Contents

Chapter 5 Table Functions

Chapter 6 List Functions

Chapter 7 Base-n Mode Calculations

Chapter 8 Statistical Calculations And Graphs

Chapter 9 Games

Chapter 10 Programming

Chapter 1 Getting Started

1 – 1 Power

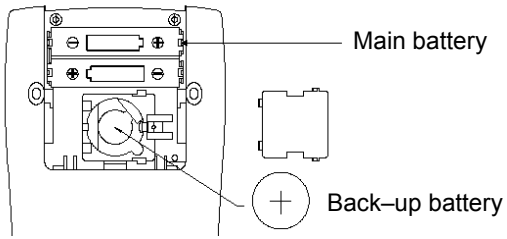
1 – 1 – 1 To Turn On Or Off

To turn the calculator on, press [$^{ON}/_{CL}$] ; To turn the calculator off, press [2nd] [OFF].

1 – 1 – 2 Battery Replacement

Power is supplied by three batteries. Two AAA'size batteries (The main batteries, LR03 (AM4) or R03 (UM–4)) powers normal operations, while the other lithium battery (The back-up battery, CR2032) provides the power required to retain data in memory.

When the power of the main batteries become weak, the " LOW BATTERY " message appears on the display. If you still continue using the calculator, power may be turned OFF automatically and operation will become impossible even if you press [$^{ON}/_{CL}$] key. Please replace the batteries as soon as possible.



!! IMPORTANT !!

Never remove the main batteries and the back–up one from the unit at the same time.

(A) To replace the main batteries

1. Press [2nd] [OFF] to turn power off.
2. Remove the battery compartment cover on the back of the calculator in the direction.
3. Remove the two old batteries and load a new set of two batteries in the proper directions of their polarity.
4. Replace the battery compartment cover and press [$^{ON}/_{CL}$] to turn power on. The back-up battery provides power to the memory while the main batteries are removed, so memory data is not lost.

(B) To replace the back–up battery

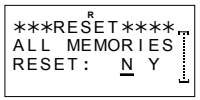
1. Press [2nd] [OFF] to turn power off.
2. Remove the battery compartment cover on the back of the calculator in the direction.
3. Remove the old battery and load a new one in the proper directions of its polarity.
4. Replace the battery compartment cover and press [$^{ON}/_{CL}$] to turn power on. The main batteries provide power to the memory while the back–up battery is removed, so memory data is not lost.

1 – 1 – 3 Auto Power–Off Function

This calculator automatically turns it off when not operated for approximately 9~15 minutes. It can be reactivated by pressing [$^{ON}/_{CL}$] key and the display, memory, settings are retained.

1 – 2 Reset Operation

If the calculator is on but you get unexpected results, press [MODE] 7 (RESET) 2 (RESET) in sequence. A message appears on the display to confirm whether you want to reset all memories in the calculator or not.



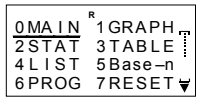
Move the cursor to " Y " by [▶], then press [EXE] to reset all memories of the calculator. To abort the reset operation without clearing the calculator, please choose " N " .

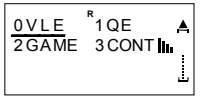
If the calculator stops operating correctly for some reason, use a thin, pointed object to press the RESET button on the back of the calculator. This should make the RESET confirmation screen appear on the display. Perform the procedure to complete the RESET operation.

(Note) : Once you reset the calculator, the system will be initialized to its default setting.

1 – 3 Using The Working Mode Menu

The working mode menu contains a number of items that let you select the mode (working area) for the type of operation you want to perform. You can also make the working mode menu appear at any time by pressing [MODE].





Item	Meaning
MAIN	Use this mode for arithmetic calculations and function calculations.
GRAPH	Use this mode to store graph functions and to draw graphs using the functions.
STAT	Use this mode to perform single-variable (standard deviation) and paired-variable (regression) statistical calculations, and to draw statistical graphs.
TABLE	Use this mode to store functions, to generate a numeric table of different solutions as the values assigned to variables in a func-

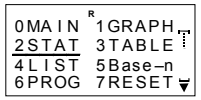
	tion change, and to draw graphs.
LIST	Use this mode for storing and editing numeric data.
Base–n	Use this mode to perform binary, octal, decimal and hexadecimal calculations.
PROG	Use this mode to store programs in the program area and to run programs.
RESET	Use this mode to check how much memory is used and remaining, to delete data from memory, and to initialize (reset) the calculator.
VLE	Use this mode to perform variable linear equation calculations.
QE	Use this mode to perform quadratic equation calculations.
GAME	Use this mode to play games.
CONT	Use this mode to adjust the contrast of the display.

(Example) : Enter the STAT mode

(Method 1)

(Step 1) : Press [MODE] to display the working mode menu. Scroll through the menu using the cursor keys until " 2 STAT " is underlined.

[MODE] [▼]



(Step 2) : Press [EXE] to enter the STAT mode.

(Method 2)

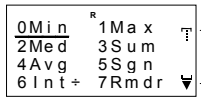
(Step 1) : Press [MODE] to display the working mode menu.
(Step 2) : You can also enter a mode without using the cursor keys by inputting the corresponding number marked in the left side of the item, " 2 ".

1 – 4 Displaying A Menu

Each working mode of the calculator has some functions or settings assigned to [FUNC.], [SYSTEM], [MATH]..., etc. Those functions and settings are a menu of items displayed across the screen. You often will need to access items from its menus.

(A) To select a item from a menu

For example, press [MATH] to display the below menu in the Main working mode.



Indicate there are more pages below the current screen

If you want to select " Max ",

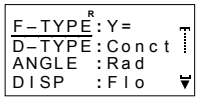
- Make the item " Max " underlined using the cursor keys, then press [EXE].
- You can also enter a corresponding number marked in the item, " 1 ", without using the cursor keys.

(B) To move from one page to next

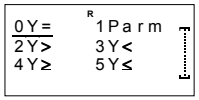
Some function menus have more pages. When this happens, a bar indicator appears on the right side of the screen, where indicates there are more pages below (or above) the current screen . You can use the cursor keys or press the function key again to advance to the next page.

(C) Multiple menus

Some items marked in all capital letters mean it have multiple menus . After entering the item, there are more items for selecting. For example, press [2nd] [SYSTEM],



[EXE]



(D) Leaving a Menu

You can leave a menu in any of three methods.

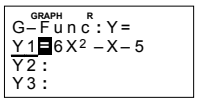
- Press [EXIT] to return the previous display
- Press [2nd] [QUIT] to return to the home screen.
- Press any key for another menu or screen.

1 – 5 Display

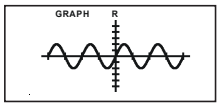
1 – 5 – 1 Display Readout

This calculator uses two types of display : text display and graphic display.

Text Display



Graph Display



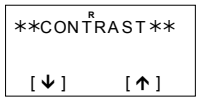
The text display can show 12 columns and four lines of characters.
The following indicators appear on the display to indicate you the current status of the calculator.

Indicator	Meaning
M	Independent memory
A	Alphabetic keys are active
2nd	2nd set of function keys are active
GRAPH	Graph mode is active
STAT	Statistics mode is active

TBLE	Table mode is active
D R G	Angle mode : **D**egrees, **R**adians, or **G**rads
PROG	Program mode is active
VLE	Variable linear equation mode is active
QE	Quadratic equation mode is active
ENGSCI	**SCI**entific or **ENG**ineering display format
FIX	Number of decimal places displayed is fixed
HYP	Hyperbolic-trig function will be calculated
d h b o	**d**ecimal, **h**exadecimal, **b**inary, **o**ctal base
◢	Displayed value is intermediate result
⊖	The operation is inactive while pressing
▲ ▼	There are more entry or pages hidden the above or below of the screen. Those two indicators will be blinked while an operation or program is executing.

1 – 5 – 2 Contrast Adjustment

Press [MODE] [MODE] 3 (CONT) to display the contrast screen.



Pressing the [▼] or [▲] key can make the contrast of the screen lighter or darker.

1 – 6 Key

1 – 6 – 1 Key Markings

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

Keyboard marking	Meaning
Deep Blue	Direct input
Yellow	Press [2nd] and then key
In a shade	Press [ALPHA] and then key

(Note): For key marking, some models maybe print other colors which are different from the above described.

