][o]36[EXE]	□□□■ 00001110 b
23_8 OR $61_8 = 63_8$	[Oct] → "o" 23[SHIFT][or]61[EXE]	□■ 00000063 o
120_{16} OR $1101_2 = 12D_{16}$	[Hex] → "H" 120[SHIFT][or][SHIFT][b]1101[EXE]	0000012d H
1010_2 AND (A_{16} OR 7_{16}) $= 1010_2$	[Bin] → "b" 1010[SHIFT][and][(][SHIFT][h]A [SHIFT][or][SHIFT][h]7[)][EXE]	□□□■ 00001010 b
5_{16} XOR $3_{16} = 6_{16}$	[Hex] → "H" 5[SHIFT][xor]3[EXE]	00000006 H
$2A_{16}$ XNOR $5D_{16} = FFFFFF88_{16}$	[Hex] → "H" 2A[SHIFT][xnor]5D[EXE]	FFFFFF88 H
Negation of 1234_8	[Oct] → "o" [Not]1234[EXE]	□■ 77776543 o
Negation of $2FFFED_{16}$	[Hex] → "H" [Not]2FFFED[EXE]	FFd00012 H

Statistical calculations

This unit can be used to make statistical calculations including standard deviation in the SD mode, and regression calculation in the LR mode.

■Standard deviation

In the SD mode, calculations including 2 types of standard deviation formulas, mean, number of data, sum of data, and sum of squares can be performed.

● Data input

1. Press [MODE][3] to specify the SD mode.
2. Press [2ndF][Scl][EXE] to clear the statistical memories.
3. Input data, pressing [DT] key (=[M+]) each time a new piece of data is entered. For negative values, press [(-)] followed by [DT].

Example **Data: 10, 20, 30**
Key operation: 10[DT]20[DT]30[DT]

*When multiples of the same data are input, two different entry methods are possible:

Example 1 **Data: 10, 20, 20, 30**
Key operation: 10[DT]20[DT][DT]30[DT]

The previously entered data is entered again each time the [DT] key is pressed without entering data (in this case 20 is re-entered).

Example 2 **Data: 10, 20, 20, 20, 20, 20, 20, 30**
Key operation: 10[DT]20[SHIFT][;]6[DT]30[DT]

By pressing [SHIFT] and then entering a semicolon followed by a value that represents the number of items the data is repeated (6, in this case) and the [DT] key, the multiple data entries (for 20, in this case) are made automatically.

● Deleting input data

There are various ways to delete value data, depending on how and where it was entered.

Example 1 **40[DT]20[DT]30[DT]50[DT]**
To delete 50, press [SHIFT][CL].

Example 2 **40[DT]20[DT]30[DT]50[DT]**
To delete 20, press 20 [SHIFT][CL].

Example 3 **30[DT]50[DT]120[SHIFT][;]**
To delete 120 [SHIFT][;], press [AC].

Example 4 30 DT 50 DT 120 SHIFT ; 31
To delete 120 SHIFT ; 31, press AC.

Example 5 30 DT 50 DT 120 SHIFT ; 31 DT
To delete 120 SHIFT ; 31 DT, press SHIFT CL.

Example 6 50 DT 120 SHIFT ; 31 DT 40 DT 30 DT
To delete 120 SHIFT ; 31 DT, press 120 SHIFT ; 31 SHIFT CL.

Example 7 √ 10 DT √ 20 DT √ 30 DT
To delete √ 20 DT, press √ 20 EXE Ans SHIFT CL.

Note: You need to press EXE Ans to delete a calculation result, such as $\sqrt{20}$.

Example 8 √ 10 DT √ 20 DT √ 30 DT
To delete √ 20 DT, press √ 20 SHIFT ; (−) 1 DT.

•Performing calculations

The following procedures are used to perform the various standard deviation calculations.

Key operation	Result	
2ndF $x\sigma_n$ EXE	Population standard deviation $x\sigma_n$	$x\sigma_n$ = ·
2ndF $x\sigma_{n-1}$ EXE	Sample standard deviation $x\sigma_{n-1}$	$x\sigma_{n-1}$ = EXP
2ndF $\bar{x}$ EXE	Mean	$\bar{x}$ = 0
2ndF Σx^2 EXE	Sum of squares of data	Σx^2 = 1
2ndF Σx EXE	Sum of data	Σx = 2
2ndF n EXE	Number of data	n = 3

Standard deviation and mean calculations are performed as shown below:

•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 the entire data of a finite population to estimate 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 for a population to estimate the standard deviation for the population.]

•Mean

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

Example	Operation	Display (Lower)
Data 55, 54, 51, 55, 53, 53, 54, 52	MODE 3 → "SD"	
	(Memory cleared) 2ndF Sci EXE	
	55 DT 54 DT 51 DT 55 DT 53	
	DT DT 54 DT 52 DT	52.
*Results can be obtained in any order desired.		
	(Standard deviation σ_n) 2ndF $x\sigma_n$ EXE	1.316956719
	(Standard deviation σ_{n-1}) 2ndF $x\sigma_{n-1}$ EXE	1.407885953
	(Mean x) 2ndF $\bar{x}$ EXE	53.375
	(Number of data n) 2ndF n EXE	8.
	(Sum total Σx) 2ndF Σx EXE	427.
	(Sum of squares Σx^2) 2ndF Σx^2 EXE	22805.
What is deviation of the unbiased variance, the difference between each datum, and the mean of the above data?	(Continuing) 2ndF $x\sigma_{n-1}$ SHIFT x^2 EXE	1.982142857
	55 − 2ndF $\bar{x}$ EXE	1.625
	54 − 2ndF $\bar{x}$ EXE	0.625
	51 − 2ndF $\bar{x}$ EXE	−2.375
	⋮	⋮
What is x and σ_{n-1} for the following table?	2ndF Sci 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.
	2ndF n EXE	70.
	2ndF $\bar{x}$ EXE	137.7142857
	2ndF $x\sigma_{n-1}$ EXE	18.42898069

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

■Regression calculation

In the LR mode, calculations including linear regression, logarithmic regression, exponential regression, and power regression can be performed.

● Linear regression

Linear regression calculations are carried out using the following formula: $y=\mathrm{A}+\mathrm{B}x$.

•Data input

1. Press $\boxed{\text{MODE}}\boxed{2}$ to specify the LR mode.
2. Press $\boxed{\text{2ndF}}\boxed{\text{Scl}}\boxed{\text{EXE}}$ to clear the statistical memories.
3. Input data in the following format:
   $<x$ data$>$ $\boxed{,}$ $<y$ data$>$ $\boxed{\text{DT}}$

*When multiples of the same data are input, two different entry methods are possible:

Example 1 **Data: 10/20, 20/30, 20/30, 40/50**
Key operation: **10**$\boxed{,}$**20**$\boxed{\text{DT}}$
20$\boxed{,}$**30**$\boxed{\text{DT}}$
$\boxed{\text{DT}}$
40$\boxed{,}$**50**$\boxed{\text{DT}}$

The previously entered data is entered again each time the $\boxed{\text{DT}}$ key is pressed (in this case 20/30 is re-entered).

Example 2 **Data: 10/20, 20/30, 20/30, 20/30, 20/30, 20/30, 40/50**
Key operation: **10**$\boxed{,}$**20**$\boxed{\text{DT}}$
20$\boxed{,}$**30**$\boxed{\text{SHIFT}}\boxed{;}$**5**$\boxed{\text{DT}}$
40$\boxed{,}$**50**$\boxed{\text{DT}}$

By pressing $\boxed{\text{SHIFT}}$ and then entering a semicolon followed by a value that represents the number of times the data is repeated (5, in this case) and the $\boxed{\text{DT}}$ key, the multiple data entries (for 20/30, in this case) are made automatically.

•Deleting input data

There are various ways to delete value data, depending on how and where it was entered.

Example 1 **10**$\boxed{,}$**40**$\boxed{\text{DT}}$
20$\boxed{,}$**20**$\boxed{\text{DT}}$
30$\boxed{,}$**30**$\boxed{\text{DT}}$
40$\boxed{,}$**50**

To delete 40 $\boxed{,}$ 50, press $\boxed{\text{AC}}$.

Example 2 **10**$\boxed{,}$**40**$\boxed{\text{DT}}$
20$\boxed{,}$**20**$\boxed{\text{DT}}$
30$\boxed{,}$**30**$\boxed{\text{DT}}$
40$\boxed{,}$**50**$\boxed{\text{DT}}$

To delete 40 $\boxed{,}$ 50 $\boxed{\text{DT}}$, press $\boxed{\text{SHIFT}}\boxed{\text{CL}}$.

Example 3

To delete 20 $\boxed{,}$ 20 $\boxed{\text{DT}}$, press 20 $\boxed{,}$ 20 $\boxed{\text{SHIFT}}\boxed{\text{CL}}$.

Example 4 $\boxed{\sqrt{}}$**10**$\boxed{,}$**40**$\boxed{\text{DT}}$
$\boxed{\sqrt{}}$**20**$\boxed{,}$**20**$\boxed{\text{DT}}$
$\boxed{\sqrt{}}$**30**$\boxed{,}$**30**$\boxed{\text{DT}}$
$\boxed{\sqrt{}}$**40**$\boxed{,}$**50**$\boxed{\text{DT}}$

To delete $\boxed{\sqrt{}}$ 20 $\boxed{,}$ 20 $\boxed{\text{DT}}$, press $\boxed{\sqrt{}}$ 20 $\boxed{\text{EXE}}\boxed{\text{Ans}}\boxed{,}$ 20 $\boxed{\text{SHIFT}}\boxed{\text{CL}}$.

Example 5

To delete $\boxed{\sqrt{}}$ 20 $\boxed{,}$ 20 $\boxed{\text{DT}}$, press $\boxed{\sqrt{}}$ 20 $\boxed{,}$ 20 $\boxed{\text{SHIFT}}\boxed{;}\boxed{(-)}$ 1 $\boxed{\text{DT}}$.

•Performing calculations

The following procedures are used to perform the various linear regression calculations.

Key operation	Result	
$\boxed{\text{2ndF}}\boxed{\text{A}}\boxed{\text{EXE}}$	Constant term of regression A	$\boxed{\text{A}}=\boxed{\text{STO}}$
$\boxed{\text{2ndF}}\boxed{\text{B}}\boxed{\text{EXE}}$	Regression coefficient B	$\boxed{\text{B}}=\boxed{\text{RCL}}$
$\boxed{\text{2ndF}}\boxed{r}\boxed{\text{EXE}}$	Correlation coefficient r	$\boxed{r}=\boxed{(}$
$\boxed{\text{2ndF}}\boxed{\hat{x}}\boxed{\text{EXE}}$	Estimated value of x	$\boxed{\hat{x}}=\boxed{)}$
$\boxed{\text{2ndF}}\boxed{\hat{y}}\boxed{\text{EXE}}$	Estimated value of y	$\boxed{\hat{y}}=\boxed{,}$

The regression formula is $y=\mathrm{A}+\mathrm{B}x$. The constant term of regression A, regression coefficient B, correlation coefficient r, estimated value of x, and estimated value of y are calculated as shown below:

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

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

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

<table>
<tr><th>Example</th><th>Operation</th><th>Display (Lower)</th></tr>
<tr><td rowspan="16">•Temperature and length of a steel bar
<table><tr><th>Temp.</th><th>Length</th></tr><tr><td>10°C</td><td>1003mm</td></tr><tr><td>15°C</td><td>1005mm</td></tr><tr><td>20°C</td><td>1010mm</td></tr><tr><td>25°C</td><td>1011mm</td></tr><tr><td>30°C</td><td>1014mm</td></tr></table>
Using this table, the regression formula and correlation coefficient can be obtained. Based on the coefficient formula, the length of the steel bar at 18°C and the temperature at 1000mm can be estimated. Furthermore, 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.</td><td>[MODE][2] → "LR"</td><td></td></tr>
<tr><td>(Memory clear) [2ndF][Scl][EXE]</td><td></td></tr>
<tr><td>10[,]1003[DT]</td><td>10.</td></tr>
<tr><td>15[,]1005[DT]</td><td>15.</td></tr>
<tr><td>20[,]1010[DT]</td><td>20.</td></tr>
<tr><td>25[,]1011[DT]</td><td>25.</td></tr>
<tr><td>30[,]1014[DT]</td><td>30.</td></tr>
<tr><td>(Constant term A) [2ndF][A][EXE]</td><td>997.4</td></tr>
<tr><td>(Regression coefficient B) [2ndF][B][EXE]</td><td>0.56</td></tr>
<tr><td>(Correlation coefficient <i>r</i>) [2ndF][r][EXE]</td><td>0.982607368</td></tr>
<tr><td>(Length at 18°C) 18[2ndF][$\hat{y}$][EXE]</td><td>1007.48</td></tr>
<tr><td>(Temperature at 1000mm)
1000[2ndF][$\hat{x}$][EXE]</td><td>4.642857143</td></tr>
<tr><td>(Critical coefficient)[2ndF][r][SHIFT][x^2][EXE]</td><td>0.965517241</td></tr>
<tr><td>(Covariance) [(][2ndF][Σxy][−][2ndF][n]</td><td></td></tr>
<tr><td>[×][2ndF][$\bar{x}$][×][2ndF][$\bar{y}$][)][/][(]</td><td></td></tr>
<tr><td>[2ndF][n][−]1[)][EXE]</td><td>35.</td></tr>
</table>

• Logarithmic regression

Logarithmic regression calculations are carried out using the following formula: $y = \mathrm{A} + \mathrm{B}\cdot\ln x$.

•Data input

1. Press [MODE][2] to specify the LR mode.
2. Press [2ndF][Scl][EXE] to clear the statistical memories.
3. Input data in the following format:
   [ln] <*x* data> [,] <*y* data> [DT]

*To make multiple entries of the same data, follow procedures described for linear regression, however always press [ln] before inputting *x* data.

•Deleting input data

To delete input data, follow the procedures described for linear regression, but be sure to use the [ln] key when specifying *x* data for deletion.

Example 1

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

Example 2

To delete [ln] 10 [,] 20 [DT], press [ln] 10 [,] 20 [SHIFT][;][(−)] 1 [DT].

•Performing calculations

The following procedures are used to perform the various calculations.

Key operation	Result	
[2ndF][A][EXE]	Constant term of regression A	[A]=[STO]
[2ndF][B][EXE]	Regression coefficient B	[B]=[RCL]
[2ndF][r][EXE]	Correlation coefficient *r*	[r]=[(]
y[2ndF][$\hat{x}$][EXE][SHIFT][e^x][Ans][EXE]	Estimated value of *x*	[$\hat{x}$]=[)]
[ln]*x*[2ndF][$\hat{y}$][EXE]	Estimated value of *y*	[$\hat{y}$]=[,]

If we assume that $\ln x = x$, the logarithmic regression formula $y = \mathrm{A} + \mathrm{B}\cdot\ln x$ becomes the linear regression formula $y = \mathrm{a} + \mathrm{b}x$. Therefore, the formulas for constant term A, regression coefficient B and correlation coefficient *r* are identical for logarithmic and linear regression.