1 – 6 – 2 To Use " 2nd " " ALPHA " Keys

To execute the functions marked in yellow (or a color which is the same as [2nd] key), please press [2nd] and then the corresponding key. When you press [2nd], the " 2nd " indicator shown in the display is to tell you that you will be selecting the second function of the next key you press. If you press [2nd] by mistake, simply press [2nd] again to remove the " 2nd " indicator.

To execute the functions marked in a shade, please press [ALPHA] and then the corresponding key. When you press [ALPHA], the " A " indicator shown in the display is to tell you that you will be selecting the alphabetical function of the next key you press. If you press [ALPHA] by mistake, simply press [ALPHA] again to remove the " A " indicator. Pressing [2nd] [ALPHA] will lock the calculator in this mode and allow consecutive input of alphabetical function keys until [ALPHA] is pressed.

1 – 6 – 3 Cursor

Pressing [◀] or [▶] key can move the cursor to the left or the right. Hold down any of those keys to move the cursor at high speed.

Pressing [▲] or [▼] key can scroll the display up or down while there are previous entries hidden the display. You can reuse or edit a previous entry when it is on the entry line.

Pressing [2nd] [◀] or [2nd] [▶] moves the cursor to the beginning or the end in the current line. Pressing [2nd] [▲] or [2nd] [▼] can move the cursor to the top or bottom of all entries.

1 – 7 Order Of Operations

Each calculation is performed in the following order of precedence :

1) Expression inside parentheses.
2) Coordinates transformation, and Type B functions which are required pressing the function key before entering, for example, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, log, ln, 10^x, e^x, $\sqrt{\ }$, d /dx, $\int dx$, Neg, Not, X '( ), Y '( ), Max, Min, Sum, Sgn, Avg, Abs, Int, Frac, List, Fill, Dim, Seq, Med, Intg : d, h, b, o.
3) Type A functions which are required entering values before pressing the function key, for example, x^2, x^{-1}, x!, ○,,,, r, g, %, ten engineering notation.
4) Exponentiation (∧), $\sqrt[x]{\ }$
5) Fractions
6) Abbreviated multiplication format in front of variables, π , Rand, RandI.
7) (–)
8) Abbreviated multiplication format in front of Type B functions $2\sqrt{3}$, Alog2, etc.
9) nPr, nCr
10) x , ÷, Int ÷, Rmdr
11) +, –
12) Relational operators ==, < , >, ≠, ≤, ≥
13) And, Nand -- Base–n calculations only.

14) Or, Xor, Xnor -- Base–n calculations only.

15) Conversion ($A^{b}/_{c}$ ◀▶ $^{d}/_{e}$, F◀▶D, ▶ DMS)

- Simplification function (Simp) can't be allowed to perform with other functions. It also can't be an argument in any of functions.
- When functions with the same priority are used in series, execution is performed from right to left.

  e^{x} ln120 → e^{x}{ ln (120) }

  otherwise, execution is from left to right.
- Compound functions are executed from right to left.
- Anything contained within parentheses receives the highest priority.

1 – 8 Accuracy And Capacity

Calculating digits : Up to 24 digits

In general, every reasonable calculation is displayed 10 digits, or 9–digits mantissa plus 2-digits exponent up to $10^{\pm 99}$.

Numbers used as input must be within the range of the given function as follow :

Functions	Input range
sin x, cos x , tan x	Deg : $\lvert x \rvert < 4.5 \times 10^{10}$ deg Rad : $\lvert x \rvert < 2.5 \times 10^{8}\pi$ rad Grad : $\lvert x \rvert < 5 \times 10^{10}$ grad however, for tan x Deg : $\lvert x \rvert \neq 90$ (2n+1) Rad : $\lvert x \rvert \neq \frac{\pi}{2}$ (2n+1) Grad : $\lvert x \rvert \neq 100$ (2n+1) (n is an integer)
$\sin^{-1} x$, $\cos^{-1} x$	$\lvert x \rvert \leq 1$
$\tan^{-1} x$	$\lvert x \rvert < 1 \times 10^{100}$
sinh x, cosh x	$\lvert x \rvert \leq 230.2585092$
tanh x	$\lvert x \rvert < 1 \times 10^{100}$
$\sinh^{-1} x$	$\lvert x \rvert < 5 \times 10^{99}$
$\cosh^{-1} x$	$1 \leq x < 5 \times 10^{99}$
$\tanh^{-1} x$	$\lvert x \rvert < 1$
log x, ln x	$1 \times 10^{-99} \leq x < 1 \times 10^{100}$
10^{x}	$-1 \times 10^{100} < x < 100$
e^{x}	$-1 \times 10^{100} < x \leq 230.2585092$
$\sqrt{x}$	$0 \leq x < 1 \times 10^{100}$
x^{2}	$\lvert x \rvert < 1 \times 10^{50}$
x^{-1}	$\lvert x \rvert < 1 \times 10^{100}$, $X \neq 0$
x !	$0 \leq x \leq 69$, x is an integer.
P (x, y)	$\sqrt{x^2+y^2} < 1 \times 10^{100}$
R (r, £ ⊂)	$0 \leq r < 1 \times 10^{100}$, Deg : $\lvert \theta \rvert < 4.5 \times 10^{10}$ deg , Rad : $\lvert \theta \rvert < 2.5 \times 10^{8}\pi$ rad, Grad: $\lvert \theta \rvert < 5 \times 10^{10}$ grad however, for tan x Deg : $\lvert \theta \rvert \neq 90$ (2n+1), Rad : $\lvert \theta \rvert \neq \frac{\pi}{2}$ (2n+1), Grad: $\lvert \theta \rvert \neq 100$ (2n+1) (n is an integer)
DMS	$\lvert D \rvert$, M, S $< 1 \times 10^{100}$, $0 \leq$ M, S , $\lvert x \rvert < 10^{100}$
$\sqrt[x]{y}$	$y > 0$: $x \neq 0$, $-1 \times 10^{100} < \frac{1}{x} \log y < 100$ $y = 0$: $x > 0$ $y < 0$: $x = 2n+1$. l/n, n is an integer.($n \neq 0$) but $-1 \times 10^{100} < \frac{1}{x} \log \lvert y \rvert < 100$
nPr, nCr	$0 \leq r \leq n$, $n < 10^{100}$, n, r are integers.
STAT	$\lvert x \rvert < 1 \times 10^{100}$, $\lvert y \rvert < 1 \times 10^{100}$ 1–AR: $n \leq 255$, 2–-VAR : $n \leq 255$ FREQ. = n, $\lvert n \rvert < 1 \times 10^{100}$ σx,σy, x, y, a, b, c, r : $n \neq 0$ Sx, Sy : $n \neq 0,1$
BaseN	DEC : $-2147483648 \leq x \leq 2147483647$ BIN : 10000000000000000000000000000000 ≤ x ≤ 11111111111111111111111111111111 (for negative) $0 \leq x \leq$ 01111111111111111111111111111111 (for zero, positive) OCT : 20000000000 ≤ x ≤ 3777777777 (for negative) 0 ≤ x ≤ 17777777777 (for zero or positive) HEX : 80000000 ≤ x ≤ FFFFFFFF (for negative) 0 ≤ x ≤ 7FFFFFFF (for zero or positive)

1 – 9 Error Conditions

Error message will appear on the display and further calculation becomes impossible when any of the following conditions occur.

Indicator	Meaning
DOMAIN Er	(1) When specifying an argument to a function outside the valid range. (2) The dimensions don't match between two or more lists. (3) When USL value < LSL value. (4) Attempt to execute a list which there is no data stored. (5) Attempt to draw a memory area which there is no function stored.

(6) You input a negative C_{PU} or C_{PL} value ,

where $C_{PU}=\frac{USL-\bar{x}}{3\sigma}$, $C_{PL}=\frac{\bar{x}-LSL}{3\sigma}$

DIVIDE BY O	You attempted to divide by 0.
OVERFLOW Er	When result of function calculations exceeds the range specified.
SYNTAX Er	(1) Input errors are made. (2) When improper arguments are used in commands or functions that require arguments. (3) Miss an End command for marking the end of the program (4) You use improper syntax for the operation. (5) There is no corresponding data in the Data command when the Read command is used. (6) The number in the Locate command you input is outside the valid range.
LENGTH Er	An entry exceeds 88 digits after implied multiplication with auto-correction.
STAT Er	(1)You must enter statistical data before drawing a statistical graph or performing statistical calculations. (2) Attempt to view summary points (x1, y1, x2, y2, x3, y3) when the Med–Med regression hasn't be drawn or performed.
NEST Er	(1) A subroutine nesting exceeds 4 levels. (2) A If–Then–Else nesting exceeds 6 levels. (3) A For loop nesting exceeds 6 levels.
GOTO Er	(1)There is no corresponding Label n when Goto n is used. (2) In the MAIN mode, attempt to run a program whose file name is invalid.
GOSUB Er	There is no corresponding file name when Gosub PROG < file name > is used.
MEMORY Er	(1) There is not enough memory for what you are trying to do.
NO SOLUTION	There is no solution to the simultaneous equation under VLE mode.
MULTI SOLUTION	There is infinite to the simultaneous equation under VLE mode.
NO REAL SOL	There is no real solution to quadratic equation under QE mode.
LABLE Er	Attempt to use the same label name more than once.

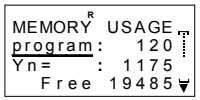
To release the above errors, please press [$^{ON}/_{CL}$] key.

1 – 10 Memory Status And Clear

1 – 10 – 1 To Check The Memory Status

You can check how much memory is used for storage for each type of data. You can also see how many bytes of memory are still available for storage.

In the working mode menu, press [MODE] 7 (RESET) 0 (MEM USAGE) to display the memory status screen.



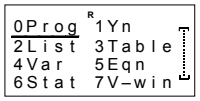
Move the cursor and view the amount of memory (in bytes) used for storage of each type of data.

The following table shows all of the data types that appear on the memory status screen.

Item	Meaning
program	Program data
Y n =	Graph functions
list	List data
table	Table & Graph data

1 – 10 – 2 To Clear Memory Contents

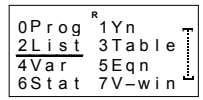
To clear all data within a specific data type, press [MODE] 7 (RESET) 1 (CLEAR) to display the data type menu.



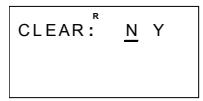
Program ... Program data
List ... List data
Var ... Alpha–variable memory data
Stat ... Statistics Variables
Y n ... Graph functions
Table ... Table & Graph data
Eqn ... Equation storage
V–win ... V–Window memory data

Select the data type whose data you want to clear.

[▼]



[EXE]



Move the cursor to " Y " to delete the data type or " N " to abort the operation without deleting anything.

Chapter 2 Basic Calculations

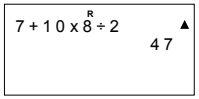
2 – 1 Mixed Calculation

(A) Arithmetic operations

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

(Example): 7 + 10 x 8 ÷ 2 = 47

7 [+] 10 [x] 8 [÷] 2 [EXE]

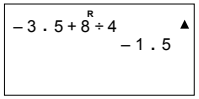


(B) Negative values

For negative values, press [(–)] before entering the value.

(Example): – 3.5 + 8 ÷ 4 = –1.5

[(–)] 3.5 [+] 8 [÷] 4 [EXE]

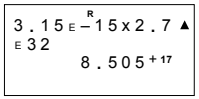


(C) Exponential forms

You can enter a number in mantissa and exponent form by [EXP] key.

(Example): (3.15 x 10^{-15}) x (2.7 x 10^{32}) = 8.505 x 10^{17}

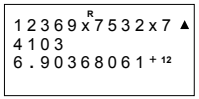
3.15 [EXP] [(–)] 15 [x] 2.7 [EXP] 32 [EXE]



Results greater than 10^{10} or less than 10^{-9} are displayed in exponential form.

(Example):12369 x 7532 x 74103 = 6903680613000

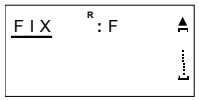
12369 [x] 7532 [x] 74103 [EXE]



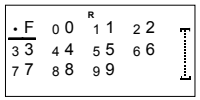
2 – 2 Display Formats

2 – 2 – 1 Decimal Place Formats

The decimal place format (F0123456789) is set by pressing [2nd] [SYSTEM] twice and selecting " FIX " to display the menu. (The default setting for the decimal display format is floating point notation F and n is •)

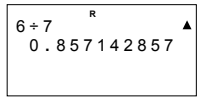


[EXE]

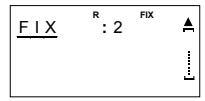


(Example): 6 ÷ 7 = 0.857142857

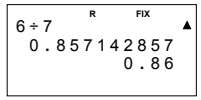
6 [÷] 7 [EXE]



[2nd] [SYSTEM] [2nd] [SYSTEM] (FIX) [EXE] 2 (2)

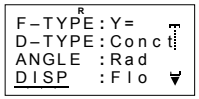


[EXIT] [EXE]

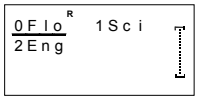


2 – 2 – 2 Number Display Formats

The number display format (Flo, Sci, Eng) is set by pressing [2nd] [SYSTEM] and selecting " DISP " to display the menu. (The default setting for the number display format is " Flo ")



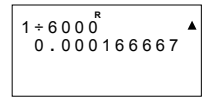
[EXE]



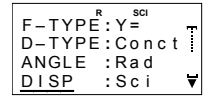
The items on the menu are Flo (for floating point), Sci (for scientific), and Eng (for engineering).

(Example): 1 ÷ 6000 = 0.0001666...

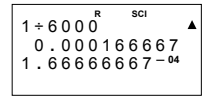
1 [÷] 6000 [EXE]



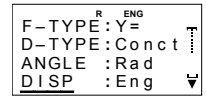
[2nd] [SYSTEM] [▼] [▼] [▼] (DISP)
[EXE] 1 (Sci)



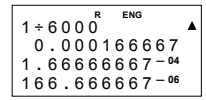
[EXIT] [EXE]



[2nd] [SYSTEM] [▼] [▼] [▼] (DISP)
[EXE] 2 (Eng)



[EXIT] [EXE]

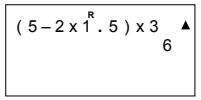


2 – 3 Parentheses Calculation

Operation inside parentheses are always executed first. The calculator can use up to 12 levels of consecutive parentheses in a single calculation.

(Example): (5 – 2 x 1.5) x 3 = 6

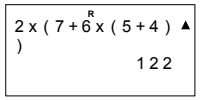
[( )] 5 [–] 2 [x] 1.5 [▶] [x] 3 [EXE]



Closed parentheses occurring immediately before operation of the [EXE] key may be omitted, no matter how many are required.

(Example): 2 x { 7 + 6 x (5 + 4) } = 122

2 [x] [( )] 7 [+] 6 [x] [( )] 5 [+] 4 [EXE]

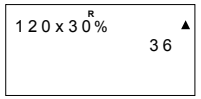


2 – 4 Percentage Calculation

[2nd] [%] divides the number in the display by 100. You can use this key sequence to calculate percentages, add-ons, discounts, and percentage ratios.

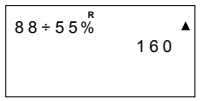
(Example): 120 x 30 % = 36

120 [x] 30 [2nd] [%] [EXE]



(Example): 88 ÷ 55% = 160

88 [÷] 55 [2nd] [%] [EXE]



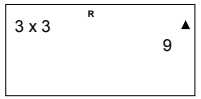
2 – 5 Useful Calculation Features

2 – 5 – 1 Continuous Calculation Function

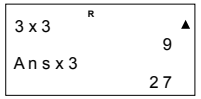
The calculator enables you to repeat the last operation executed by pressing [EXE] key for further calculation.

(Example): 3 x 3 x 3 x 3 x 3 = 243

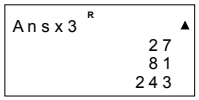
3 [x] 3 [EXE]



[x] 3 [EXE]



[EXE] [EXE]



2 – 5 – 2 Marking Corrections During Input

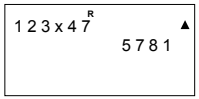
The blinking cursor " ◀ " means the calculator is in insert mode. To delete a character at the cursor, make the character underlined by using the cursor keys, and then press [DEL] to delete the character.

To insert a character, move the cursor to the position of the character where you want to insert, it will be inserted automatically in the front of the character after pressing a new character.

To clear all characters, press [$^{ON}/_{CL}$].