A number of logarithmic regression calculation results differ from those produced by linear regression. Note the following:

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

<table>
<tr><th>Example</th><th>Operation</th><th>Display (Lower)</th></tr>
<tr><td rowspan="12"><table><tr><th><i>xi</i></th><th><i>yi</i></th></tr><tr><td>29</td><td>1.6</td></tr><tr><td>50</td><td>23.5</td></tr><tr><td>74</td><td>38.0</td></tr><tr><td>103</td><td>46.4</td></tr><tr><td>118</td><td>48.9</td></tr></table>
Through logarithmic regression of the above data, the regression formula and correlation coefficient are obtained. Furthermore, respective estimated values $\hat{y}$ and $\hat{x}$ can be obtained for $xi = 80$ and $yi = 73$ using the regression formula.</td><td>[MODE][2] → "LR"</td><td></td></tr>
<tr><td>[2ndF][Scl][EXE]</td><td></td></tr>
<tr><td>[ln]29[,]1.6[DT]</td><td>3.36729583</td></tr>
<tr><td>[ln]50[,]23.5[DT]</td><td>3.912023005</td></tr>
<tr><td>[ln]74[,]38.0[DT]</td><td>4.304065093</td></tr>
<tr><td>[ln]103[,]46.4[DT]</td><td>4.634728988</td></tr>
<tr><td>[ln]118[,]48.9[DT]</td><td>4.770684624</td></tr>
<tr><td>(Constant term A) [2ndF][A][EXE]</td><td>−111.1283976</td></tr>
<tr><td>(Regression coefficient B) [2ndF][B][EXE]</td><td>34.02014749</td></tr>
<tr><td>(Correlation coefficient <i>r</i>) [2ndF][r][EXE]</td><td>0.994013946</td></tr>
<tr><td>($\hat{y}$ when $xi = 80$) [ln]80[2ndF][$\hat{y}$][EXE]</td><td>37.94879482</td></tr>
<tr><td>($\hat{x}$ when $yi = 73$)
73[2ndF][$\hat{x}$][EXE][SHIFT][e^x][Ans][EXE]</td><td>224.1541314</td></tr>
</table>

• Exponential regression

Exponential regression calculations are carried out using the following formula: $y = A \cdot e^{B \cdot x}$ ($\ln y = \ln A + Bx$)

•Data input

1. Press [MODE][2] to specify the LR mode.
2. Press [2ndF][Scl][EXE] to clear the statistical memories.
3. Input data in the following format:
   <x data> [,][ln] <y data> [DT]

*To make multiple entries of the same data, follow procedures described for linear regression, however always press [ln] before inputting y data.

•Deleting input data

To delete input data, follow the procedures described for linear regression, but be sure to use the [ln] key when specifying y data for deletion.

Example 1

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

Example 2

To delete 10 [,][ln] 20 [DT], press 10 [,][ln] 20 [SHIFT][;][(-)] 1 [DT].

•Performing calculations

The following procedures are used to perform the various calculations.

Key operation	Result	
[SHIFT][e^x][2ndF][A][EXE]	Constant term of regression A	[A] = [STO]
[2ndF][B][EXE]	Regression coefficient B	[B] = [RCL]
[2ndF][r][EXE]	Correlation coefficient r	[r] = [(]
[ln]y[2ndF][$\hat{x}$][EXE]	Estimated value of x	[$\hat{x}$] = [)]
x[2ndF][$\hat{y}$][EXE][SHIFT][e^x][Ans][EXE]	Estimated value of y	[$\hat{y}$] = [,]

If we assume that $\ln y = y$ and $\ln A = a'$, the exponential regression formula $y = A \cdot e^{B \cdot x}$ ($\ln y = \ln A + Bx$) becomes the linear regression formula $y = a + bx$. Therefore, the formulas for constant term A, regression coefficient B and correlation coefficient r are identical for exponential and linear regression.

A number of exponential regression calculation results differ from those produced by linear regression. Note the following:

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

Example

xi	yi
6.9	21.4
12.9	15.7
19.8	12.1
26.7	8.5
35.1	5.2

Through exponential regression of the above data, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtain the respective estimated values of $\hat{y}$ and $\hat{x}$, when $xi = 16$ and $yi = 20$.

Operation	Display (Lower)
[MODE][2] → "LR"	
[2ndF][Scl][EXE]	
6.9[,][ln]**21.4**[DT]	**6.9**
12.9[,][ln]**15.7**[DT]	**12.9**
19.8[,][ln]**12.1**[DT]	**19.8**
26.7[,][ln]**8.5**[DT]	**26.7**
35.1[,][ln]**5.2**[DT]	**35.1**
(Constant term A) [SHIFT][e^x][2ndF][A][EXE]	**30.49758742**
(Regression coefficient B) [2ndF][B][EXE]	**–0.049203708**
(Correlation coefficient r) [2ndF][r][EXE]	**–0.997247351**
($\hat{y}$ when $xi = 16$) **16**[2ndF][$\hat{y}$][EXE][SHIFT][e^x][Ans][EXE]	**13.87915739**
($\hat{x}$ when $yi = 20$) [ln]**20**[2ndF][$\hat{x}$][EXE]	**8.574868046**

• Power regression

Power regression calculations are carried out using the following formula: $y = A \cdot x^B$ ($\ln y = \ln A + B\ln x$)

•Data input

1. Press [MODE][2] to specify the LR mode.
2. Press [2ndF][Scl][EXE] to clear the statistical memories.
3. Input data in the following format:
   [ln] <x data> [,][ln] <y data> [DT]

*To make multiple entries of the same data, follow procedures described for linear regression, however always press [ln] before inputting x data and y data.

•Deleting input data

To delete input data, follow the procedures described for linear regression, but be sure to use the [ln] key when specifying x and y data for deletion.

Example 1

To delete [ln] 10 [,][ln] 20 [DT], press [ln] 10 [STO][A][ln] 20 [EXE][ALPHA][A][,][Ans][SHIFT][CL].

Example 2

To delete [ln] 10 [,][ln] 20 [DT], press [ln] 10 [,][ln] 20 [SHIFT][;][(-)] 1 [DT].

•Performing calculations

The following procedures are used to perform the various calculations.

Key operation	Result	
[SHIFT][e^x][2ndF][A][EXE]	Constant term of regression A	[A]=[STO]
[2ndF][B][EXE]	Regression coefficient B	[B]=[RCL]
[2ndF][r][EXE]	Correlation coefficient *r*	[r]=[(]
[ln]*y*[2ndF][$\hat{x}$][EXE][SHIFT][e^x][Ans][EXE]	Estimated value of *x*	[$\hat{x}$]=[)]
[ln]*x*[2ndF][$\hat{y}$][EXE][SHIFT][e^x][Ans][EXE]	Estimated value of *y*	[$\hat{y}$]=[,]

If we assume that ln$y$=y, lnA=a' and ln$x$=x, the power regression formula $y=\mathrm{A}\cdot x^{\mathrm{B}}$ (ln$y$=lnA+Bln$x$) becomes the linear regression formula $y=\mathrm{a}+\mathrm{b}x$. Therefore, the formulas for constant term A, regression coefficient B and correlation coefficient r are identical for power and linear regression.

A number of power regression calculation results differ from those produced by linear regression. Note the following:

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	$\Sigma \ln x \cdot \ln y$

Example	Operation	Display (Lower)
x_i y_i 28 2410 30 3033 33 3895 35 4491 38 5717	[MODE][2] → "LR"	
	[2ndF][Scl][EXE]	
	[ln]28[,][ln]2410[DT]	3.33220451
	[ln]30[,][ln]3033[DT]	3.401197382
	[ln]33[,][ln]3895[DT]	3.496507561
	[ln]35[,][ln]4491[DT]	3.555348061
Through power regression of the above data, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtain the respective estimated values of $\hat{y}$ and $\hat{x}$, when x_i=40 and y_i=1000.	[ln]38[,][ln]5717[DT]	3.63758616
	(Constant term A) [SHIFT][e^x][2ndF][A][EXE]	0.238801082
	(Regression coefficient B) [2ndF][B][EXE]	2.771866148
	(Correlation coefficient *r*) [2ndF][r][EXE]	0.998906256
	($\hat{y}$ when x_i=40) [ln]40[2ndF][$\hat{y}$][EXE][SHIFT][e^x][Ans][EXE]	6587.674743
	($\hat{x}$ when y_i=1000) [ln]1000[2ndF][$\hat{x}$][EXE][SHIFT][e^x]	
	[Ans][EXE]	20.26225659

Formula memory function

■Purpose of the formula memory function

This unit has a built-in formula memory that allows consecutive execution of the same formula, using different variables. The memory function keys ([IN], [OUT], [CALC]) are used to operate this memory.

[SHIFT][IN]: Inputs displayed formula into memory.
[OUT]: Displays formula retained in memory.
[CALC]: Used to calculate results of formula when variable is input..

There is only a single formula memory (formulas connected as multistatements are counted as a single formula). The maximum formula length is 127 steps. Calculation modes are retained in memory along with the formula, so the mode is recalled along with the formula in memory. Execution of the formula stored in memory is carried out by pressing the [CALC] key.

Example 1 **To memorize, display and calculate the following formula:**
Y=X²+3X−12

Formula input

[ALPHA][Y][2ndF][=][ALPHA][X][SHIFT][x^2][+]
3[ALPHA][X][−]12

```
Y=X²+3X−12_
          D
```

Formula stored into memory

[SHIFT][IN]

```
_
          D
```

Check formula

[OUT]

```
Y=X²+3X−12_
          D
```

Calculation

[CALC]

```
X?
         0.
          D
```

Value input for variable

7 EXE

$Y=X^2+3X-12$
58.
D

EXE *

X?
7.
D

8 EXE

$Y=X^2+3X-12$
76.
D

*Press CALC key in place of EXE key to execute calculation.

When formula is displayed, corrections or alterations can also be made.

Example 2 **Changing [$Y=X^2+3X-12$] to [$Y=X^2+5X-12$]:**

Formula displayed

OUT

$Y=X^2+3X-12$_
D

Move cursor to position where correction is to be made.

⇦ ⇦ ⇦ ⇦ ⇦

$Y=X^2+\underline{3}X-12$
D

Make correction

5

$Y=X^2+5\underline{X}-12$
D

Input into memory

SHIFT IN

_
D

Check formula

OUT

$Y=X^2+5X-12$_
D

To clear the contents of the formula memory, press AC followed by SHIFT IN.

● Using formula memory in creating tables

By inserting a " ◢ ", it is possible to write multiple formulas. This makes it easy to create tables, such as the one shown below.

Example 3 **Complete the following table:**

A	B	P=A×B	Q=A/B
4.27	1.17		
8.17	6.48		
6.07	9.47		
2.71	4.36		
1.98	3.62		

Solution)

ALPHA P 2ndF = ALPHA A × ALPHA B 2ndF ◢ ALPHA Q 2ndF = ALPHA A / ALPHA B

P=A×B◢Q=A/B_
D

SHIFT IN

_
D

CALC (Calculation started)

A?
0.
D

4.27 EXE (Input A)

B?
0.
D

1.17 EXE (Input B)

P=A×B
4.9959
Disp D

EXE

Q=A/B
3.64957265
D

EXE

A?
4.27
D

8.17 EXE (Input A)

B?
1.17
D

6.48 EXE (Input B)

P=A×B
52.9416
Disp D

EXE	Q=A/B 1.260802469 D
EXE	A? 8.17 D

(Continuation omitted)

<NOTES>

(1) A maximum of 127 steps can be input into the formula memory, using the IN key.

(2) Memory contents are protected even when power is turned OFF (or when auto power OFF function turns power OFF). However, when a new formula is input into memory, the previous formula is deleted.

(3) Array variables cannot be used in formulas input into memory. If used, it will be impossible to input variables into formula on display.

(4) Variable memories can hold only one variable each.
Example: A × BC NO!
A × B × C YES!

(5) Consecutive calculations using +, −, ×, /, and SHIFT x^2 can be performed utilizing formula calculation answers.

● Text display

Using double quotation marks, it is possible to assign names to variables in memory.

Example **Write formula [A "UNIT PRICE" × B] to memory:**

Formula input	SHIFT ALPHA A " U N I T SPACE P R I C E " ALPHA × ALPHA B	← IT PRICE"×B_
	SHIFT IN	_
	CALC	UNIT PRICE? 0.
	100 EXE	B? 0.

5 EXE	A"UNIT PRICE → 500.

Text which is over 12 characters in length is shown from the left and followed by a "?". To view the all of the text, use the ⇦ and ⇨ key to scroll left and right.

Example **Write formula [A "SINGLE UNIT PRICE" × B] to memory:**

SHIFT ALPHA A " S I N G L E SPACE U N I T SPACE P R I C E " ALPHA × ALPHA B	← IT PRICE"×B_
SHIFT IN	_
CALC	SINGLE UNIT? → 0.
⇨	← INGLE UNIT ? → 0.
⇨	← NGLE UNIT P? → 0.
⇨	← GLE UNIT PR? → 0.
⇨	← LE UNIT PRI? → 0.
⇨	← E UNIT PRIC? → 0.
⇨	← UNIT PRICE? 0.
⇦	← E UNIT PRIC? → 0.

Text can be assigned to a variable memory used in a substitution formula by enclosing the text in double quotation marks. Then when the formula is executed, the text appears on the display.

Example Write [A “ANSWER” = 123 × 456]:

[SHIFT][ALPHA][A][”][A][N][S][W][E][R] [”][2ndF][=]123[×]456	← ER”=123×456_
[SHIFT][IN]	_
[CALC]	ANSWER= 56088.

Text which is over 12 characters in length is shown from the left and followed by a “=”.

Example Write [A “ABCDEFGHIJKLMN” = 123] to memory:

[SHIFT][ALPHA][A][”][A][B][C][D][E][F] [G][H][I][J][K][L][M][N][”][2ndF] [=]123	← IJKLMN”=123_
[SHIFT][IN]	_
[CALC]	ABCDEFGHIJK= → 123.

*You can use the [⇦] and [⇨] key to scroll the text left and right while execution is stopped by a "Disp" symbol.

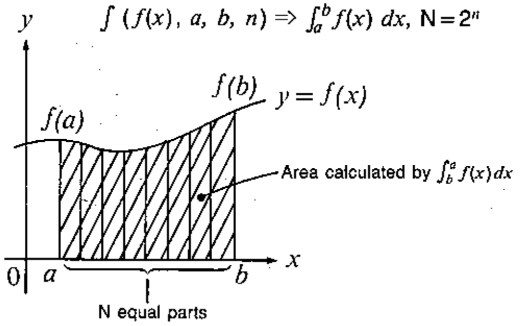
Section 3 Integration Calculation

Input of function $f(x)$ and integration calculation

Section 3 »»» Integration Calculation

- Integration calculation can be carried out by entering the integral calculus formula in the following format:

SHIFT ∫dx f(x) , a , b , n)
└ Value of n when number of divisions $N=2^n$
└ Ending point
└ Starting point



$$\int(f(x),\ a,\ b,\ n) \Rightarrow \int_a^b f(x)\,dx,\ N=2^n$$

- Integration calculation is performed using Simpson's rule to determine function $f(x)$. Because of this, partition of the integrated area is necessary, however if the number of divisions is not specified, the unit automatically sets N according to the formula. To specify the number of divisions for $N=2^n$, n can be an integer from 1 ~ 9.

Input of function $f(x)$ and integration calculation

(1) Press SHIFT ∫dx to specify integration calculation.

(2) Input the formula for the function $f(x)$, then input integral partitions $[a, b]$.
*$f(x)$ can use the X variable only. Anything other than X (A ~ W, Y, Z or array variables) is treated as a constant, and its memory contents are applied.

(3) Next input n (number of divisions for $N=2^{-n}$, n being an integer between 1 and 9) and finish by inputting a parenthesis.
*Input of n (number of divisions for $N=2^n$) and parenthesis can be omitted. When input is omitted, N is automatically set.