(Example):To change 123 x 45 as 123 x 47

123 [x] 45 [◀] 7 [DEL] [EXE]



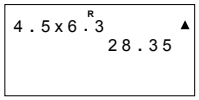
To abort a character which is just deleted by [DEL], please press [2nd] [↶].

2 – 5 – 3 Replay Function

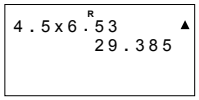
While the result of a calculation is on the display, you can use [◀] or [▶] to move the cursor to any position within the expression used to produce the result. This means you can back up and correct mistakes without having to input the entire calculation.

(Example):To calculate 4.5 x 6.3 and then change the calculation to 4.5 x 6.53

4.5 [x] 6.3 [EXE]



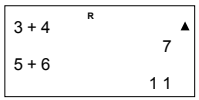
[◀] [◀] 5 [EXE]



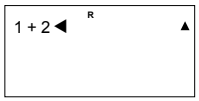
For multi-replay , press [▲] or [▼] sequentially recalls and displays past calculations.

(Example):To recall the operation 1 + 2 = 3 after executing 1 + 2 , 3 + 4 , 5 + 6

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



[▲] [▲] [▲] [▲] [▲] [▲] [EXE]



2 – 5 – 4 Error Position Display Function

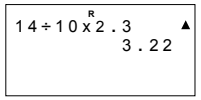
When a mathematically illegal calculation is performed or a program you enter causes an error, an error message (See « 1 – 9 Error Conditions ») appears 5 second and then the error position display function will tell you with the cursor where the error is. In that case, please make necessary corrections before executing the calculation again.

(Example): 14 ÷ 0 x 2.3 mistakenly input instead of 14 + 10 x 2.3

14 [÷] 0 [x] 2.3 [EXE]

(5 Seconds)

[◀] 1 [EXE]

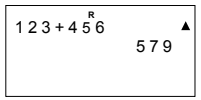


2 – 5 – 5 Answer Function

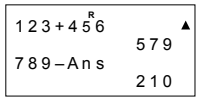
Answer function stores the most recently calculated result. It is retained even after the power is turned off. Once a numeric value or numeric expression is entered and [EXE] is pressed, the result is stored by this function.

(Example): 123 + 456 = 579 → 789 – 579 = 210

123 [+] 456 [EXE]



789 [–] [2nd] [ANS] [EXE]



(Note): Even if execution of a calculation results in an error, however, Answer memory retains its current value.

2 – 5 – 6 Implied Multiplication

You can leave out the multiplication sign in any of the following cases.

- In front of the following scientific functions : sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, log, ln, 10^x, e^x, $\sqrt{\ }$, Pol(x , y), Rec(r, θ), d/*d*x, Seq, Min, Max, Avg, Med, List, Dim, Sum

  Example : 2 sin30, 10log1.2, 2 $\sqrt{3}$, etc.
- In front of constants, variable names, Ans memory contents.
  Example : 2π, 2AB, 3Ans, 6X, etc.
- In front of an open parenthesis.
  Example : 3(5 + 6), (A + 1)(B –1)

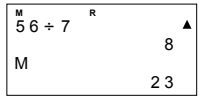
2 – 6 Memory Calculations

2 – 6 – 1 Independent Memory

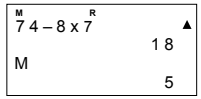
Press [M+] to add a result to running memory. Press [2nd] [M–] to subtract the value from running memory. To recall the value in running memory, press [MRC]. To clear running memory, press [MRC] twice.

(Example): [(3 x 5) + (56 ÷ 7) – (74 – 8 x 7)] = 5

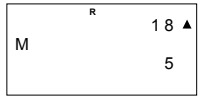
3 [x] 5 [M +] 56 [÷] 7 [M +] [MRC] [EXE]



74 [–] 8 [x] 7 [2nd] [M –] [MRC] [EXE]



[MRC] [MRC] [$^{ON}/_{CL}$]



2 – 6 – 2 Standard Variables

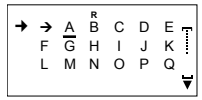
The calculator has 28 standard variables for repeated use : A~ Z, X_1 and X_2. You can store a real number or complex number in any one of those variables.

- [SAVE] lets you store values to a specified variable.
- [2nd] [RECALL] recalls the value of variable.
- [ALPHA] + < variable name (A ~Z) > recalls the content to a specified variable.

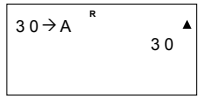
To clear the contents of all variables, please see « 1– 10 Memory Status and Clear » .

(Example):(1) To save the value 30 into the variable A
(2) To multiple 5 to the variable A, then save the result into the variable B
(3) To add 3 to the variable B

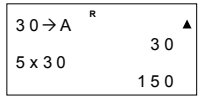
① 30 [SAVE] [▶]



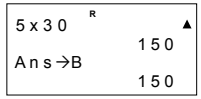
[EXE]



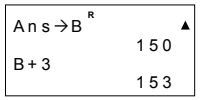
② 5 [x] [2nd] [RECALL] (A) [EXE] [EXE]



[SAVE] [▶] [▶] [EXE]



③ [ALPHA] [B] [+] 3 [EXE]



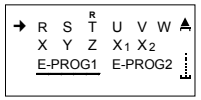
(Note): To assign multiple data of the same value to more than one variable, it can be input using [ALPHA] [~]. For example, to assign the value 98 into memory variable A, B, C, D, press 98 [SAVE] (→) [EXE] [ALPHA] [A] [ALPHA] [~] [ALPHA] [D] [EXE].

2 – 6 – 3 Equation Storage

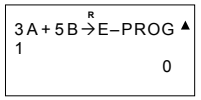
You also can store one equation in E-PROG1 or E-PROG2 memory for instant recall when you need it. Then you can recall the equation at any time, input values, and perform calculations quickly and easily.

(Example): To set E-PROG1 = 3A + 5B, then A = 20, B = 18 ⇒E-PROG1 = 150

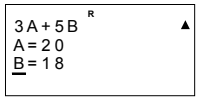
3 [ALPHA] [A] [+] 5 [ALPHA] [B] [SAVE]
[SAVE] [▼] [▼] (E-PROG1)



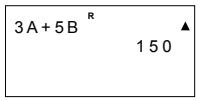
[EXE]



[2nd] [RECALL] [2nd] [RECALL] [▼] [▼]
(E-PROG1) [EXE] [EXE] 20 [EXE] 18 [EXE]



[EXE]

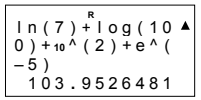


2 – 7 Logarithm And Antilogarithm

The calculator can calculate common and natural logarithms and antilogarithms using [LOG], [LN], [2nd] [10^x], and [2nd] [e^x].

(Example): ln7 + log100 + 10^2 + e^{-5} = 103.9526481

[LN] 7 [▶] [+] [LOG] 100 [▶] [+] [2nd]
[10^x] 2 [▶] [+] [2nd] [e^x] [(–)] 5 [EXE]



2 – 8 Fraction Calculation

To enter a mixed number, enter the integer part, press [$A^{b}/_{c}$], enter the numerator, press [$A^{b}/_{c}$], and enter the denominator ; To enter an improper fraction, enter the numerator, press [$A^{b}/_{c}$], and enter the denominator.

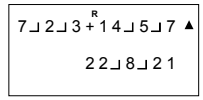
Fraction value display is as follow :

5 ⌟ 12 Display of $\frac{5}{12}$ 56 ⌟ 5 ⌟ 12 Display of $56\frac{5}{12}$

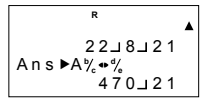
By pressing [2nd] [$A^{b}/_{c}$ ◀ ▶ $^{d}/_{e}$], the displayed value will be converted to the improper fraction and vice versa.

(Example): $7\frac{2}{3}+14\frac{5}{7}=22\frac{8}{21}=\frac{470}{21}$

7 [$A^{b}/_{c}$] 2 [$A^{b}/_{c}$] 3 [+] 14 [$A^{b}/_{c}$] 5 [$A^{b}/_{c}$] 7 [EXE]



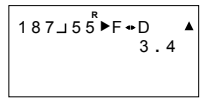
[2nd] [$A^{b}/_{c}$ ◀ ▶ $^{d}/_{e}$] [EXE]



To convert between a decimal and fractional result, press [2nd] [F ◀ ▶ D] and [EXE].

(Example): $\frac{187}{55}=3.4$

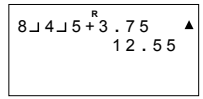
187 [$A^{b}/_{c}$] 55 [2nd] [F ◀ ▶ D] [EXE]



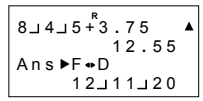
Calculations containing both fractions and decimals are calculated in decimal format.

(Example): $8\frac{4}{5}+3.75=12.55$

8 [$A^{b}/_{c}$] 4 [$A^{b}/_{c}$] 5 [+] 3.75 [EXE]



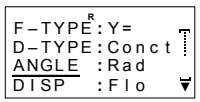
[2nd] [F ◀ ▶ D] [EXE]



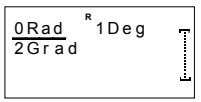
2 – 9 Angle units conversion

2 – 9 – 1 Default Angle Setting

The angle unit (Deg, Rad, Grad) is set by pressing [2nd] [SYSTEM] and selecting " ANGLE " to display the menu. (The default setting is " Rad ")



[EXE]



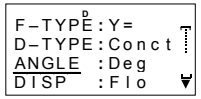
The relation among the three angle units is :

180 Deg. = πRad. = 200 Grad.

(Example): 2 π rad. = 360 deg.

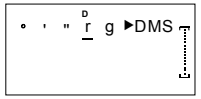
(Step 1): Change the default angle setting to the unit you want to convert to.

[2nd] [SYSTEM] [▼] [▼] (ANGLE) [EXE]
1 (Deg)



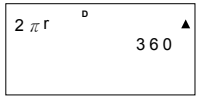
(Step 2) : Enter the value of the unit to convert, and then press [2nd] [DMS] to display the menu. The units you can select are ° (degrees), ' (minutes), '' (seconds), r (radians), g (gradians) or ▸DMS (Degrees-Minutes-Seconds).

[EXIT] 2 [2nd] [π] [2nd] [DMS] [▶] [▶] [▶]



(Step 3) : After selecting the units you are converting from, press [EXE] twice.

[EXE] [EXE]



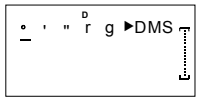
2 – 9 – 2 DMS Notation

To convert a DMS notation to a decimal value, press [2nd] [DMS] and select ° (degrees), ' (minutes), '' (seconds) for input, i.e., where **2° 45 ' 10.5 ''** represents 2 degrees, 45 minutes, 10.5 seconds.

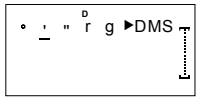
(Note) : When using those functions, make sure the calculator is set for the angle unit you want.

(Example): 2 ° 45 ' 10.5 '' = 2.752916667

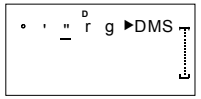
2 [2nd] [DMS]



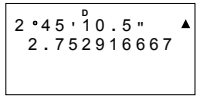
[EXE] 45 [2nd] [DMS] [▶]



[EXE] 10.5 [2nd] [DMS] [▶] [▶]



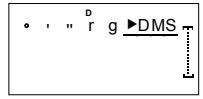
[EXE] [EXE]



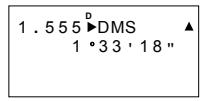
To convert a decimal value to DMS notation, press [2nd] [DMS] and select " ▸DMS ", which converts an entry to DMS notation.

(Example): 1.555 = 1° 33 ' 18 '' (DMS)

1.555 [2nd] [DMS] [▶] [▶] [▶] [▶] [▶]



[EXE] [EXE]



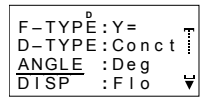
2 – 10 Trigonometric / Inverse-Tri. Function

The calculator provides standard trigonometric functions and inverse trigonometric functions - sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$.

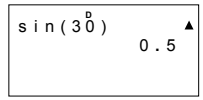
(Note): When using those keys, make sure the calculator is set for the angle unit you want.

(Example): sin30 Deg. = 0.5

[2nd] [SYSTEM] [▼] [▼] (ANGLE) [EXE]
1 (Deg)

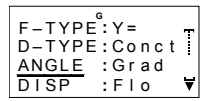


[EXIT] [SIN] 30 [EXE]

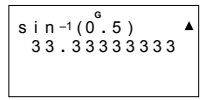


(Example): $\sin^{-1}$ 0.5 = 33.33333333 Grad.

[2nd] [SYSTEM] [▼] [▼] (ANGLE) [EXE]
2 (Grad)



[EXIT] [2nd] [$\sin^{-1}$] 0.5 [EXE]



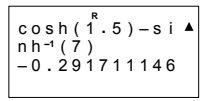
2 – 11 Hyperbolic / Inverse-Hyp. Function

The calculator uses [2nd] [HYP] to calculate the hyperbolic functions and inverse-hyperbolic functions - sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$ and $\tanh^{-1}$.

(Note): When using those keys, make sure the calculator is set for the angle unit you want.

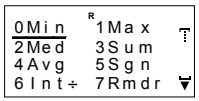
(Example): cosh1.5 – $\sinh^{-1}$ 7 = – 0.291711146

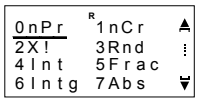
[2nd] [HYP] [COS] 1.5 [▶] [–] [2nd]
[HYP] [2nd] [$\sin^{-1}$] 7 [EXE]

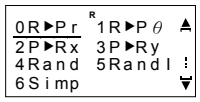


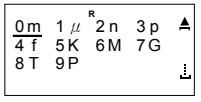
2 – 12 Mathematical Function

Each time [MATH] is pressed, various mathematical menus and all argument values corresponding the desired item are shown on the screen. With the following functions :







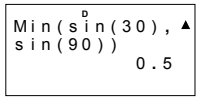


2 – 12 – 1 Numerical Calculations

Min… Input values to obtain the minimum value
Max… Input values to obtain the maximum value
Med… Input values to obtain the medium value
Sum…Input values to obtain the sum
Avg… Input values to obtain the average value
Sgn… Input a value to indicate the sign of a given number, if negative value, display – 1 ; if zero, display 0 ; if positive , display 1

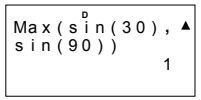
(Example): Min (sin 30 Deg., sin 90 Deg.) = Min (0.5, 1) = 0.5

[MATH] 0 (Min) [SIN] 30 [▶] [,] [SIN] 90 [EXE]



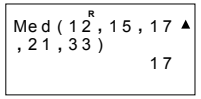
(Example): Max (sin 30 Deg. , sin 90 Deg.) = Max (0.5, 1) = 1

[MATH] 1 (Max) [SIN] 30 [▶] [,] [SIN] 90 [EXE]



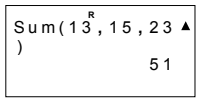
(Example): Med (12 , 15 , 17 , 21 , 33) = 17

[MATH] 2 (Med) 12 [,] 15 [,] 17 [,] 21 [,] 33 [EXE]



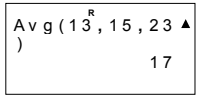
(Example): Sum (13 , 15 , 23) = 51

[MATH] 3 (Sum) 13 [,] 15 [,] 23 [EXE]



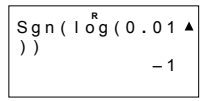
(Example): Avg (13 , 15 , 23) = 17

[MATH] 4 (Avg) 13 [,] 15 [,] 23 [EXE]



(Example): Sgn (log 0.01) =Sgn (– 2) = – 1

[MATH] 5 (Sgn) [LOG] 0.01 [EXE]



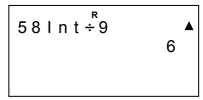
2 – 12 – 2 Quotient And Remainder Division

Int ÷ ... Produce the quotient of division operations involving two integers
Rmdr ... Produce the reminder of division operations involving two integers

(Note): Remember that you can use only integers in quotient division operations. You cannot use expressions such as $\sqrt{2}$ or sin60 because their results have a decimal part.