(4) Press EXE to execute calculation.
*Results are displayed in a few seconds or a number of minutes (mantissa is number of significant digits). Note that following integration data is input in memories G ~ L:

Memory	G	H	I	J	K	L
Data	a	b	2^n	$\int_a^b(f(x))dx$	$f(a)$	$f(b)$

■Examples of operation

Example 1 Calculate the following: $\int_1^5 (2x^2+3x+4)\,dx$

MODE 4 (Specify "D")	_ D	
SHIFT ∫dx 2 ALPHA X SHIFT x^2 + 3 ALPHA X + 4 , ($f(x)$ input)	$\int(2X^2+3X+4,$_ D	
1 , 5 , (a, b input)	←^{2}+3X+4,1,5,_ D	
6) (n input)	←3X+4,1,5,6)_ D	Answer displayed in approximately 15 seconds
EXE (Calculation executed)	$\int(2X^2+3X+4,1$ → 134.6666667 D	
RCL G	G= 1. D	a
RCL H	H= 5. D	b
RCL I	I= 64. D	N
RCL J	J= 134.6666667 D	$\int_a^b f(x)dx$
RCL K	K= 9. D	$f(a)$
RCL L	L= 69. D	$f(b)$

Example 2 Calculate the following, omitting specification of the number of divisions: $\int_1^3 (\log x)\, dx$

MODE 4 (Specify "D")	_ D	
SHIFT ∫dx log ALPHA X , ($f(x)$ input)	∫(log X, D	
1 , 3) (a, b input)	← log X,1,3)_ D	Answer displayed in approximately 8 seconds
EXE (Calculation executed)	∫(log X,1,3) ← 0.56277 D	
RCL G	G= 1. D	a
RCL H	H= 3. D	b
RCL I	I= 32. D	N ($n=5$)
RCL J	J= 0.56277 D	$\int_a^b f(x)dx$
RCL K	K= 0. D	$f(a)$
RCL L	L= 0.477121254 D	$f(b)$

● Application of integration calculation

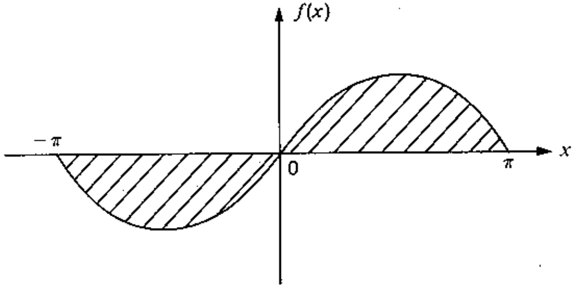
•Integrals or results of integration calculations can be used in arithmetic calculations.

Example $\int_a^b f(x)dx + \int_c^d g(x)dx$, $2 \times \int_a^b f(x)dx$, etc.

* Results of integration calculation cannot be used in integration calculation formulas.

•When calculating area, Abs (absolute value) should be inserted into formula:
$\int$ (Abs $f(x)$, a, b, n) $\Rightarrow \int_a^b |f(x)|\, dx$

Example 3



Calculate the [$-\pi$, π] areas of $f(x)=\sin x$. Omit input of number of divisions.

MODE 5 (Specify "R")	_ R	
SHIFT ∫dx SHIFT Abs sin ALPHA X , ($f(x)$ input)	← Abs sin X,_ R	
(–) SHIFT π , SHIFT π) (a, b input)	← sin X,–π,π)_ R	Answer displayed in approximately 20 seconds
EXE (Calculation executed)	∫(Abs sin X, ← 4. R	
RCL G	G= –3.141592654 R	a
RCL H	H= 3.141592654 R	b

RCL I	I= 64. R	N
RCL J	J= 4. R	$\int_a^b f(x)dx$
RCL K	K= 0. R	$f(a)$
RCL L	L= 0. R	$f(b)$

■Notes on integration calculation

- •Press AC key during integration calculation (when display is blank) to abort calculation.
- •Integration of trigonometric functions carried out in "R" mode (MODE 5).
- •This unit utilizes Simpson's rule for integration calculation. As number of significant digits is increased, extended calculation time is required. In some cases, calculation results may be erroneous even after considerable time expires in calculation. In particular, when significant digits are less than 1, an ERROR (Ma ERROR) sometimes occurs.
  In these cases, use the following methods to shorten calculation time and improve accuracy:

1. If integration value varies widely with slight changes in the integration range, divide integration areas to obtain solutions individually.
2. If some periodic functions or integration values are positive and some are negative, divide according to periods or divide positive and negative values and calculate individually.

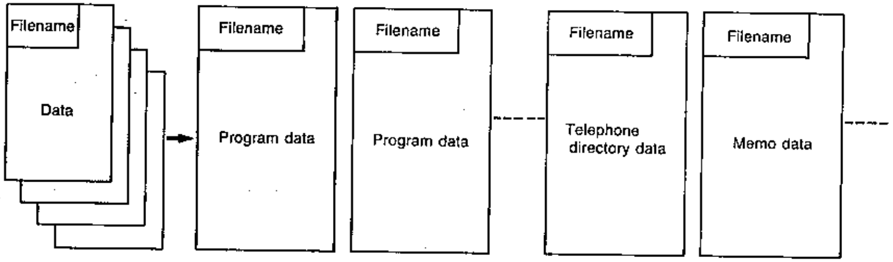
Section 4 Program Calculation

What is a program?
Program correction, addition and deletion
Program searchs
Program execution
Convenient program commands
Remaining program capacity
Using the unit as a data bank

Section 4 Program Calculation

What is a program?

This unit has a built-in program function that facilitates repeat calculations. As with the "multistatement function", the program function lets you execute series calculations in a series. In addition, the programs entered using this program function are stored in memory as individual files, under filenames. This system lets you search for and edit programs quickly and easily. Any number of programs can be written, provided the total program memory capacity of 1103 steps is not exceeded.
In place of programs, this memory can also be used to store telephone numbers or memos, much in the same way Casio Data Bank entries are made. Each line may contain up to 127 steps.

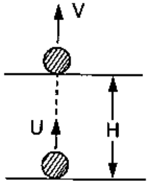


Programming

The following are practical examples of how the program function can be used.

Example 1 **Entering formulas**

(Problem 1) An object is thrown straight up at an initial velocity of 50 meters per second. How fast will it be travelling after 1 second, and how high will it be? After 3 seconds? After 5 seconds?



Time (T)	Velocity (V)	Height (H)
1 second	( )m/second	( )m
3 seconds	( )m/second	( )m
5 seconds	( )m/second	( )m

Calculation formula

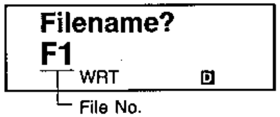
The following formulas are used to calculate velocity "V" after "T" seconds, as well as height "H" after "T" seconds, with "U" representing initial velocity, "T" representing time, and "G" representing gravitational acceleration.

$$V = U - GT, \ H = UT - \frac{1}{2}GT^2$$

Registering filenames

To carry out filename registration, press [MODE][EXP] to specify the WRT mode. The "Filename?" prompt then appears on the display. After the filename is input, press the [EXE] key to register it to memory.

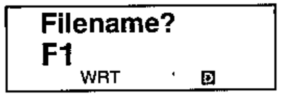
[MODE][EXP]


Filename?
F1
WRT D

*Up to 127 steps can be used to store filenames. In addition to the actual number of steps in a name, 2 steps are used each time a filename is registered.

Example **Input the filename "GOING UP":**

[MODE][EXP]


Filename?
F1
WRT D

[SHIFT][ALPHA][G][O][I][N][G][SPACE][U][P]


GOING UP_
F1
A WRT D

[EXE]


GOING UP
F1
WRT D

*The calculation mode specified at the time a filename is registered is also held in memory. (Programmed calculation is carried out in mode specified at this time.)

■Writing programs

When the filename is displayed in the WRT mode, press the ⇩ key (or ⇧ key) to display the first line of the program, and begin writing the program.

	GOING UP F1 WRT D
⇩ (or ⇧)	F1 L1 WRT D

Indicates program line number

When you've finished inputting the first line, press the EXE key to register to first line.

Example Input [V = U − GT ◢] as the first line in the program:

	F1 L1 WRT D
ALPHA V 2ndF = ALPHA U − SHIFT ALPHA G T 2ndF ◢	V = U − GT ◢ _ F1 L1 WRT D
EXE	V = U − GT ◢ F1 L1 WRT D

If you want to input a second line, programming automatically moves to the second line.

Example Input [$H = UT - \frac{1}{2}GT^2$] as the second line in the program:

	V = U − GT ◢ F1 L1 WRT D
ALPHA H	H_ F1 L2 WRT D
2ndF = SHIFT ALPHA U T ALPHA − (1 / 2) SHIFT ALPHA G T SHIFT x^2	← UT − (1/2)GT²_ F1 L2 WRT D
EXE	H = UT−(1/2)GT → F1 L2 WRT D

*A maximum of 127 steps can be input into a single line. In addition to the actual number of steps in a program line, 1 step is used each time a line is registered.

■Program execution

Press MODE EXP to cancel the WRT mode, then press the FILE key to call up the filename, and press the EXE key to execute the program.

MODE EXP	_ D
SHIFT Mcl EXE	Mcl 0. D
FILE	GOING UP F1 FILE D
EXE	U? 0. D
50 EXE	G? 0. D
9.8 EXE	T? 0. D
1 EXE	V = U − GT 40.2 Disp D
EXE	H=UT−(1/2)GT → 45.1 D
EXE	U? 50. D
EXE	G? 9.8 D
EXE	T? 1. D
3 EXE	V = U − GT 20.6 Disp D

EXE	H=UT−(1/2)GT ◢ 105.9 D
EXE	U? 50. D
EXE	G? 9.8 D
EXE	T? 3. D
5 EXE	V=U−GT 1. Disp D
EXE	H=UT−(1/2)GT ◢ 127.5 D

Program correction, addition and deletion

■Inserting lines

To insert a line between two existing lines, display the line just before the place you want to insert the new line. After inputting the desired program, press the EXE key.

■Inserting a line at the beginning

To insert a line at the beginning, display first line by pressing the ⇧ key and then press the ⇧ key once again. After inputting the desired program, press the EXE key.

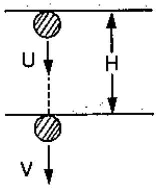
Example **Insert [S=GT], a program to determine the displacement velocity in the problem previously presented:**

	V=U−GT ◢ F1 L1 WRT D
⇧	_ F1 L1 WRT D
ALPHA S 2ndF = SHIFT ALPHA G T 2ndF ◢	S=GT ◢ _ F1 L1 WRT D
EXE	S=GT ◢ F1 L1 WRT D
⇩	V=U−GT ◢ F1 L2 WRT D

■Editing programs

To understand how editing is carried out, work through the following exercise.

(Problem 2) An object is dropped at an initial velocity of 50 meters per second. How fast will it be travelling after 1 second, and how far will it have travelled? After 3 seconds? After 5 seconds?



Time (T)	Velocity (V)	Distance (H)
1 second	( )m/second	( )m
3 seconds	( )m/second	( )m
5 seconds	( )m/second	( )m

● Registering filename

As the object is dropped in this problem (instead of being thrown up, as in Problem 1 presented previously), input "COMING DOWN" as the filename.

● Calculation formula

The following formulas are used to calculate the velocity "V" after "T" seconds, as well as the distance travelled "H" after "T" seconds, with "U" representing the initial velocity when the object is dropped, "T" representing time, and "G" representing gravitational acceleration.

$$V=U+GT,\ H=UT+\frac{1}{2}GT^2$$

● Programming

As with Problem 1 presented previously, programming is carried out in a manner similar to manual calculation:

Speed: [ALPHA] [V] [2ndF] [=] [ALPHA] [U] [+] [SHIFT] [ALPHA] [G] [T] V

Distance: [ALPHA] [H] [2ndF] [=] [SHIFT] [ALPHA] [U] [T] [ALPHA] [+] [(] [1] [/] [2] [)]
[SHIFT] [ALPHA] [G] [T] [SHIFT] [x^2] .... H

When programmed, this formula is input as follows:

[ALPHA] [V] [2ndF] [=] [ALPHA] [U] [+] [SHIFT] [ALPHA] [G] [T] [2ndF] [◢]
[ALPHA] [H] [2ndF] [=] [SHIFT] [ALPHA] [U] [T] [ALPHA] [+] [(] [1] [/] [2] [)]
[SHIFT] [ALPHA] [G] [T] [SHIFT] [ALPHA]

As this program is similar to that used in Problem 1, we can simply "edit" the program already input.

● Editing filenames

When in the RUN mode, press [MODE] [EXP] to specify the WRT mode. Then press the [FILE] key to display the desired filename. Next press the [⇨] key (or [⇦] key) to move the cursor to the beginning (or end) of the filename ([EDIT] symbol appears on display). After editing the filename, press the [EXE] key to register the new (altered) filename.

Example **Change "GOING UP" to "COMING DOWN":**

[MODE] [EXP]	Filename? F2 WRT D
[FILE]	GOING UP F1 WRT D
[⇨]	GOING UP F1 WRT EDIT D
[SHIFT] [ALPHA] [C] [O] [M] [I] [N] [G] [SPACE] [D] [O] [W] [N]	COMING DOWN_ F1 A WRT EDIT D
[EXE]	COMING DOWN F1 WRT D

*Note that edited filenames are not registered in memory until [EXE] key is pressed. If [EXE] key has not been pressed, previously registered name will still be held in memory.

● Program editing

Press [MODE] [EXP] to specify the WRT mode. Then press the [FILE] key to display the desired filename. Next press the [⇩] key (or [⇧] key) to move to the beginning (or end) of the line you want to edit. Then use the [⇨] and [⇦] keys to move to the exact point you want to edit. While in the editing mode, the [EDIT] symbol appears on the display. After editing the program, press the [EXE] key to register the edited program.

Example **Change the Problem 1 program, which determines speed and height, to the Problem 2 program, which determines speed and distance:**

[MODE] [EXP]	Filename? F2 WRT D
[FILE]	COMING DOWN F1 WRT D
[⇩] [⇩]	V=U−GT ◢ F1 L2 WRT D
[⇨]	V=U−GT ◢ F1 L2 WRT EDIT D
[⇨] [⇨] [⇨] [+]	V=U+GT ◢ F1 L2 WRT EDIT D
[EXE]	V=U+GT ◢ F1 L2 WRT D

⇩	H=UT−(1/2)GT → F1 L3 WRT D
⇨	H=UT−(1/2)GT → F1 L3 WRT EDIT D
⇨⇨⇨⇨+	H=UT+(1/2)GT → F1 L3 WRT D
EXE	H=UT+(1/2)GT → F1 L3 WRT D

*Note that edited programs are not registered in memory until EXE key is pressed. If EXE key has not been pressed, the previously registered program will still be held in memory.

MODE EXP	– D
FILE	COMING DOWN F1 FILE D
EXE	G? 9.8 D
EXE	T? 5. D
1 EXE	S=GT 9.8 Disp D
EXE	U? 50. D
EXE	V=U+GT 59.8 Disp D
EXE	H=UT+(1/2)GT → 54.9 D

EXE	G? 9.8 D
EXE	T? 1. D
3 EXE	S=GT 29.4 Disp D
EXE	U? 50. D
EXE	V=U+GT 79.4 Disp D
EXE	H=UT+(1/2)GT → 194.1 D
EXE	G? 9.8 D
EXE	T? 3. D
5 EXE	S=GT 49. Disp D
EXE	U? 50. D
EXE	V=U+GT 99. Disp D
EXE	H=UT+(1/2)GT → 372.5 D

■Program deletion

Press MODE EXP to specify the WRT mode. As with program editing, display the line containing the program you want to delete and set the unit for editing (EDIT symbol appears on display). Next press the AC key or DEL key and then the EXE key. The displayed line will be deleted.

Example **Delete the [S=GT] line from the "COMING DOWN" program:**

MODE EXP	Filename? F2 WRT D
FILE	COMING DOWN F1 WRT D
⇩	S=GT◢ F1 L1 WRT D
⇨	S=GT◢ F1 L1 WRT EDIT D
AC	_ F1 L1 WRT EDIT D
EXE	V=U+GT◢ F1 L1 WRT D

*Note that after a line is deleted, the succeeding line is displayed. When the last line is deleted, however, the line before it is displayed.

● Deleting filenames (programs)

Press MODE EXP to specify the WRT mode. Press the FILE key to display the filename you want to delete and set the unit for editing (EDIT symbol appears on display). Next press the AC key or DEL key and then the EXE key. The displayed filename (and program) will be deleted.

Example **Delete the [PROGRAM] file from the list of files to the right:**

F1	GOING UP
F2	COMING DOWN
F3	PROGRAM
F4	FORMULA

MODE EXP	Filename? F5 WRT D
FILE FILE FILE	PROGRAM F3 WRT D
⇨	PROGRAM F3 WRT D
AC	_ F3 WRT EDIT D
EXE	FORMULA F3 WRT D

*Note that after a filename is deleted, the succeeding filename is displayed. When the last line is deleted, however, the filename listed before it is displayed.

Program searchs

This unit features a program search function which allows you to search for filenames and program lines using either of the following methods:

1. Sequential search (search according to numerical order from beginning)
2. Direct search (search of all filenames or program lines which match input specifications)

■Filename sequential search

a. In the RUN mode:

When in the WRT mode, press MODE EXP to specify the RUN mode. Then press the FILE key. File number 1 (F1) will be called up. Each time you press the FILE key, the file number will be incremented, and the succeeding filename will be called up. To go back to previous filenames, press SHIFT FILE.

Example **Search for the [PROGRAM] file from the filenames listed at the right:**

F1	GOING UP
F2	COMING DOWN
F3	PROGRAM
F4	FORMULA

AC FILE	GOING UP F1 FILE D
FILE FILE	PROGRAM F3 FILE D

*Note that if you press the FILE key when the last filename is displayed, the last filename remains displayed. Also, if you press SHIFT FILE when the first filename is displayed, it remains displayed.

*You can specify the RUN mode after the display has been cleared (by pressing the AC key), during display of a calculation result, during input of a value for a variable, or while text is displayed.

*If you press the AC key while a filename is displayed, filename display disappears and unit enters "Manual calculations" status.

b. In the WRT mode:

Press MODE EXP to specify the WRT mode. At this time, the "Filename ?" prompt appears on the display. Press the FILE key to display filenames sequentially.

If you press the FILE key when the last filename is displayed, filename input becomes possible, and the display returns to the first filename. Press SHIFT FILE to display names in reverse order.

Example **Search for the [PROGRAM] file:**

MODE EXP	Filename? F5 WRT D
FILE	GOING UP F1 WRT D
FILE FILE	PROGRAM F3 WRT D

*Note that if you press SHIFT FILE when the first filename is displayed, it remains displayed.

*If you press the AC key while a filename is displayed, "Filename?" prompt appears on the display.

AC	Filename? F5 WRT D

■Sequential search of program lines

a. In the RUN mode:

When in the WRT mode, press MODE EXP to specify the RUN mode. Then call up the filename of the program you want to search. Press the ⇩ key to scroll down through program lines. Press the ⇧ to scroll up through program lines.

Example **In File 1, we programmed the "GOING UP" program. Search for the 2nd line in this program:**

AC FILE	GOING UP F1 FILE D
⇩ ⇩	H=UT−(1/2)GT → F1 L2 FILE D

*Note that if you press the ⇩ key when the last program line is displayed, the last program line remains displayed. Also, if you press ⇧ when the first program line is displayed, it remains displayed.

*If AC is pressed when program is displayed, file display disappears and unit enters "Manual calculations" status.

b. In the WRT mode:

Press MODE EXP to specify the WRT mode. Then call up the filename containing the program you want to search. Press the ⇩ key to scroll down through program lines. If you press the ⇩ key when the last filename is displayed, input of additional lines becomes possible. Press the ⇧ key to scroll up through program lines. If you press the ⇧ key when the first program line is displayed, it becomes possible to insert additional lines at the first of the file.

Example **As in the previous example, search for the 2nd line in the "GOING UP" program:**

MODE EXP	Filename? F5 WRT D
FILE	GOING UP F1 WRT D
⇩ ⇩	H=UT−(1/2)GT → F1 L2 FILE D

⇩

```
F1  L3
  WRT     D
```

⇧⇧⇧

```
F1  L1
  WRT     D
```

*If AC is pressed when program is displayed, the last line is automatically displayed and input of new lines becomes possible.

AC

```
F1  L3
  WRT     D
```

■Direct search

● Direct search of filename

By inputting the first character or characters of a filename (up to 127 steps) and pressing the FILE key, it is possible to search for an individual filename directly.

•In the RUN mode:

Example **Search "COMING DOWN" from the filenames at the right:**

F1	GOING UP
F2	COMING DOWN
F3	PROGRAM
F4	FORMULA

AC ALPHA C

```
C_
          D
```

FILE

```
COMING DOWN
F2
     FILE  D
```

*Character input for search must be carried out in "Manual calculations" status or when filenames are displayed.
*If the filename cannot be found, operation returns to "Manual calculations" status.

•In the WRT mode:

Example **Search for "COMING DOWN":**

MODE EXP

```
Filename?
F5
  WRT     D
```

ALPHA C

```
C_
F5
  WRT     D
```

FILE

```
COMING DOWN
F2
  WRT     D
```

*Character input for search must be carried out while the "Filename?" prompt is displayed or when filenames are displayed.
*If the filename cannot be found, the "Filename?" prompt appears on the display.

● Direct search of program lines

By inputting the first character or characters of a line (up to 127 steps) when the corresponding filename is displayed and pressing the ⇩ key (or ⇧ key), it is possible to search for an individual program line directly. The same procedure is used in both the RUN mode and WRT mode.

•In the RUN mode:

Example **In File 2, we programmed the "COMING DOWN" program. Search for the 2nd line in this program:**

AC FILE FILE

```
COMING DOWN
F2
     FILE  D
```

ALPHA H

```
H_
F1
           D
```

⇩

```
H=UT+(1/2)GT →
F1  L2
     FILE  D
```

*Press the ⇩ key repeatedly to continue direct search. After initial direct search, press the ⇧ key to abort search.
*If the specified line is not found, the last line is automatically displayed and input of new lines becomes possible. If no program has been entered, input becomes possible from the first line.

Notes on Direct search function

- The "C" in *n*C*r* and "C" used in the BASE-N mode cannot be searched simultaneously. The same is true for the P of "Pol (" and the letter "P".

■Scrolling right and left in filenames and program lines

When filenames or program lines contain more than 12 characters, use the [⇦] and [⇨] keys to scroll to the right or left.

*In the WRT mode, the cursor flashes allowing editing of the filename or program.

Example **Check contents of 2nd line of program below:**

F1	HELON
L1 L2	L=(A+B+C)/2◢ S=√ (L(L−A) (L−B) (L−C))

[AC][FILE]	HELON F1 FILE D
[⇩]	L=(A+B+C)/2◢ → F1 L1 FILE D
[⇩]	S=√(L(L−A)(L → F1 L2 FILE D
[⇨]	=√(L(L−A)(L− → F1 L2 FILE D
[⇨][⇨][⇨][⇨][⇨][⇨][⇨][⇨][⇨][⇨]	← (L−B)(L−C)) F1 L2 FILE D
[⇦]	←)(L−B)(L−C)) → F1 L2 FILE D

Program execution

Programs can be executed in two different ways:

■Execution through filename search

After specifying the RUN mode, press the [FILE] key. The first filename (F1) is displayed. Search the desired filename and press the [EXE] key to execute the program.

Example **Execute the "GOING UP" program:**

[AC][SHIFT][Mcl][EXE]	Mcl. 0. D
[FILE]	GOING UP F1 FILE D
[EXE]	U? 0. D
50[EXE]	G? 0. D
9.8[EXE]	T? 0. D
1[EXE]	V=U−GT 40.2 Disp D
[EXE]	H=UT−(1/2)GT → 45.1 D
[EXE]	U? 50. D

(Continuation omitted)

■Execution by pressing [SHIFT][Prog]

After pressing [SHIFT][Prog], input the filename and press the [EXE] key to execute the program.

Example **Execute the "COMING DOWN" program:**

[AC][SHIFT][Mcl][EXE]	Mcl 0. D
[SHIFT][Prog]	Prog _ D
[SHIFT][ALPHA][C][O][M][I][N][G][SPACE] [D][O][W][N]	← COMING DOWN_ D
[EXE]	U? 0. D
50[EXE]	G? 0. D
9.8[EXE]	T? 0. D
1[EXE]	V=U+GT 59.8 Disp D
[EXE]	54.9 D
[EXE]	U? 50. D

(Continuation omitted)

To have the final formula in a program (executed by [SHIFT][Prog]) remain on the upper display, include a "◢" as the last command in the program, after the final formula.

*By inputting "Prog" and then the filename, the filename can be used as a subroutine in the program (see page 114 for details).

■Aborting execution

Press the [FILE] key to abort execution while a program is being executed. The first filename then appears on the display. By pressing the [AC] key in place of the [FILE] key, execution is aborted and operation returns to the "Manual calculations" status.

■Program debugging (correcting errors)

After a program has been created and input, it will sometimes generate error messages when it is executed, or it will produce unexpected results. This indicates that there is an error somewhere within the program that needs to be corrected. Such programming errors are referred to as "bugs", while the process of correcting them is called "debugging".

When an error message is displayed, press the [⇦] or [⇨] key to move the cursor to the place where the error is generated (see page 49), and correct the program. For details, see the error message table on page 154.
When an incorrect or unusual result is generated, press [MODE][EXP] to enter the WRT mode, then press the [FILE] key to display the filename corresponding to the program you want to correct. (See page 97 for details on program editing.)

Convenient program commands

The programs for this unit are made based upon manual calculations. Special program commands, however, are available to allow the selection of the formula, and repetitive execution of the same formula.
Here, some of these commands will be used to produce more convenient programs.

■Jump commands

Jump commands are used to change the flow of program execution. Programs are executed in the order that they are input until the end of the program is reached. This system is not very convenient when there are repeat calculations to be performed, or when it is desirable to transfer execution to another formula. It is in these cases, however, that the jump commands are very effective. There are two types of jump commands: a simple unconditional jump to a branch destination and a conditional jump that decides the branch destination by determining whether a certain condition is true or not.

• Unconditional jump

The unconditional jump is composed of "Goto" and "Lbl". When program execution reaches the statement "Goto" and a label name, execution then jumps to the same "Lbl" [label] label name listed with the "Goto" command. The unconditional jump is often used in simple programs to return execution to the beginning for repetitive calculations, or to repeat calculations from a point within a program.

*Label names can contain alphabetic characters, numbers, functional commands (sin, cos, etc.), etc., however they may not contain delimiter codes (:, ◢, ⇒, ⇏, ◣ , etc.).
*Label names may be comprised of up to 126 steps.

Example **Rewrite the program used in Problem 1 using the "Goto 0" and "Lbl 0" commands to allow repeat calculations:**

F1	GOING UP
L1	V = U – GT ◢
L2	H = UT – (1/2) GT²

The program used in Problem 1 (presented previously) is shown to the right. Add "Goto 0" to the end of the program, and add "Lbl 0" to the beginning of the program which is the branch destination. If this is simply left the way it is, however, the height will not be displayed and only the initial velocity will be displayed. To prevent this, insert the display command " ◢ " at the end of the formula that calculates height H.

F1	GOING UP
L1	Lbl 0
L2	{T}
L3	V = U – GT ◢
L4	H = UT – (1/2) GT² ◢
L5	Goto 0

The program is still not complete, because after the first execution, the unit will retain the first value of T that you enter, so repeat calculation using different values for T will not be possible (values for U and G are fixed). Here, we will add the variable input command "{T}" (see page 118) to tell the program to prompt for a new input for variable T each time the program is executed.

With this, we will execute the program:

AC FILE

```
GOING  UP
F1
              FILE     D
```

EXE

```
U?
                  0.
                  D
```

50 EXE

```
G?
                  0.
                  D
```

9.8 EXE

```
T?
                  0.
                  D
```

1 EXE

```
V = U – GT
                40.2
            Disp  D
```

EXE

```
H=UT–(1/2)GT →
                45.1
            Disp  D
```

EXE

```
T?
                   1
                   D
```

3 EXE

```
V = U – GT
                20.6
            Disp  D
```

EXE

```
H=UT–(1/2)GT →
               105.9
            Disp  D
```

EXE

```
T?
                  3.
                  D
```

5 EXE

```
V = U – GT
                  1.
            Disp  D
```

EXE

```
H=UT–(1/2)GT →
               127.5
            Disp  D
```

In this way, an unconditional jump is made in accordance with "Goto" and "Lbl", and the flow of program operation is changed. When there is no "Lbl [label name]" to correspond to the "Goto [label name]" command, an error (Go ERROR) appears on the display.

● Conditional jump

The conditional jump compares a numeric value with a constant or another numeric value in memory. If the condition is true, the statement following "⇒" is executed up to the next "⇏" or "◣". If the condition is not true, execution skips the statement following "⇏" up to the next "◣". In either case, execution continues from the above following the jump end code "◣ ".
Conditional jumps are formed in the following ways:

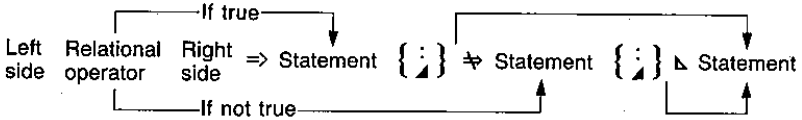
1. Left side Relational operator Right side ⇒ Statement { : / ◢ } ⇏ Statement { : / ◢ } ◣ Statement
2. Left side Relational operator Right side ⇒ Statement { : / ◢ } ◣ Statement

One variable (A ~ Z), constant or variable formula (A × 2, D – E, etc.) is used for the left side and one for the right side.

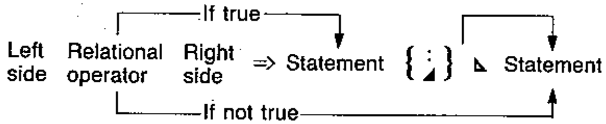
The relational operator is a comparison symbol. There are 6 types of relational operators: =, ≠, ≧, ≦, >, <.

Left side = right side (left side equals right side)
Left side ≠ right side (left side does not equal right side)
Left side ≧ right side (left side greater than or equal to right side)
Left side ≦ right side (left side less than or equal to right side)
Left side > right side (left side greater than right side)
Left side < right side (left side less than right side)

The "⇒" is displayed when [2ndF][⇒] are pressed. If the condition is true, execution advances to the next statement. The "⇏" is displayed when [2ndF][⇏] are pressed. If the condition is not true, execution advances to the next statement. After this, if [2ndF][⊾] are pressed, execution continues from the next "⊾".



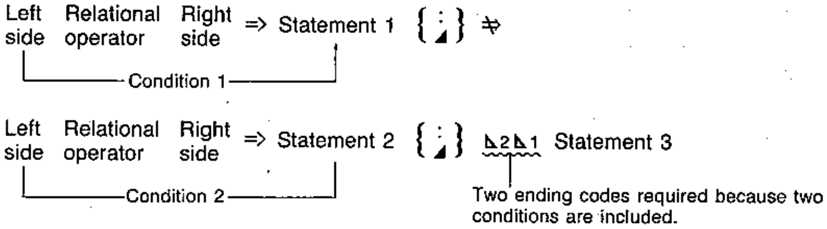
*If statement following "⇏" is unnecessary, flow of operations is as follows:



*For statements following "⇒" and "⇏", multistatements can also be used.