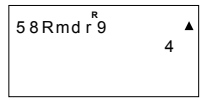
(Example): To display the quotient produced by 58 ÷ 9

58 [MATH] 6 (Int÷) 9 [EXE]



(Example): To display the reminder produced by 58 ÷ 9

58 [MATH] 7 (Rmdr) 9 [EXE]

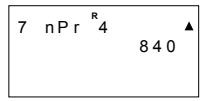


2 – 12 – 3 Permutation And Combination

nPr ... Permutation **nCr** ... Combination

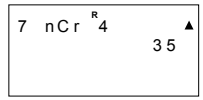
(Example): 7 ! ÷ [(7 – 4) !] = 840

7 [MATH] [MATH] 0 (nPr) 4 [EXE]



(Example): 7 ! ÷ [(7 – 4) ! x 4 !] = 35

7 [MATH] [MATH] 1(nCr) 4 [EXE]



2 – 12 – 4 Factorials, Round, Integers, Fractionals, Absolute Values, Random Numbers

X ! ... Calculate the factorial of a specified positive integer n, where n ≤ 69.
Rnd ...Round off the result to to match to the decimal place format (FIX)
Int ... Input a value to extract the integer part.
Frac ... Input a value to extract the fraction part.
Intg ... Input a value to obtain the largest integer that is not greater than the value.
Abs ... Input a value to obtain the absolute value
Rand ...Generate a random number between 0 and 1
RandI ... Generate a random integer value between two specified integers, A and B,

where A ≤ random value ≤ B .

(Example): 5 ! = 120

5 [MATH] [MATH] 2 (X !) [EXE]

```
5!
          120
```

(Example): Rnd (82.3 ÷ 5) = Rnd (16.46) = 16.5 (FIX : 1)

[MATH] [MATH] 3 (Rnd) 82.3 [÷] 5 [EXE]

```
Rnd(82.3÷5)
          16.5
```

(Example): Int (10 ÷ 8) = Int (1.25) = 1

[MATH] [MATH] 4 (Int) 10 [÷] 8 [EXE]

```
Int(10÷8)
             1
```

(Example): Frac (10 ÷ 8) = Frac (1.25) = 0.25

[MATH] [MATH] 5 (Frac) 10 [÷] 8 [EXE]

```
Frac(10÷8)
          0.25
```

(Example): Intg (25 ÷ 4) = Intg (6.25) = 6

[MATH] [MATH] 6 (Intg) 25 [÷] 4 [EXE]

```
Intg(25÷4)
             6
```

(Example): Abs (log 0.01) =Abs (– 2) = 2

[MATH] [MATH] 7 (Abs) [LOG] 0.01 [EXE]

```
Abs(log(0.01
))
             2
```

(Example): Generates a random number between 0 and 1

[MATH] [MATH] [MATH] 4 (Rand) [EXE]

```
Rand
  0.464370728
```

(Example): Generates a random integer between 7 and 9

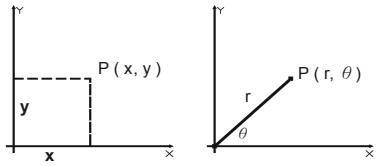
[MATH] [MATH] [MATH] 5 (RandI) 7 [,] 9 [EXE]

```
RandI(7,9)
             7
```

2 – 12 – 5 Coordinates Transformation

R▶P r , **R▶P θ** ... Rectangular coordinate → Polar coordinate
P▶R x , **P▶R y** ... Polar coordinate → Rectangular coordinate

Rectangular Coordinate Polar Coordinate
x + y i= r (cos θ + i sin θ 1)



(Note):When using those functions, make sure the calculator is set for the angle unit you want.

(Example): If x = 5 , y = 30, what are r , θ ? Ans : r = 30.41381265, θ = 80.53767779 ° (Angle unit : D)

[MATH] [MATH] [MATH]

```
0R▶Pr 1R▶Pθ
2P▶Rx 3P▶Ry
4Rand 5RandI
6Simp
```

[EXE] 5 [,] 30 [EXE]

```
R▶Pr(5,30)
  30.41381265
```

[MATH] [MATH] [MATH] [▶]

```
0R▶Pr 1R▶Pθ
2P▶Rx 3P▶Ry
4Rand 5RandI
6Simp
```

[EXE] 5 [,] 30 [EXE]

```
R▶Pθ(5,30)
  80.53767779
```

2 – 12 – 6 Fraction Simplification

Simp ... Simplify a fraction using the calculator's or your factor.

(A) To simplify using the calculator's divisor

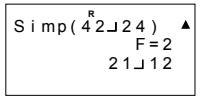
According to the below syntax to use the calculator's factor for simplification:

[MATH] [MATH] [MATH] 6 (Simp) < fraction > [EXE]

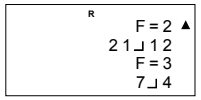
The calculator automatically selects the smallest possible prime divisor (Factor , F =) for simplification. You can repeat the operation to simplify again until the display indicates that further simplification is impossible, if necessary.

(Example): To simplify the fraction $\frac{42}{24}$ using the calculator's factor

[MATH] [MATH] [MATH] 6 (Simp) 42 [$A^{b}/_{c}$]
24 [EXE]



[EXE]



(B) To simplify using your factor

According to the below syntax to specify your factor for simplification :

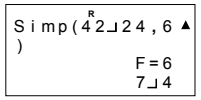
[MATH] [MATH] [MATH] 6 (Simp) < fraction > [,] < factor > [EXE].

You can specify only a positive integer as the factor.

(Note): If the value you specify is invalid as a factor for simplification, the calculator automatically uses the smallest possible prime divisor.

(Example):To simplify the fraction $\frac{42}{24}$ using your factor 6

[MATH] [MATH] [MATH] 6 (Simp) 42 [$A^{b}/_{c}$]
24 [,] 6 [EXE]



2 – 12 – 7 Engineering Notation

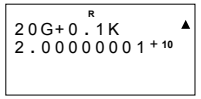
This calculator also provides a list of symbols for input of value using engineering notation.

There are ten symbols in the menu .

milli m = 10^{-3}, micro μ = 10^{-6}, nano n = 10^{-9}, pico p = 10^{-12}, femto f = 10^{-15},
kilo K = 10^{3}, mega M = 10^{6}, giga G = 10^{9}, tera T = 10^{12}, peta P = 10^{15}

(Example): 20 G byte +0.1 K byte = 2.000000015 x 10^{10} byte

20 [MATH] [MATH] [MATH] [MATH] 7 (G)
[+] 0.1 [MATH] [MATH] [MATH] [MATH] 5
(K) [EXE]

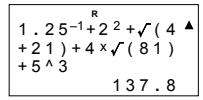


2 – 13 Other Functions (x^{-1}, $\sqrt{\ }$, $\sqrt[x]{\ }$, x^{2}, $\wedge$)

The calculator also provides reciprocal ([x^{-1}]), square root ([$\sqrt{\ }$]), square ([x^{2}]), universal root ([$\sqrt[x]{\ }$]), and exponentiation ([$\wedge$]) functions.

(Example) : $\frac{1}{1.25}+2^{2}+\sqrt{(4+21)}+\sqrt[4]{81}+5^{3}=137.8$

1.25 [2nd] [X^{-1}] [+] 2 [X^{2}] [+] [$\sqrt{\ }$] 4 [+]
21 [▶] [+] 4 [2nd] [$\sqrt[x]{\ }$] 81 [▶] [+] 5 [^] 3
[EXE]



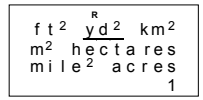
2 – 14 Unit Conversion

The calculator has a built–in unit conversion feature that enables you to convert numbers from metric to English units and vice versa. There are 7 menus, covering distance, area, temperature, capacity, weight, energy, and pressure.

(Example): 1yd ^{2} = 9 ft ^{2} = 0.000000836 km ^{2}

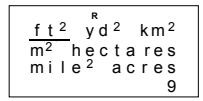
(Step 1) : Enter the number you want to convert, and scroll through the list of units until a appropriate units menu is shown, , then [EXE]

1 [CONV] [CONV] [▶] [EXE]

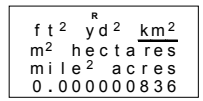


(Step 2) : Pressing [◀] or [▶] can convert the number to another unit.