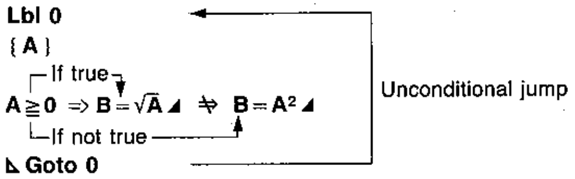
*When creating a conditional jump with a multistatement condition (a statement made up of more than one condition), the conditional jump must be followed by multiple ending codes. The number of ending codes "⊾" should match the number of conditions contained in the conditional statement.

Example



Example **If an input numeric value is greater than or equal to zero, calculate the square root of that value. If the value is less than zero, display the square of that value:**

Program must be written as follows.
In the following program, A representing input numeric value, B representing calculation result.



```
Lbl 0
{A}
A≧0 ⇒ B=√A◢ ⇏ B=A²◢
⊾Goto 0
```

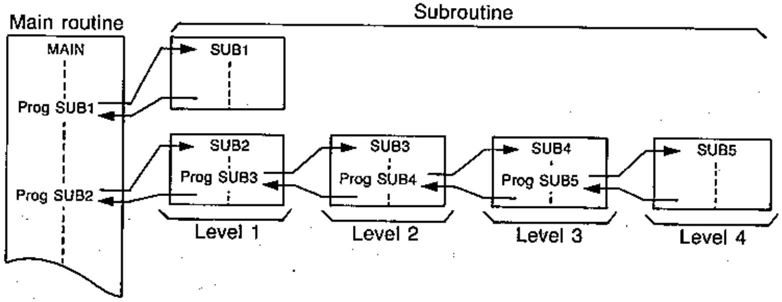
In this formula, a value is input for variable A. If this value is equal to or greater than zero, the statement between "⇒" and "◢" is executed. If it is less than zero, the statement between "⇏" and "◢" is executed. When "Goto 0" is reached, execution returns to "Lbl 0", for repeated calculation.

Input the filename [VALUE] and execute the program:

[AC][ALPHA][V][FILE]	VALUE F5
[EXE]	A? 0.
2[EXE]	B=√A 1.414213562
[EXE]	A? 2.
0[EXE]	B=√A 0.
[EXE]	A? 0.
−2[EXE]	B=A² 4.

■Subroutines

A program contained in a single program area is called a "main routine". Often used program segments stored in other program areas are called "subroutines". Subroutines can be used in a variety of ways to help make calculations easier. They can be used to store formulas for repeat calculations as one block to be jumped to each time, or to store often used formulas or operations for call up as required.



The subroutine command is "Prog", followed by a filename which is used to specify a program area.

Example **Prog ABC — Jump to program area [ABC]:**

After the jump is performed using the Prog command, execution continues from the beginning of the program stored in the specified program area. After execution reaches the end of the subroutine, the program returns to the statement following the Prog name command in the original program area. Jumps can be performed from one subroutine to another, and this procedure is known as "nesting". Nesting can be performed to a maximum of 9 levels, and attempts to exceed this level will cause an error (Ne ERROR) to be generated. Attempting to use Prog to jump to a filename in which there is no program stored will also result in an error (Go ERROR).

Example **Simultaneously execute the two previously presented programs (Problem 1 and Problem 2) to determine the speed and height of an object which is tossed straight up, and the speed and distance of an object which is dropped:**

This example employs the two programs previously presented:

F1	GOING UP
L1	Lbl 0
L2	{T}
L3	V=U−GT◢
L4	H=UT−(1/2)GT²◢
L5	Goto 0

F2	COMING DOWN
L1	Lbl 0
L2	{T}
L3	V=U+GT◢
L4	H=UT+(1/2)GT²◢
L5	Goto 0

When these two programs are compared, it is evident that lines 1, 2 and 5 are identical. If these portions are incorporated into a common routine, the programs are simplified and the number of steps required is decreased. Also, if it is possible to choose which calculation is going to be carried out when this program is executed, the calculation becomes even easier. For this, the conditional jump command is used in the main routine in the following way:

F3	MAIN
L1	Lbl 0
L2	{T, N}
L3	N "GOING UP:0, COMING DOWN:1"
L4	N=1⇒Prog COMING DOWN: ⇏N=0⇒Prog GOING UP◣◣
L5	Goto 0

The portions of the program which are not identical are as follows:

F1	GOING UP
L1	V=U−GT◢
L2	H=UT−(1/2)GT²◢

F2	COMING DOWN
L1	V=U+GT◢
L2	H=UT+(1/2)GT²◢

If the program is written in this way, after the program assigned to the filename "MAIN" is executed, zero is input to jump to the "GOING UP" subroutine to calculate the velocity and height of the object tossed in the air, with an unconditional jump from "Goto 0" to "Lbl 0". If a value of 1 is input for N, execution jumps to the "COMING DOWN" subroutine to calculate the velocity and distance of the object which is dropped.

Actual programming and execution:

AC SHIFT Mcl EXE	Mcl 0.
ALPHA M FILE	MAIN F3
EXE	GOING UP:0,? 0.
EXE	U? 0.
50 EXE	G? 0.

9.8 EXE	T? 0. D
1 EXE	V=U−GT 40.2 Disp D
EXE	H=UT−(1/2)GT → 45.1 Disp D
EXE	GOING UP:0,? → 0. D
1 EXE	T? 1. D
EXE	V=U+GT 59.8 Disp D
EXE	H=UT+(1/2)GT → 54.9 Disp D
EXE	GOING UP:0,? → 1. D

(Continuation omitted)

In this way, subroutines can be used to isolate the common portions of two original programs and store them in separate program areas. Steps are shortened, and programs take on a clearer configuration.

■Pause command

By inputting [Pause *n* (*n*= an integer between 0 and 9)] in the program, execution can be interrupted (paused) for up to 4.5 seconds.
While in the pause state, the answer from the previous line's calculation and the formula (or text) are displayed.

Example **Perform a calculation wherein a value of 1 is added consecutively to variable A. In this case, variable A's initial value is 1:**

For this case, the program is as follows:

Lbl 0
A=A+1
Pause 3 (Displayed for approximately 1.5 seconds)
Goto 0

Unconditional jump

When a value is input for variable A, "Pause 3" causes a pause of 1.5 seconds, after which "Goto 0" causes execution to return to "Lbl 0", with the formula [A=A+1] calculated repeatedly.
Here, we will insert the name "ADDITION" and execute the program:

AC SHIFT Mcl EXE	Mcl 0. D
ALPHA A FILE	ADDITION F6 FILE D
EXE	A? 0. D
1 EXE	A=A+1 2. D
(After approximately 1.5 seconds)	A=A+1 3. D
	⋮
(After approximately 15 seconds)	A=A+1 12. D

AC

```
_
                D
```

The amount of time (approximate) corresponding to "Pause *n*" ("*n*" being an integer between 0 and 9) is as follows:

n	0	1	2	3	4	.....	8	9
Pause time (seconds)	0	0.5	1	1.5	2	.....	4	4.5

*"Pause *n*" is treated as a single statement.

■Variable input command

When a value is input for a variable in a program, that value is stored in memory as a defined value. If it becomes necessary to input a new value for that variable, the variable input command 2ndF {, 2ndF } can be used to return the variable to its undefined status. This is done by inputting the variable (A~Z) in brackets "{ }".

Example {A} .... Variable A returned to undefined status.
{AB} {A, B} {A␣B} .... Variables A and B returned to undefined status.

*"{ }" is treated as a single statement.
*Array variables cannot be used as variables.

■Fixm

When 2ndF Fixm is input in a program, all values for variables (A~Z) after the command are treated as defined values. When the program is executed, the program does not wait for entry of values for variables, but completes calculation using values which have already been input.

Example **Input "Fixm" in the first line of the program written for Problem 2 (see page 95):**

The program written for Problem 2 is as shown at the right. We will assume that the following values have been input: U=50, G=9.8, T=1.

F2	COMING DOWN
L1	Fixm
L2	V=U+GT◢
L3	H=UT+(1/2)GT^2

AC FILE FILE

```
COMING DOWN
F2
          FILE   D
```

EXE

```
V=U+GT
           59.8
       Disp   D
```

EXE

```
H=UT+(1/2)GT →
           54.9
              D
```

EXE

```
V=U+GT
           59.8
       Disp   D
```

In this case, the calculation was carried out using only the values which had already been entered, so the results did not vary. If the variable input command "{ }" is contained in the same program where "Fixm" is used, the "{ }" command takes priority.

Example **Input the "{ }" command into the Problem 2 program which contains "Fixm":**

In this program, variables U and G are calculated using the defined values already input. Variable T, however is called up, and a value is input. Here, we will input the value and execute the program:

F2	COMING DOWN
L1	Fixm
L2	U=50:G=9.8
L3	{T}
L4	V=U+GT◢
L5	H=UT+(1/2)GT^2

AC FILE FILE

```
COMING DOWN
F2
          FILE   D
```

EXE

```
T?
              1.
              D
```

EXE

```
V=U+GT
           59.8
       Disp   D
```

EXE

```
H=UT+(1/2)GT →
           54.9
              D
```

EXE

```
T?
              1.
              D
```

3 EXE

```
V=U+GT
      79.4
   Disp  D
```

EXE

```
H=UT+(1/2)GT →
     194.1
         D
```

(Continuation omitted)

*"Fixm" is treated as a single statement.

Remaining program capacity

The program capacity of this unit is 1103 steps. The number of steps indicates the amount of storage space available, and it will decrease as programs are input.
The number of remaining steps will also be decreased when steps are converted to memories. (See page 41.)

*Basically, one function requires a single step, but there are some commands where one function requires two steps.
•One function/one step: sin, cos, tan, log, (,), :, A, B, 1, 2, 3, etc.
•One function/two steps: Lbl "label name", Goto "label name", Prog "filename", etc.
*When the step capacity is exceeded, a "Mem ERROR" is generated.

■Determining the number of remaining steps

Hold down SHIFT CAPA to display the current remaining number of steps. Display returns to normal when keys are released.

Example

SHIFT CAPA

(Indicates 847 steps available)

```
Free
      847.
```

Using the unit as a data bank

In place of data or programs, it is possible to store often used formulas or even telephone numbers in this unit, using it much like a data bank.
Here, we will input a list of telephone numbers.

Filename: TEL DATA

Data:

Listing No.	Numbers
1	Robert Jones 03-012-3456
2	Samuel Stevens 03-023-4567
3	John Smith 0425-034-5678
4	Henry White 0425-045-6789
5	Jane Bell 0473-056-7890

a. Inputting data

Press MODE EXP to specify WRT mode. Specify this telephone list as "File 5":

MODE EXP

```
Filename?
F5
 WRT      D
```

Input the filename:

SHIFT ALPHA T E L SPACE
D A T A EXE

```
TEL DATA
F5
 WRT      D
```

Press ⇩ key to input listing number 1:

⇩

```
_
F5  L1
 WRT      D
```

Input data for listing number 1:

SHIFT ALPHA R O B E R T SPACE
J O N E S SPACE ALPHA 0 3 –
0 1 2 – 3 4 5 6

```
←03-012-3456
F5  L1
 WRT      D
```

EXE

```
ROBERT JONES →
F5  L1
 WRT      D
```

Other listings are input in the same way.

b. Recalling data

First, call up the filename "TEL DATA". The direct search function can be used as shown below:

[AC] [ALPHA] [T] [FILE]	TEL DATA F5 FILE D

Next, call up the data for "Samuel Stevens":

[ALPHA] [S]	S_ F5 D
[⇩]	SAMUEL STEVE → F5 L2 FILE D
[⇨]	← AMUEL STEVEN → F5 L2 FILE D
[⇨]	← MUEL STEVENS → F5 L2 FILE D

Use the [⇦] and [⇨] keys to scroll to the left or right:

[⇨][⇨][⇨][⇨][⇨][⇨][⇨][⇨][⇨][⇨] [⇨][⇨]	← 03-023-4567 F5 L2 FILE D

As a space is inserted before entering the telephone number, listings can also be searched according to number:

[AC] [ALPHA] [T] [FILE]	TEL DATA F5 FILE D

Search using the prefix "03":

03[⇩]	← 03-012-3456 F5 L1 FILE D

Press the [⇩] key until the listing you're searching for appears:

[⇩]	← 03-023-4567 F5 L2 FILE D

Use the [⇦] and [⇨] keys to scroll to the left or right:

[⇦][⇦][⇦][⇦][⇦][⇦][⇦][⇦][⇦][⇦] [⇦][⇦]	UEL STEVENS → F5 L2 FILE D

PROGRAM LIBRARY

1. Prime factor analysis
2. Greatest common measure
3. Δ↔Y transformation
4. Minimum loss matching
5. Cantilever under concentrated load
6. Normal distribution
7. Numerical solution of an equation (Newton's law)
8. Quadratic equation
9. Complex numbers

CASIO PROGRAM SHEET

Program for		No.
	Prime factor analysis	1

Description

Prime factors of arbitrary positive integers are produced.

For $1 < m < 10^{10}$

prime numbers are produced from the lowest value first. "END" is displayed at the end of the program.

⟨Overview⟩

m is divided by 2 and by all successive odd numbers ($d = 3, 5, 7, 9, 11, 13, \ldots$) to check for divisibility.

Where d is a prime factor, $m_i = m_{i-1}/d$ is assumed, and division is repeated until $\sqrt{m_i} + 1 \leq d$.

Example

⟨1⟩

$119 = 7 \times 17$

⟨2⟩

$630 = 2 \times 3 \times 3 \times 5 \times 7$

⟨3⟩

$987654321 = 3 \times 3 \times 17 \times 17 \times 379721$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	EXE	PRIME FACTOR → 5. Disp D
2	FILE	PRIME FACTOR → F1 FILE D	12	EXE	PRIME FACTOR → 7. Disp D
3	EXE	M? 0. D	13	EXE	END 630. Disp D
4	119 EXE	PRIME FACTOR → 7. Disp D	14	EXE	M? 7. D
5	EXE	PRIME FACTOR → 17. Disp D	15	987654321 EXE	PRIME FACTOR → 3. Disp D
6	EXE	END 119. Disp D	16	EXE	PRIME FACTOR → 3. Disp D
7	EXE	M? 17. D	17	EXE	PRIME FACTOR → 17. Disp D
8	630 EXE	PRIME FACTOR → 2. Disp D	18	EXE	PRIME FACTOR → 17. Disp D
9	EXE	PRIME FACTOR → 3. Disp D	19	EXE (After approx. 1.5 minutes)	PRIME FACTOR → 379721. Disp D
10	EXE	PRIME FACTOR → 3. Disp D	20	EXE	END 987654321. Disp D

No.	1

Line	MODE EXP					Program										Notes	Number of steps
F1	P	R	I	M	E		F	A	C	T	O	R					14
L1	Lbl	0	:	{	A	}	:	A	"	M	"	:	N	=	A		
	:	Goto	2	◺													34
2	Lbl	1	:	B	=	2	:	"	P	R	I	M	E		F		
	A	C	T	O	R	"	◢	A	=	A	/	2	:	A	=		
	1	⇒	Goto	9	◺												70
3	Lbl	2	:	Frac	(	A	/	2	)	=	0	⇒	Goto	1	◺		
	B	=	3														89
4	Lbl	3	:	C	=	√	A	+	1								99
5	Lbl	4	:	B	≥	C	⇒	Goto	8	◺	Frac	(	A	/	B		
	)	=	0	⇒	Goto	6	◺										122
6	Lbl	5	:	B	=	B	+	2	:	Goto	4	◺					135
7	Lbl	6	:	(	A	/	B	)	B	−	A	=	0	⇒	Goto		
	7	◺	Goto	5													155
8	Lbl	7	:	B	:	"	P	R	I	M	E		F	A	C		
	T	O	R	"	◢	A	=	A	/	B	:	Goto	3	◺			185
9	Lbl	8	:	A	:	"	P	R	I	M	E		F	A	C		
	T	O	R	"	◢												206
10	Lbl	9	:	N	:	"	E	N	D	"	◢	Goto	0				220
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	

Memory contents							
A	m_i	H		O		V	
B	d	I		P		W	
C	$\sqrt{m_i} + 1$	J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M		T			
G		N	m	U			

CASIO PROGRAM SHEET

Program for **Greatest common measure** No. 2

Description

Euclidean general division is used to determine the greatest common measure for two integers a and b.

For $|a|$, $|b| < 10^9$, positive values are taken as $< 10^{10}$

〈Overview〉

$n_0 = \max(|a|, |b|)$

$n_1 = \min(|a|, |b|)$

$$n_k = n_{k-2} - \left[\frac{n_{k-2}}{n_{k-1}}\right] n_{k-1}$$

$k = 2, 3 \ldots\ldots$

If $n_k = 0$, then the greatest common measure (c) will be n_{k-1}.

Example

	〈1〉	〈2〉	〈3〉
When	$a = 238$	$a = 23345$	$a = 522952$
	$b = 374$	$b = 9135$	$b = 3208137866$
	↓	↓	↓
	$c = 34$	$c = 1015$	$c = 998$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	3208137866 EXE	C 998. Disp D
2	FILE	COMMON MEASU → F1 FILE D			
3	EXE	A? 0. D			
4	238 EXE	B? 0. D			
5	374 EXE	C 34. Disp D			
6	EXE	A? 102. D			
7	23345 EXE	B? 34. D			
8	9135 EXE	C 1015. Disp D			
9	EXE	A? 4060. D			
10	522952 EXE	B? 1015. D			

No. 2

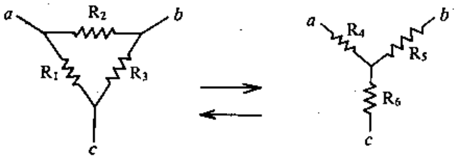
Line	MODE EXP Program															Notes	Number of steps
F1	C	O	M	M	O	N		M	E	A	S	U	R	E			16
L1	Lbl	1															19
2	{	A	,	B	}												25
3	A	=	Abs	A	:	B	=	Abs	B								35
4	B	>	A	=>	C	=	A	:	A	=	B	:	B	=	C		
	◺																52
5	Lbl	2															55
6	C	=	−	(	Int	(	A	/	B	)	×	B	−	A	)		71
7	C	≠	0	=>	A	=	B	:	B	=	C	:	Goto	2	◺		87
8	B	:	"	C	"	◢	Goto	1									96
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	
25																	
26																	

Memory contents								
A	a, n_0	H		O		V	
B	b, n_1	I		P		W	
C	n_k	J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M		T			
G		N		U			

CASIO PROGRAM SHEET

Program for	Δ↔Y transformation	No.	3

Description



1) Δ→Y

$$R_4=\frac{R_1\cdot R_2}{R_1+R_2+R_3}$$

$$R_5=\frac{R_2\cdot R_3}{R_1+R_2+R_3}$$

$$R_6=\frac{R_3\cdot R_1}{R_1+R_2+R_3}$$

2) Y→Δ

$$R_1=\frac{R_4R_5+R_5R_6+R_6R_4}{R_5}$$

$$R_2=\frac{R_4R_5+R_5R_6+R_6R_4}{R_6}$$

$$R_3=\frac{R_4R_5+R_5R_6+R_6R_4}{R_4}$$

Example

⟨1⟩
$R_1=12$ (Ω)
$R_2=47$ (Ω)
$R_3=82$ (Ω)

⟨2⟩
$R_4=100$ (Ω)
$R_5=150$ (Ω)
$R_6=220$ (Ω)

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	2 EXE	R4? 4. D
2	FILE	TRANSFORMATI→ F1 FILE D	12	100 EXE	R5? 27.33333333 D
3	EXE	D⇒Y:1,Y⇒D:2? 0. D	13	150 EXE	R6? 6.978723404 D
4	1 EXE	R1? 0. D	14	220 EXE	R1= 466.6666667 Disp D
5	12 EXE	R2? 0. D	15	EXE	R2= 318.1818182 Disp D
6	47 EXE	R3? 0. D	16	EXE	R3= 700. Disp D
7	82 EXE	R4= 4. Disp D			
8	EXE	R5= 27.33333333 Disp D			
9	EXE	R6= 6.978723404 Disp D			
10	EXE	D⇒Y:1,Y⇒D:2? 1. D			

No. 3

Line	MODE EXP	Program														Notes	Number of steps
F1	T	R	A	N	S	F	O	R	M	A	T	I	O	N			16
L1	Lbl	1															19
2	{	N	}	:	N	"	D	⇒	Y	:	1	,	Y	⇒	D		
	:	2	"														38
3	N	=	2	⇒	Goto	2	:	⇏	N	≠	1	⇒	Goto	1	⊿		
	⊿																55
4	{	A	}	:	A	"	R	1	"	:	{	B	}	:	B		
	"	R	2	"	:	{	C	}	:	C	"	R	3	"			85
5	D	=	A	+	B	+	C										93
6	E	"	R	4	"	=	A	B	/	D	◢						105
7	F	"	R	5	"	=	B	C	/	D	◢						117
8	G	"	R	6	"	=	C	A	/	D	◢						129
9	Goto	1															132
10	Lbl	2															135
11	{	E	}	:	E	"	R	4	"	:	{	F	}	:	F		
	"	R	5	"	:	{	G	}	:	G	"	R	6	"			165
12	H	=	E	F	+	F	G	+	G	E							176
13	A	"	R	1	"	=	H	/	F	◢							187
14	B	"	R	2	"	=	H	/	G	◢							198
15	C	"	R	3	"	=	H	/	E	◢							209
16	Goto	1															212
17																	
18																	
19																	
20																	
21																	
22																	
23																	

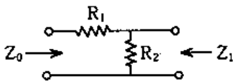
Memory contents	A	R_1	H	$R_4R_5+R_5R_6+R_6R_4$	O		V	
	B	R_2	I		P		W	
	C	R_3	J		Q		X	
	D	$R_1+R_2+R_3$	K		R		Y	
	E	R_4	L		S		Z	
	F	R_5	M		T			
	G	R_6	N	For judgement	U			

CASIO PROGRAM SHEET

Program for	Minimum loss matching	No.	4

Description

Calculate R_1 and R_2 which match Z_0 and Z_1 with loss minimized. ($Z_0 > Z_1$)



$$R_1 = Z_0\sqrt{1-\frac{Z_1}{Z_0}} \qquad R_2 = \frac{Z_1}{\sqrt{1-\frac{Z_1}{Z_0}}}$$

$$\text{Minimum loss } L_{min} = 20\log\left(\sqrt{\frac{Z_0}{Z_1}}+\sqrt{\frac{Z_0}{Z_1}-1}\right)\text{[dB]}$$

Example

Calculate the values of R_1, R_2 and L_{min} for $Z_0 = 500\Omega$ and $Z_1 = 200\Omega$.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl D 0.			
2	FILE	LOSS MATCHIN → F1 FILE D			
3	EXE	Z0 ? D 0.			
4	500 EXE	Z1? D 0.			
5	200 EXE	R1 = 387.2983346 Disp D			
6	EXE	R2 = 258.1988897 Disp D			
7	EXE	LMIN = 8.961393328 Disp D			

No.	4

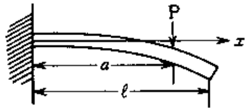
Line	MODE EXP Program															Notes	Number of steps
F1	L	O	S	S		M	A	T	C	H	I	N	G				15
L1	Y	"	Z	0	"	:	Z	"	Z	1	"						27
2	A	=	√	(	1	−	Z	/	Y	)	:	B	=	Y	/		
	Z																44
3	R	"	R	1	"	=	Y	A	◢								54
4	S	"	R	2	"	=	Z	/	A	◢							65
5	T	"	L	M	I	N	"	=	2	0	log	(	√	.B	+		
	√	(	B	−	1	)	)	◢									89
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	
25																	

Memory contents	A	$\sqrt{1-\frac{Z_1}{Z_0}}$	H		O		V	
	B	$\frac{Z_0}{Z_1}$	I		P		W	
	C		J		Q		X	
	D		K		R	R_1	Y	Z_0
	E		L		S	R_2	Z	Z_1
	F		M		T	L_{min}		
	G		N		U			

CASIO PROGRAM SHEET

Program for **Cantilever under concentrated load**	No. 5

Description



E : Young's modulus [kg/mm²]

I : Geometrical moment of inertia [mm⁴]

a : Distance of concentrated load from support [mm]

P : Load [kg]

x : Distance of point of interest from the support [mm]

Deflection y [mm], Angle of deflection s [°], Bending moment M [kg·mm]

① $\ell > x > a$

$$y = \frac{Pa^3}{6EI} - \frac{Pa^2}{2EI}x$$

$$s = \tan^{-1}\left[-\frac{Pa^2}{2EI}\right]$$

M = 0 (shearing load $W_s = 0$)

② $x \leqq a$

$$y = \frac{P}{6EI}x^3 - \frac{Pa}{2EI}x^2$$

$$s = \tan^{-1}\left[\frac{Px}{2EI}(x - 2a)\right]$$

M = P $(x - a)$ (shearing load $W_s = P$)

Example

E = 4000 kg/mm²
I = 5 mm⁴
a = 30 mm
P = 2 kg

What are deflection, angle of deflection, bending moment and shearing load at x = 25 mm and x = 32 mm?

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	EXE	X? 25. D
2	FILE	CANTILEVER → F1 D	12	32 EXE	Y = PA²/2EI × (A → − 0.99 Disp D
3	EXE	E? 0. D	13	EXE	S = tan⁻¹(− PA² → − 2.57657183 Disp D
4	4000 EXE	I? 0. D	14	EXE	M = 0 0. Disp D
5	5 EXE	A? 0. D			
6	30 EXE	P? 0. D			
7	2 EXE	X? 0. D			
8	25 EXE	Y = PX²/2EI × (X → − 0.677083333 Disp D			
9	EXE	S = tan⁻¹(PX/2 → − 2.505092867 Disp D			
10	EXE	M = P(X − A) − 10. Disp D			

No. 5

Line	MODE EXP						Program									Notes	Number of steps
F1	C	A	N	T	I	L	E	V	E	R							12
L1	Deg																14
2	Lbl	1															17
3	E	:	I	:	A	:	P	:	{	X	}						29
4	X	≦	A	=>	Goto	2	◣										37
5	Y	=	P	A	x^2	/	2	E	I	×	(	A	/	3	−		
	X	)	◢														56
6	S	=	tan^{-1}	(	−	P	A	x^2	/	2	E	I	)	◢			71
7	M	=	0	◢													76
8	Goto	1															79
9	Lbl	2															82
10	Y	=	P	X	x^2	/	2	E	I	×	(	X	/	3	−		
	A	)	◢														101
11	S	=	tan^{-1}	(	P	X	/	2	E	I	×	(	X	−	2		
	A	)	)	◢													121
12	M	=	P	(	X	−	A	)	◢								131
13	Goto	1															134
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	

Memory contents								
	A	a	H		O		V	
	B		I	I	P	P	W	
	C		J		Q		X	x
	D		K		R		Y	y
	E	E	L		S	s	Z	
	F		M	M	T			
	G		N		U			

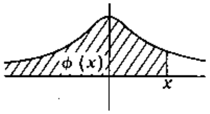
CASIO PROGRAM SHEET

Program for	No.
Normal distribution	6

Description

Obtain normal distribution function $\phi\ (x)$ (by Hastings' best approximation).

$$\phi\ (x)=\int_{-\infty}^{t}\phi t dx$$



$$\phi t=\frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}$$

Put $t=\frac{1}{1+\mathrm{P}x}$

$\phi\ (x)\fallingdotseq 1-\phi t\ (c_1t+c_2t^2+c_3t^3+c_4t^4+c_5t^5)$

$\mathrm{P}=0.2316419$

$C_1=0.31938153$

$C_2=-0.356563782$

$C_3=1.78147937$

$C_4=-1.821255978$

$C_5=1.330274429$

Example

Calculate the values of $\phi\ (x)$ at $x=1.18$ and $x=0.7$.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D			
2	FILE	DISTRIBUTION → F1 D			
3	EXE	X? 0. D			
4	1.18 EXE	PX = 0.880999696 Disp D			
5	EXE	X? 1.18 D			
6	0.7 EXE	PX = 0.758036136 Disp D			

No.	6

Line	MODE EXP Program															Notes	Number of steps
F1	D	I	S	T	R	I	B	U	T	I	O	N					14
L1	Lbl	0															17
2	[	X	]														21
3	T	=	1	⁄	(	1	+	0	.	2	3	1	6	4	1		
	9	X	)														40
4	Q	=	1	⁄	√	2	π	×	e^x	(	−	X	x^2	⁄	2		
	)																57
5	A	=	0	.	3	1	9	3	8	1	5	3					70
6	B	=	(−)	0	.	3	5	6	5	6	3	7	8	2			85
7	C	=	1	.	7	8	1	4	7	9	3	7					98
8	D	=	(−)	1	.	8	2	1	2	5	5	9	7	8			113
9	E	=	1	.	3	3	0	2	7	4	4	2	9				127
10	P	"	P	X	"	=	1	−	Q	(	A	T	+	B	T		
	x^2	+	C	T	x^y	3	+	D	T	x^y	4	+	E	T	x^y		
	5	)	◢														161
11	Goto	0															164
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	

Memory contents								
	A	C_1	H		O		V	
	B	C_2	I		P	$\phi(x)$	W	
	C	C_3	J		Q	ϕt	X	x
	D	C_4	K		R		Y	
	E	C_5	L		S		Z	
	F		M		T	t		
	G		N		U			

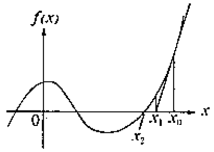
CASIO PROGRAM SHEET

Program for
Numerical solution of an equation (Newton's law)

No. 7

Description

Using Newton's law to calculate x so that $f(x)=0$ in $y=f(x)$



Parameters:

x_0 ... Initial value

h ... Micro interval in direction of x axis when numeric differential is performed for points $(x, f(x))$

ε ... Convergent condition of solution ("ε" used to continue calculation until inequality in $\varepsilon > |x_{n+1}-x_n|$ is developed).

$$x_{n+1}=x_n-\frac{f(x_n)}{f'(x_n)} \qquad f'(x)=\frac{f(x+h)-f(x)}{h}$$

x_n is root for $|x_{n+1}-x_n|<\varepsilon$

Example

Write a program for the following: $f(x)=ax^3+bx^2+cx+d$

$f(x)=2x^3+3x^2-x-5$

$x_0=1$, $\varepsilon=1\times10^{-5}$, $h=0.001$

Note: If solution does not appear after an extended period, no root exists. In this case, press AC to abort execution and re-execute with a different value for x_0.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	0.001 EXE (After approx. 9 seconds)	CALCULATING D
2	FILE	NEWTON F1 D	12		ANSWER= 1.084900341 Disp D
3	EXE	AXx^y3+BX²+CX → 0. D			
4	(After approx. 1 second)	A? 0. D			
5	2 EXE	B? 0. D			
6	3 EXE	C? 0. D			
7	(−) 1 EXE	D? 0. D			
8	(−) 5 EXE	EPSILON? 0. D			
9	1 EXP (−) 5 EXE	X0 ? 0. D			
10	1 EXE	H? 0. D			

No. 7

Line	MODE EXP							Program								Notes	Number of steps
F1	N	E	W	T	O	N											8
L1	"	A	X	x^y	3	+	B	X	x^2	+	C	X	+	D	=		
	0	"	:	Pause	2												29
2	A	:	B	:	C	:	D										37
3	E	"	E	P	S	I	L	O	N	"	:	P	"	X	0		
	"	:	H														56
4	"	C	A	L	C	U	L	A	T	I	N	G	"				70
5	Lbl	1															73
6	S	=	P	:	N	=	2										81
7	Lbl	2															84
8	Y	=	A	P	x^2	P	+	B	P	x^2	+	C	P	+	D		100
9	P	=	P	+	H	:	N	=	N	−	1						112
10	N	≠	0	⇒	Z	=	Y	:	Goto	2	◢						124
11	Y	=	(	Y	−	Z	)	/	H								134
12	Z	=	S	−	Z	/	Y										142
13	Abs	(	Z	−	S	)	≥	E	⇒	P	=	Z	:	Goto	1		
	◢																159
14	S	:	"	A	N	S	W	E	R	=	"	◢					172
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	

Memory contents

A	a	H	h	O		V	
B	b	I		P	x_0	W	
C	c	J		Q		X	
D	d	K		R		Y	$ax_0^3+bx_0^2+cx+d$
E	ε	L		S	x_n	Z	x_{n+1}
F		M		T			
G		N	n	U			

CASIO PROGRAM SHEET

Program for	Quadratic equation	No.	8

Description

$ax^2+bx+c=0$ (Condition) $a\neq0$ Accuracy to 6 significant digits.