[◀]



[▶] [▶]



2 – 15 Physics Constants

You can use a number physics constants in your calculations. With the following constants :

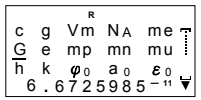
Symbol	Meaning	Value
c	Speed of light	299792458 m / s
g	Acceleration of gravity	9.80665 $m.s^{-2}$
G	Gravitational constant	6.6725985 x 10^{-11} $N.m^{2}$ kg^{-2}
Vm	molar volume of ideal gas	0.0224141 m^{3} mol^{-1}
N_A	Avogadro's number	6.022136736 x 10^{23} mol^{-1}
e	Elementary charge	1.6021773349 x 10^{-19} C
me	Electron mass	9.109389754 x 10^{-31} kg
mp	Proton mass	1.67262311 x 10^{-27} kg
h	Plank's constant	6.62607554 x 10^{-34} J.s
k	Boltzmann's constant	1.38065812 x 10^{-23} $J.K^{-1}$
lR	Gas constant	8.3145107 J / mol • k
lF	Faraday constant	96485.30929 C / mol
mn	Neutron mass	1.67492861 x 10^{-27} kg
mμ	Muon mass	1.8835327 x 10^{-28} kg
μ	Atomic mass constant	1.66054021 x 10^{-27} kg

ε_0	Dielectric permittivity	8.85418782 x 10^{-12} F / m
μ_0	Magnetic permittivity	0.000001257 H / m
ϕ_0	Flux quantum	2.0678346161 x 10^{-15} Vs
a_0	Bohr radius	5.2917724924 x 10^{-11} m
μB	Bohr magneton	9.274015431 x 10^{-24} A • m^2
μN	Nuclear magneton	5.05078662 x 10^{-27} J / T
h	h-bar = h / 2 π	1.05457266 x 10^{-34} J.s
α	Fine structure constant	7.29735308 x 10^{-3}
γ e	Electron classical radius	2.81794092 x 10^{-15} m
λc	Electron Compton wavelength	2.42631058 x 10^{-12} m
γ p	Proton gyromagnetic ratio	267522128 T^{-1} s^{-1}
λcp	Proton Compton wavelength	1.32141002 x 10^{-15} m
λcn	Neutron Compton wavelength	1.3195911 x 10^{-15} m
R∞	Rydberg constant	10973731.53 m^{-1}
μp	Shielded proton moment	1.41060761x 10^{-26} J T^{-1}
μe	Electron magnetic moment	9.2847701x 10^{-24} J T^{-1}
μn	Neutron magnetic moment	9.6623707x 10^{-27} J T^{-1}
μu	Muon magnetic moment	4.4904514 x 10^{-26} J T^{-1}
C_1	First radiation constant	3.7417749 x 10^{-16} W m^2
C_2	Second radiation constant	0.01438769 m K
σ	Stefan-Boltzmann constant	5.67051x 10^{-8} W m^{-2} K^{-4}
AU	Astronomical unit	1.4959787x 10^{11} m
t	Celsius temperature	273.15 K
atm	Standard atmosphere	101325 Pa
pc	Parsec	3.0856776 x 10^{16} m

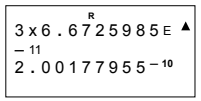
To insert a constant at the cursor position, press [2nd] [CONST] to display the physics constants menu. Scroll through the menu until the constant you want is underlined.

(Example): 3 x G = 2.00177955 x 10^{-10}

3 [x] [2nd] [CONST] [▼]



[EXE] [EXE]



2 – 16 Multistatement Function

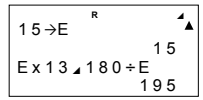
Multistatements are formed by connecting a number of individual statements for sequential execution. You can use multistatement in manual For statements that are connected with a display result command (◢), when execution reaches the end of a statement followed by ◢ , execution stops and the result up to that point appears on the display. You can resume execution by pressing [EXE].

(Example): Use Multistatement function to the two statements : (E = 15)

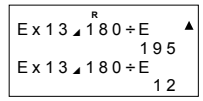
$$\begin{cases} \underline{E} \times 13 = 195 \\ 180 \div \underline{E} = 12 \end{cases}$$

15 [SAVE] [▶] [▶] [▶] [▶] [▶] (E) [EXE]

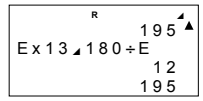
[ALPHA] [E] [x] 13 [ALPHA] [◢] 180
[÷] [APLHA] [E] [EXE]



[EXE]



[EXE]



2 – 17 Integration And Differentiation

This calculator can perform numerical integration and differentiation by [∫dx] and [2nd] [d/dx].

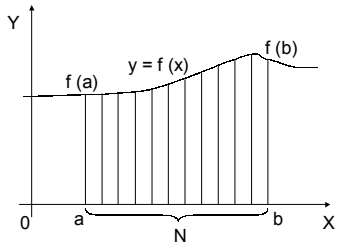
2 – 17 – 1 Integration

The calculator uses Simpson's rule to perform integration calculations as shown in the below :

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

where [a, b] is integration interval and N is the number of division. (n is an integer from 1 to 9)

Simpson's Rule



Area = $\frac{h}{3}\{f(a) + 4\{f(a+h) + f(a+3h) + ... + f(a+(N-1)h\} + 2\{f(a+2h) + f(a+4h) + ... + f(a+(N-2)h)\} + f(b)\}$, Where $h = \frac{b-a}{N}$

In general, the larger n is, the more calculation time is required and the higher precision for the result is. In some case, the results of your integration may be erroneous even if the larger n is used. In particular, when significant digits are less than 1, an error message sometimes will be shown.

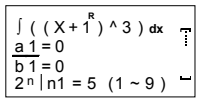
(Note): The calculator always perform trigonometric integration using radians as the unit of angular measurement.

(Note): Integration involving certain types of functions or ranges can result in relatively large errors being generated in the values produced.

(Example): $\int_1^5 (x+1)^3 dx = 320$

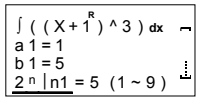
(Step 1) : Enter the function f (x). You can use [X, T] key to enter the variable x into the function.

[∫ dx] [( )] [X, T] [+] 1 [▶] [^] 3 [EXE]



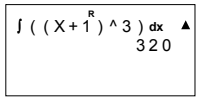
(Step 2) : Enter the lower and upper limits of integration (a and b). Give the number of division to specify 2^n = N, where the value of n is an integer from 1 to 9 and the default value is 5.

1 [EXE] 5 [EXE]



(Step 3) : Press [EXE]

[EXE]



2 – 17 – 2 Differentiation

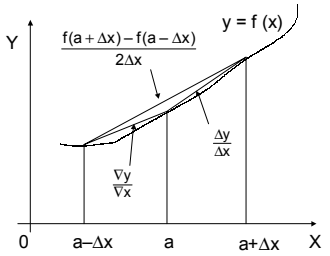
The calculator uses Central difference to perform differential calculations as shown in the below :

$$f'(a) = \lim_{\Delta \to 0} \frac{f(a+\Delta x) - f(a)}{\Delta x}$$

Where a is the point you want to determine the derivative and Δx is increase/ decrease of x.

Central difference

$$f'(a) = \frac{1}{2}\left(\frac{\Delta Y}{\Delta X} + \frac{\nabla Y}{\nabla X}\right)$$
$$= \frac{1}{2}\left(\frac{f(a+\Delta x) - f(a)}{\Delta x} + \frac{f(a) - f(a-\Delta x)}{\Delta x}\right)$$
$$= \frac{f(a+\Delta x) - f(a-\Delta x)}{2\Delta x}$$

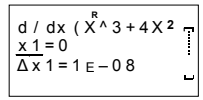


The smaller Δx is, the more calculation time is required and the higher precision for the derivative is. In general, the precision is ± 1 at the least significant digit of the result. However, you needn't input a value of Δx and just press [EXE] to skip it. The calculator automatically assigns the default value of 10^{-8}.

(Example): $f(x) = x^3 + 4x^2 + x - 6 \Rightarrow f'(3) = (3x^2 + 8x + 1)\Big|_{x=3} = 52$

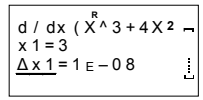
(Step 1) : Enter the function f (x). You can use [X, T] key to enter the variable x into the function.

[2nd] [d/dx] [X ,T] [^] 3 [+] 4 [X ,T] [X^2]
[+] [X ,T] [−] 6 [EXE]



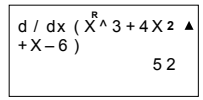
(Step 2) : Enter point x_1 = a to determinate the derivative. Then enter the increase / decrease of x (Δx)

3 [EXE]



(Step 3) : Press [EXE]

[EXE]



(Note): If the result for integration or differentiation takes a long time to calculate and you want to interrupt, please press [EXIT].