By inputting coefficients a, b, and c in the above formula, solutions for α and β can be determined.

The root formula is used as shown below:

$$x=\frac{-b\pm\sqrt{b^2-4ac}}{2a}$$

When it is considered that $d=b^2-4ac$:

i) When $d>0$, real roots of α and β exist $\alpha=\frac{-b+\sqrt{d}}{2a}$, $\beta=\frac{-b-\sqrt{d}}{2a}$

ii) When $d=0$, the real root of α exits $\alpha=\frac{-b}{2a}$

iii) When $d<0$, imaginary roots of α and β exist $\alpha=\frac{-b}{2a}+\frac{\sqrt{-d}}{2a}i$

$$\beta=\frac{-b}{2a}-\frac{\sqrt{-d}}{2a}i$$

Example

Determine solutions for the following quadratic equations:

1) $2x^2-x-15=0$
2) $4x^2-12x+9=0$
3) $x^2+x+1=0$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	12	(−) 12 EXE	C? −15. D
2	FILE	QUADRATIC F1 FIX D	13	9 EXE	X= 1.5 Disp D
3	EXE	AX²+BX+C=0 0. D	14	EXE	AX²+BX+C=0 1.5 D
4	(After approx. 1 second)	A? 0. D	15	(After approx. 1 second)	A? 4. D
5	2 EXE	B? 0. D	16	1 EXE	B? −12. D
6	(−) 1 EXE	C? 0. D	17	1 EXE	C? 9. D
7	(−) 15 EXE	X1= 3. Disp D	18	1 EXE	X1 : REAL P. −0.5 Disp D
8	EXE	X2= −2.5 Disp D	19	EXE	IMAGINARY P. → 0.866025 Disp D
9	EXE	AX²+BX+C=0 −2.5 D	20	EXE	X2 : REAL P. −0.5 Disp D
10	(After approx. 1 second)	A? 2. D	21		IMAGINARY P. → −0.866025 Disp D
11	4 EXE	B? −1. D			

No.	8

Line	MODE EXP							Program								Notes	Number of steps
F1	Q	U	A	D	R	A	T	I	C								11
L1	Lbl	R	T	N													16
2	"	A	X	x^2	+	B	X	+	C	=	0	"	:	Pause	2		32
3	Lbl	0	:	[	A	B	C	]									41
4	A	=	0	⇒	"	A	≠	0	"	:	Pause	1	:	Goto	0		
	◺																58
5	B	:	C														62
6	D	=	B	x^2	−	4	A	C									71
7	D	>	0	⇒	Prog	S	U	B	1	:	Goto	R	T	N	◺		87
8	D	=	0	⇒	Prog	S	U	B	2	:	Goto	R	T	N	◺		103
9	Prog	S	U	B	3												109
10	Goto	R	T	N													114
F2	S	U	B	1													6
L1	(	(−)	B	+	√	D	)	/	2	A							17
2	Prog	R	N	D													22
3	P	"	X	1	"	=	Ans	◢									31
4	(	(−)	B	−	√	D	)	/	2	A							42
5	Prog	R	N	D													47
6	Q	"	X	2	"	=	Ans	◢									56
F3	S	U	B	2													6
L1	(−)	B	/	2	A												12
2	Prog	R	N	D													17
3	P	"	X	"	=	Ans	◢										25
F4	S	U	B	3													6
L1	(−)	B	/	2	A												12

Memory contents	A	a	H		O		V	
	B	b	I		P	$\frac{-b+\sqrt{d}}{2a}$, $\frac{-b}{2a}$	W	
	C	c	J		Q	$\frac{-b-\sqrt{d}}{2a}$, $\frac{\sqrt{-d}}{2a}$	X	
	D	b^2-4ac	K		R		Y	
	E		L		S		Z	
	F		M		T			
	G		N		U			

CASIO PROGRAM SHEET

Program for	No.
Quadratic equation	8

Step	Key operation	Display	Step	Key operation	Display
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

No. 8

Line	MODE EXP Program															Notes	Number of steps
2	Prog	R	N	D													17
3	P	=	Ans														21
4	√	(−)	D	/	2	A											28
5	Prog	R	N	D													33
6	Q	=	Ans														37
7	P	:	"	X	1	:	R	E	A	L		P		"	◢		53
8	Q	:	"	I	M	A	G	I	N	A	R	Y		P			
	"	◢															71
9	P	:	"	X	2	:	R	E	A	L		P		"	◢		87
10	(−)	Q	:	"	I	M	A	G	I	N	A	R	Y		P		
		"	◢														106
F5	R	N	D														5
L1	Sci	6	:	Rnd	:	Norm											12
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	

Memory contents	A	a	H		O		V	
	B	b	I		P	$\frac{-b+\sqrt{d}}{2a}, \frac{-b}{2a}$	W	
	C	c	J		Q	$\frac{-b-\sqrt{d}}{2a}, \frac{\sqrt{-d}}{2a}$	X	
	D	b^2-4ac	K		R		Y	
	E		L		S		Z	
	F		M		T			
	G		N		U			

CASIO PROGRAM SHEET

Program for	No.
Complex numbers	9

Description

$Z_1=x_1+iy_1 \quad r_1=\sqrt{x_1^2+y_1^2} \quad , \quad \theta_1=\tan^{-1}\frac{y_1}{x_1}$

$Z_2=x_2+iy_2 \quad r_2=\sqrt{x_2^2+y_2^2} \quad , \quad \theta_2=\tan^{-1}\frac{y_2}{x_2}$

- Sum, difference

  $Z_1 \pm Z_2=(x_1 \pm x_2)+i(y_1 \pm y_2)$

- Product

  $Z_1 \times Z_2=(x_1x_2-y_1y_2)+i(x_1y_2+x_2y_1)$

- Quotient

  $$\frac{Z_1}{Z_2}=\frac{(x_1x_2+y_1y_2)+i(x_2y_1-x_1y_2)}{x_2^2+y_2^2} \quad \begin{cases}\text{(Condition)}\\ Z_2 \fallingdotseq 0\\ x_2 \fallingdotseq 0,\ y_2 \fallingdotseq 0\end{cases}$$

- n-th power

  $Z_1^n=r^n \cdot e^{in\theta}=(r^n \cos n\theta)+i(r^n \sin n\theta)$

- $x,\ y \rightarrow r,\ \theta$
- $r,\ \theta \rightarrow x,\ y$

Example

$Z_1=2+\sqrt{3}i$

$Z_2=4-i$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Note: if "Mem ERROR" appears on the display while executing the program, press MODE Ans 0 EXE.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	EXE	1:+ 2:– 3:×? → 1. R
2	FILE	COMPLEX F1 FILE D	12	(Calculate product) 3 EXE	REAL= 9.732050808 Disp R
3	EXE	1:+ 2:– 3:×? → 0. R	13	EXE	IMAGE= 4.92820323 Disp R
4	(Input data of complex numbers) 8 EXE	X1(Z1)? 0. R	14	EXE	1:+ 2:– 3:×? → 3. R
5	2 EXE	Y1(Z1)? 0. R	15	9 EXE	END OF JOB 0. R
6	√ 3 EXE	X2(Z2)? 0. R			
7	4 EXE	Y2(Z2)? 0. R			
8	(–) 1 EXE	1:+ 2:– 3:×? → 8. R			
9	(Calculate sum) 1 EXE	REAL= 6. Disp R			
10	EXE	IMAGE= 0.732050807 Disp R			

No.	9

Line	MODE EXP Program															Notes	Number of steps
F1	C	O	M	P	L	E	X										9
L1	Rad																11
2	Defm	:	N	=	Ans												17
3	Defm	N	+	6													22
4	Lbl	M	E	N	U												28
5	{	O	}	:	O	"	1	:	+		2	:	–		3		
	:	×		4	:	/		5	:	Z	x^y	N		6	:		
	–	>	P	O	L		7	:	–	>	R	E	C		8		
	:	I	N	P	U	T		9	:	Q	U	I	T	"			88
6	O	=	1	⇒	Prog	+											95
7	⇏	O	=	2	⇒	Prog	–										103
8	⇏	O	=	3	⇒	Prog	×										111
9	⇏	O	=	4	⇒	Prog	/										119
10	⇏	O	=	5	⇒	Prog	N										127
11	⇏	O	=	6	⇒	Prog	P	O	L								137
12	⇏	O	=	7	⇒	Prog	R	E	C								147
13	⇏	O	=	8	⇒	Prog	I	N	P	U	T						159
14	⇏	O	=	9	⇒	Goto	E	N	D	◣	◣	◣	◣	◣	◣		
	◣	◣	◣														178
15	Goto	M	E	N	U												184
16	Lbl	E	N	D													189
17	Defm	N															192
18	"	E	N	D		O	F		J	O	B	"					205
F2	+																3

Memory contents	A		H		O	For judgement	V	$r,\ x$
	B		I		P	x^2+y^2	W	$\theta,\ y$
	C		J		Q		X	
	D		K		R	n	Y	
	E		L		S		Z	
	F		M		T			
	G		N	Expanded memories	U			
Expanded memories	Z[N+1]	x_1	Z[N+3]	x_2	Z[N+5]	x		
	Z[N+2]	y_1	Z[N+4]	y_2	Z[N+6]	y		

CASIO PROGRAM SHEET

Program for	No.
Complex numbers	9

Description

$Z_1 = x_1 + iy_1 \quad r_1 = \sqrt{x_1^2 + y_1^2} \ , \quad \theta_1 = \tan^{-1}\frac{y_1}{x_1}$

$Z_2 = x_2 + iy_2 \quad r_2 = \sqrt{x_2^2 + y_2^2} \ , \quad \theta_2 = \tan^{-1}\frac{y_2}{x_2}$

- Sum, difference

  $Z_1 \pm Z_2 = (x_1 \pm x_2) + i(y_1 \pm y_2)$
- Product

  $Z_1 \times Z_2 = (x_1 x_2 - y_1 y_2) + i(x_1 y_2 + x_2 y_1)$
- Quotient

  $$\frac{Z_1}{Z_2} = \frac{(x_1 x_2 + y_1 y_2) + i(x_2 y_1 - x_1 y_2)}{x_2^2 + y_2^2} \quad \begin{cases} \text{(Condition)} \\ Z_2 \neq 0 \\ x_2 \neq 0,\ y_2 \neq 0 \end{cases}$$
- n-th power

  $Z_1{}^n = r^n \cdot e^{in\theta} = (r^n \cos n\theta) + i(r^n \sin n\theta)$
- $x,\ y \rightarrow r,\ \theta$
- $r,\ \theta \rightarrow x,\ y$

Example

$Z_1 = 2 + \sqrt{3}i$

$Z_2 = 4 - i$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Note: if "Mem ERROR" appears on the display while executing the program, press MODE Ans 0 EXE.

Step	Key operation	Display	Step	Key operation	Display
1	AC SHIFT Mcl EXE	Mcl 0. D	11	EXE	1:+ 2:– 3:×? → 1. R
2	FILE	COMPLEX F1 [illegible] D	12	(Calculate product) 3 EXE	REAL = 9.732050808 Disp R
3	EXE	1:+ 2:– 3:×? → 0. R	13	EXE	IMAGE = 4.92820323 Disp R
4	(Input data of complex numbers) 8 EXE	X1(Z1)? 0. R	14	EXE	1:+ 2:– 3:×? → 3. R
5	2 EXE	Y1(Z1)? 0. R	15	9 EXE	END OF JOB 0. R
6	√ 3 EXE	X2(Z2)? 0. R			
7	4 EXE	Y2(Z2)? 0. R			
8	(–) 1 EXE	1:+ 2:– 3:×? → 8. R			
9	(Calculate sum) 1 EXE	REAL = 6. Disp R			
10	EXE	IMAGE = 0.732050807 Disp R			

No.	9

Line	MODE EXP Program															Notes	Number of steps
F1	C	O	M	P	L	E	X										9
L1	Rad																11
2	Defm	:	N	=	Ans												17
3	Defm	N	+	6													22
4	Lbl	M	E	N	U												28
5	{	O	}	:	O	"	1	:	+		2	:	–		3		
	:	×		4	:	/		5	:	Z	x^y	N		6	:		
	–	>	P	O	L		7	:	–	>	R	E	C		8		
	:	I	N	P	U	T		9	:	Q	U	I	T	"			88
6	O	=	1	⇒	Prog	+											95
7	⇏	O	=	2	⇒	Prog	–										103
8	⇏	O	=	3	⇒	Prog	×										111
9	⇏	O	=	4	⇒	Prog	/										119
10	⇏	O	=	5	⇒	Prog	N										127
11	⇏	O	=	6	⇒	Prog	P	O	L								137
12	⇏	O	=	7	⇒	Prog	R	E	C								147
13	⇏	O	=	8	⇒	Prog	I	N	P	U	T						159
14	⇏	O	=	9	⇒	Goto	E	N	D	◢	◢	◢	◢	◢	◢		
	◢	◢	◢														178
15	Goto	M	E	N	U												184
16	Lbl	E	N	D													189
17	Defm	N															192
18	"	E	N	D		O	F		J	O	B	"					205
F2	+																3

Memory contents							
A		H		O	For judgement	V	$r,\ x$
B		I		P	$x^2 + y^2$	W	$\theta,\ y$
C		J		Q		X	
D		K		R	n	Y	
E		L		S		Z	
F		M		T			
G		N	Expanded memories	U			

Expanded memories							
Z[N+1]	x_1	Z[N+3]	x_2	Z[N+5]	x		
Z[N+2]	y_1	Z[N+4]	y_2	Z[N+6]	y		

No. 9

Line	MODE EXP Program															Notes	Number of steps
L1	Z	[	N	+	5	]	"	R	E	A	L	"	=	Z	[		
	N	+	1	]	+	Z	[	N	+	3	]	◢					31
2	Z	[	N	+	6	]	"	I	M	A	G	E	"	=	Z		
	[	N	+	2	]	+	Z	[	N	+	4	]	◢				60
F3	–																3
L1	Z	[	N	+	5	]	"	R	E	A	L	"	=	Z	[		
	N	+	1	]	–	Z	[	N	+	3	]	◢					30
2	Z	[	N	+	6	]	"	I	M	A	G	E	"	=	Z		
	[	N	+	2	]	+	Z	[	N	+	4	]	◢				59
F4	×																3
L1	Z	[	N	+	5	]	"	R	E	A	L	"	=	Z	[		
	N	+	1	]	Z	[	N	+	3	]	–	Z	[	N	+		
	2	]	Z	[	N	+	4	]	◢								43
2	Z	[	N	+	6	]	"	I	M	A	G	E	"	=	Z		
	[	N	+	1	]	Z	[	N	+	4	]	+	Z	[	N		
	+	2	]	Z	[	N	+	3	]	◢							84
F5	/																3
L1	P	=	Z	[	N	+	3	]	x^2	+	Z	[	N	+	4		
	]	x^2															21
2	Z	[	N	+	5	]	"	R	E	A	L	"	=	(	Z		
	[	N	+	1	]	Z	[	N	+	3	]	+	Z	[	N		
	+	2	]	Z	[	N	+	4	]	)	/	P	◢				65

Memory contents	A		H		O	For judgement	V	r, x
	B		I		P	x^2+y^2	W	θ, y
	C		J		Q		X	
	D		K		R	n	Y	
	E		L		S		Z	
	F		M		T			
	G		N	Expanded memories	U			
Expanded memories	Z[N+1]	x_1	Z[N+3]	x_2	Z[N+5]	x		
	Z[N+2]	y_1	Z[N+4]	y_2	Z[N+6]	y		

No. 9

Line	MODE EXP Program															Notes	Number of steps
3	Z	[	N	+	6	]	"	I	M	A	G	E	"	=	(		
	Z	[	N	+	3	]	Z	[	N	+	2	]	–	Z	[		
	N	+	1	]	Z	[	N	+	4	]	)	/	P	◢			110
F6	N																3
L1	Lbl	0															6
2	Prog	S	E	L													11
3	Q	=	9	=>	Goto	E	N	D	◣								21
4	Pol(	Z	[	N	+	Q	]	,	Z	[	N	+	Q	+	1		
	]	)															39
5	{	R	]														43
6	Z	[	N	+	5	]	"	R	E	A	L	"	=	V	x^y		
	R	"	N	"	cos	R	W	◢									67
7	Z	[	N	+	6	]	"	I	M	A	G	E	"	=	V		
	x^y	R	sin	R	W	◢											89
8	Goto	0															92
9	Lbl	E	N	D													97
F7	P	O	L														5
L1	Lbl	0															8
2	Prog	S	E	L													13
3	Q	≠	9	=>	Pol(	Z	[	N	+	Q	]	,	Z	[	N		
	+	Q	+	1	]	)											35
4	V	:	"	R	=	"	◢										43
5	W	:	"	T	H	E	T	A	=	"	◢						55

Memory contents	A		H		O	For judgement	V	r, x
	B		I		P	x^2+y^2	W	θ, y
	C		J		Q		X	
	D		K		R	n	Y	
	E		L		S		Z	
	F		M		T			
	G		N	Expanded memories	U			
Expanded memories	Z[N+1]	x_1	Z[N+3]	x_2	Z[N+5]	x		
	Z[N+2]	y_1	Z[N+4]	y_2	Z[N+6]	y		

No. 9

Line	MODE EXP Program															Notes	Number of steps
6	Goto	0	◣														59
F8	I	N	P	U	T												7
L1	S	=	Z	[	N	+	1	]	:	{	S	}	:	Z	[		
	N	+	1	]	=	S	"	X	1	(	Z	1	)	"			37
2	S	=	Z	[	N	+	2	]	:	{	S	}	:	Z	[		
	N	+	2	]	=	S	"	Y	1	(	Z	1	)	"			67
3	S	=	Z	[	N	+	3	]	:	{	S	}	:	Z	[		
	N	+	3	]	=	S	"	X	2	(	Z	2	)	"			97
4	S	=	Z	[	N	+	4	]	:	{	S	}	:	Z	[		
	N	+	4	]	=	S	"	Y	2	(	Z	2	)	"			127
F9	S	E	L														5
L1	Lbl	0															8
2	{	Q	}	:	Q	"	1	:	Z	1		2	:	Z	2		
		9	:	Q	U	I	T	"									32
3	Q	≠	1	⇒	Q	≠	2	⇒	Q	≠	9	⇒	Goto	0	◣		
	◣	◣															50
4	Q	=	2	⇒	Q	=	3	◣									59
F10	R	E	C														5
L1	Lbl	0															8
2	Prog	S	E	L													13
3	Q	≠	9	⇒	Rec(	Z	[	N	+	Q	]	,	Z	[	N		
	+	Q	+	1	]	)											35

Memory contents	A		H		O	For judgement	V	r, x
	B		I		P	x^2+y^2	W	θ, y
	C		J		Q		X	
	D		K		R	n	Y	
	E		L		S		Z	
	F		M		T			
	G		N	Expanded memories	U			

Expanded memories	Z[N+1]	x_1	Z[N+3]	x_2	Z[N+5]	x		
	Z[N+2]	y_1	Z[N+4]	y_2	Z[N+6]	y		

No. 9

Line	MODE EXP Program															Notes	Number of steps
4	V	:	"	X	=	"	◢										43
5	W	:	"	Y	=	"	◢										51
6	Goto	0	◣														55
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
19																	
20																	
21																	
22																	
23																	
24																	
25																	
26																	
27																	
28																	

Memory contents	A		H		O	For judgement	V	r, x
	B		I		P	x^2+y^2	W	θ, y
	C		J		Q		X	
	D		K		R	n	Y	
	E		L		S		Z	
	F		M		T			
	G		N	Expanded memories	U			

Expanded memories	Z[N+1]	x_1	Z[N+3]	x_2	Z[N+5]	x		
	Z[N+2]	y_1	Z[N+4]	y_2	Z[N+6]	y		

CASIO PROGRAM SHEET

Program for	No.

Step	Key operation	Display	Step	Key operation	Display
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

No.

Line	MODE EXP	Program	Notes	Number of steps

Memory contents								
	A		H		O		V	
	B		I		P		W	
	C		J		Q		X	
	D		K		R		Y	
	E		L		S		Z	
	F		M		T			
	G		N		U			

CASIO PROGRAM SHEET

Program for

No.

Step	Key operation	Display	Step	Key operation	Display
1			11		
2			12		
3			13		
4			14		
5			15		
6			16		
7			17		
8			18		
9			19		
10			20		

No.

Line	MODE EXP	Program	Notes	Number of steps

Memory contents								
	A		H		O		V	
	B		I		P		W	
	C		J		Q		X	
	D		K		R		Y	
	E		L		S		Z	
	F		M		T			
	G		N		U			

Expanded memories								

■Error messages at-a-glance

Message	Meaning	Countermeasure
Ma ERROR	①Calculation exceeds range of operation. ②Calculation is performed outside the input range of a function. ③Illogical operation (division by zero, etc.)	① ② ③ Check the input numeric value and correct it. When using memories, check that the numeric values stored in memories are correct.
Arg ERROR	•Argument input incorrectly. Ex. Negative value input for Defm, value other than 1 ~ 9 input for *n* in integration calculation, etc.	•Re-enter argument 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 9 levels for numeric values and 24 levels for calculations. •Divide the formula into two or more parts.
Syn ERROR	①Calculation formula contains an error. ②Formula in a program contains an error.	① ② Use cursor keys to display the point where the error was generated and correct it.
Mem ERROR	•Memory expansion exceeds level remaining in program. •Attempt to use a memory such as Z[5] when no memory has been expanded. •Program written although no memory remains for program.	•Press MODE Ans (Defm) to expand memory to necessary level. •Use memories within the current number of memories. •Simplify program to fit within current available memory or delete unnecessary programs.
Ne ERROR	•Nesting of subroutines by execution exceeds 10-level limit.	•Ensure that Prog (filename) is not used to return from subroutines to main routine. If used, delete any unnecessary Prog (filename). •Trace subroutine jump destinations and ensure that no jumps are made back to the original program area. Ensure that returns are made correctly.
Go ERROR	①No corresponding Lbl (label name) to Goto (label name). ②No program stored in specified Prog (filename).	①Correctly input an Lbl corresponding to Goto. ②Store a program in program area Prog (filename) or delete the Prog (filename) if unnecessary.

■Input ranges of functions

Function	Input range	Internal digits	Accuracy	Notes
sin cos tan	(Deg) $\|x\|<9\times10^{9}$° (Rad) $\|x\|<5\times10^{7}\pi$rad (Gra) $\|x\|<1\times10^{10}$grad	12 digits	As a rule, accuracy is ±1 at the 10th digit.	However, for tan x: $\|x\|\doteqdot 90(2n+1)$: Deg $\|x\|\doteqdot \pi/2(2n+1)$: Rad $\|x\|\doteqdot 100(2n+1)$: Gra
$\sin^{-1}$ $\cos^{-1}$	$\|x\|\leqq 1$	”	”	
$\tan^{-1}$	$\|x\|<1\times10^{100}$			
sinh cosh	$\|x\|\leqq 230.2585092$	”	”	Note: For sinh and tanh, when $x=0$, errors are cumulative and accuracy is affected at a certain point.
tanh	$\|x\|<1\times10^{100}$			
$\sinh^{-1}$	$\|x\|<5\times10^{99}$	”	”	
$\cosh^{-1}$	$1\leqq x<5\times10^{99}$			
$\tanh^{-1}$	$\|x\|<1$			
log ln	$1\times10^{-99}\leqq x<1\times10^{100}$	”	”	
10^{x}	$-1\times10^{100}<x<100$	”	”	
e^{x}	$-1\times10^{100}<x$ $\leqq 230.2585092$			
$\sqrt{\ }$	$0\leqq x<1\times10^{100}$	”	”	
x^2	$\|x\|<1\times10^{50}$			
$1/x$	$\|x\|<1\times10^{100}$, $x\doteqdot 0$	”	”	
$\sqrt[3]{\ }$	$\|x\|<1\times10^{100}$			
$x!$	$0\leqq x\leqq 69$ (x is an integer)	”	”	
nPr nCr	Result$<1\times10^{100}$ n, r (n and r are integers) $0\leqq r\leqq n$, $n<1\times10^{10}$	”	”	
Pol (x,y)	$\sqrt{x^2+y^2}<1\times10^{100}$	”	”	
Rec (r,θ)	$0\leqq r<1\times10^{100}$ (Deg) $\|\theta\|<9\times10^{9}$° (Rad) $\|\theta\|<5\times10^{7}\pi$rad (Gra) $\|\theta\|<1\times10^{10}$grad	”	”	However, for tan x: $\|x\|\doteqdot 90(2n+1)$: Deg $\|x\|\doteqdot \pi/2(2n+1)$: Rad $\|x\|\doteqdot 100(2n+1)$: Gra

Function	Input range	Internal digits	Accuracy	Notes
$\circ\,'\,''$	$\lvert a\rvert$, b, c $< 1\times10^{100}$ $0 \leqq$ b, c	12 digits	As a rule, accuracy is ±1 at the 10th digit.	
$\overleftarrow{\circ\,'\,''}$	$\lvert x\rvert < 1\times10^{100}$ Hexadecimal display: $\lvert x\rvert \leqq 27777.77777$			
x^y	$x>0$: $-1\times10^{100} < y\log x < 100$ $x=0$: $y>0$ $x<0$: $y=n, \frac{1}{2n+1}$ (n is an integer) However; $-1\times10^{100} < \frac{1}{y}\log\lvert x\rvert$ < 100	”	”	
$x^{1/y}$	$x>0$: $y \fallingdotseq 0$ $-1\times10^{100} < \frac{1}{y}\log x < 100$ $x=0$: $y>0$ $x<0$: $y=2n+1, \frac{1}{n}$ ($n \fallingdotseq 0$, n is an integer) However; $-1\times10^{100} < \frac{1}{y}\log\lvert x\rvert$ < 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)	$\lvert x\rvert < 1\times10^{50}$ $\lvert y\rvert < 1\times10^{50}$ $\lvert n\rvert < 1\times10^{100}$ $x\sigma_n$, $y\sigma_n$, $\bar{x}$, $\bar{y}$, A, B, r: $n \fallingdotseq 0$ $x\sigma_{n-1}$, $y\sigma_{n-1}$: $n \fallingdotseq 0, 1$	”	”	

Function	Input range
BASE-N	Values after variable within following range: Dec: $-2147483648 \leqq x \leqq -1$ (negative) $0 \leqq x \leqq 2147483647$ (0, positive) Bin: $10000000000000000000000000000000 \leqq x$ $\leqq 11111111111111111111111111111111$ (negative) $0 \leqq x \leqq 01111111111111111111111111111111$ (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, $x^{1/y}$, $x!$, $\sqrt[3]{x}$ sometimes affecting accuracy.

■Specifications

Model:
fx-4500P

Calculations

Basic calculation functions:
Negative numbers, exponents, parenthetical addition/subtraction/multiplication/division (with priority sequence judgement function — true algebraic logic).

Built-in functions:
Trigonometric/inverse trigonometric functions (units or angular measurement: degrees, radians, grads), hyperbolic/inverse hyperbolic functions, logarithmic/exponential functions, reciprocals, factorials, square roots, cube roots, powers, roots, squares, decimal-sexagesimal conversions, binary-octal-hexadecimal conversions/calculations, coordinate transformations, permutations/combinations, π, random numbers, absolute values, integers, fractions.

Statistical calculation functions:
Standard deviation—number of data, sum, sum of squares, mean, standard deviation (two types)
Linear regression—number of data, sum of x, sum of y, sum of squares of x, sum of squares of y, mean of x, mean of y, standard deviation of x (two types), standard deviation of y (two types), constant term, regression coefficient, correlation coefficient, estimated value of x, estimated value of y.

Integration calculation: using Simpson's rule.

Memories:
26 standard (163 maximum)

Calculation range:
$\pm 1 \times 10^{-99} \sim \pm 9.999999999 \times 10^{99}$ and 0. Internal operation uses 12-digit mantissa.

Rounding:
Performed according to the specified number of significant digits or the number of specified decimal places.

Exponential display:
Norm 1 — $10^{-2} > |x|, \ |x| \geqq 10^{10}$
Norm 2 — $10^{-9} > |x|, \ |x| \geqq 10^{10}$

Programs

Number of steps: 1,103 maximum

Jump function:
Unconditional jump (Goto, Lbl)
Conditional jump ($=, \neq, >, <, \geqq, \leqq$)

Subroutines Prog: 10 routines

Number of stored programs: As many files as total memory capacity allows

Check function: Program checking, debugging, deletion, addition, etc.

Common section

Display system and contents:
Liquid crystal display, dot 12 digits, 10-digit mantissa and 2-digit exponent, binary, octal, hexadecimal display, sexagesimal display, conditional displays (WRT, FILE, EDIT, Disp, LR, SD, D, R, G, S, F, M, A, hyp, d, H, b, o, Fix, Sci, Eng, ←, →)

Character display function:
Function commands, program commands, alphabet characters (12 maximum)

Error check function:
Checks for values exceeding 10^{100}, illogical calculations and illogical jumps, error messages displayed.

Power supply:
1 lithium battery for normal operation (CR2025); 1 lithium battery for memory protection (CR1216)

Power consumption: 0.001W

Battery life: Approximately 3,000 hours on type CR2025 battery.

Auto power off:
Power is automatically switched off approximately 6 minutes after last operation.

Ambient temperature range: 0°C ~ 40°C (32°F ~ 104°F)

Dimensions: 9.2mmH × 73mmW × 141.5mmD (3/8″H × 2 7/8″W × 5 9/16″D)

Weight: 90 g (3.2 oz) including batteries