2 – 17 – 3 Application Of Integration And Differentiation

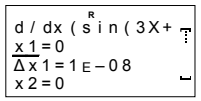
Integrals and differentials can be added, subtracted, multiplied and divided with each other. For example, $\int_a^b f(x)\,dx + \int_c^d g(x)\,dx$, $\int_a^b f(x)\,dx \times \int_c^d g(x)\,dx$, $f'(a) \div \int_a^b g(x)\,dx$ .....

(Example): $\begin{cases} f_1(x) = \sin(3x+30) \\ f_2(x) = \cos^3(x) \end{cases}$

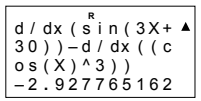
$$\Rightarrow f_1'(10) - f_2'(30) = \left[3\cos(3x+30) \right]\Big|_{X=10} - \left\{ -\left[3\cos(x)^2 \times \sin(x) \right] \right\}\Big|_{X=30}$$

$$= -2.927765162^{r} \text{ (Rad.)}$$

[2nd] [d/dx] [SIN] 3 [X ,T] [+] 30 [▶] [▶]
[–] [2nd] [d/dx] [( )] [COS] [X ,T] [▶] [^]
3 [EXE]



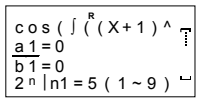
10 [EXE] [▼] 30 [EXE] [EXE]



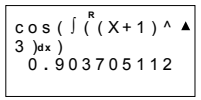
Integrated or differential results can be used in addition, multiplication, and division, and in function. For example, $5 \times \int_a^b f(x)\,dx$, $\cos(\int_a^b f(x)\,dx)$.

(Example): $\cos\left[\int_1^5 (x+1)^3\,dx \right] = \cos(320) = 0.766044443$

[COS] [∫dx] [( )] [X ,T] [+] 1 [▶] [^] 3 [EXE]



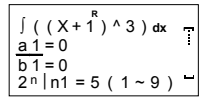
1 [EXE] 5 [EXE] [EXE]



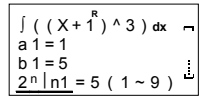
After you perform an integration, you can integrate the same f(x) again, with different limits of integration, a and b, or a different number of divisions, n. Differentiation also provides the feature.

(Example): $\begin{cases} \int_1^5 (x+1)^3\,dx = 320 \\ \int_3^8 (x+1)^3\,dx = 1576.25 \end{cases}$

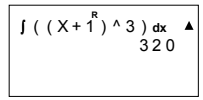
[∫dx] [( )] [X ,T] [+] 1 [▶] [^] 3 [EXE]



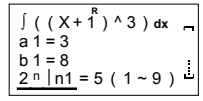
1 [EXE] 5 [EXE]



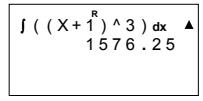
[EXE]



[EXE] 3 [EXE] 8 [EXE]



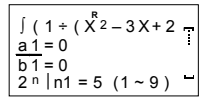
[EXE]



When integration interval [a, b] is unavailable or interrupted for the integrated function, an error message will appear on the display. It means you need to change the lower and upper limits of integration (a, b) for the integrated function.

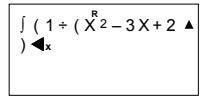
(Example): $\int_{-0.5}^{0.5} \frac{1}{(x^2-3x+2)}\,dx = 0.58789835$

[∫dx] 1 [÷] [( )] [X , T] [X²] [–] 3 [X , T]
[+] 2 [EXE]

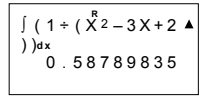


[(–)] 0.5 [EXE] 1.5 [EXE] 5 [EXE]

After 5 seconds



[EXE] [(–)] 0.5 [EXE] 0.5 [EXE] 5 [EXE]



2 – 18 Complex Numbers

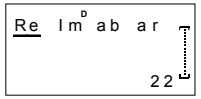
This function enables you to add, subtract, multiple, and divide complex numbers. The result of a complex operation are displayed as follow.

Re ... Real value **Im** ... Imaginary value
ab ... Absolute value **ar** ... Argument value

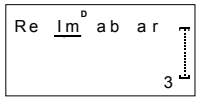
(Note):When using those functions, make sure the calculator is set for the angle unit you want.

(Example):(7 – 9 i) + (15 + 12 i) = 22 + 3i
⇒ ab = 22.20360331, ar = 7.765166018° (Angle unit : D)

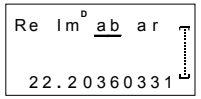
[( )] 7 [–] 9 [2nd] [i] [▶] [+] [( )] 15 [+] 12
[2nd] [i] [EXE]



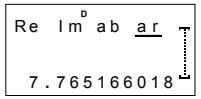
[▶]



[▶]



[▶]

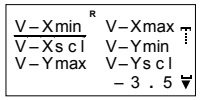


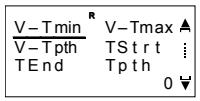
2 – 19 Variable Data (VARS) Menu

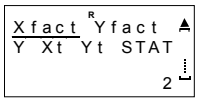
You can use the variable data menu to recall the data listed below.

- V–Window values
- Enlargement/reduction factor
- Single-variable/paired-variable statistical data
- Graph functions
- Table range and table contents

To recall variable data, press [VARS] to display the variable data menus.







V–Window values

V–Xmin ... x–axis minimum **V–Ymin** ... y–axis minimum **V–Tmin** ... Minimum of T
V–Xmax ... x–axis maximum **V–Ymax** ... y–axis maximum **V–Tmax** ... Maximum of T
V–Xscl ... x–axis scale **V–Yscl** ... y–axis scale **V–Tpth** ... Pitch of T

Table range and table contents

T Strt ... Table range start value **T End** ... Table range end value
T pth ... Table value increment

Enlargement/ reduction factor

X fact ... x–axis enlargement/reduction factor
Y fact ... y–axis enlargement/reduction factor

Graph functions

Y ... Rectangular coordinate or inequality function
X t ... Parametric graph function X t
Y t ... Parametric graph function Y t

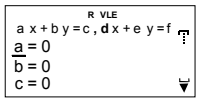
Statistical data

STAT .... Single-variable/paired-variable statistical data
(See « Chapter 8 Statistical Calculations And Graphs »)

Chapter 3 VLE & QE Calculations

3 – 1 Variable Linear Equation

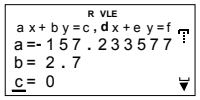
In the working mode menu, select the VLE item to enter the VLE mode. When you do, the display for inputting data into a variable linear equation is on the screen.



The VLE mode can solve a set of simultaneous equations with two unknowns as follows :

$$\begin{cases} ax+by=c \\ dx+ey=f \end{cases}$$, where x and y are unknown.

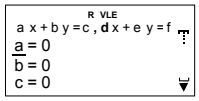
In VLE mode, you just enter each coefficient (a, b, c, d, e, f) in the correct order, and the calculator automatically solves for x, y.



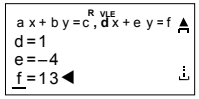
If the " = " symbol becomes " -= " , " -=- " or " =- ", it means there are more entries hidden the right or left of the screen, or both. Pressing [◀] or [▶] can move the cursor through an entry in a memory area.

(Example) : $\begin{cases} 3x+5y=5 \\ x-4y=13 \end{cases} \Rightarrow x=5, y=-2$

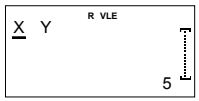
[MODE] [MODE] 0



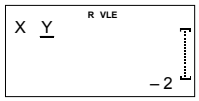
3 [EXE] 5 [EXE] 5 [EXE] 1 [EXE] [(–)] 4 [EXE] 13



[EXE]

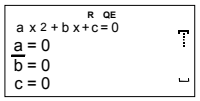


[▶]



3 – 2 Quadratic Equation

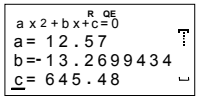
In the working mode menu, select the QE item to enter the QE mode. When you do, the display for inputting data into a quadratic equation is on the screen.



The QE mode can solve a equations as follows :

$a x^2 + b x + c = 0$, where x is unknown.

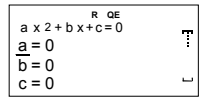
In QE mode, you just enter each coefficient (a, b, c) in the correct order, and the calculator automatically solves for all x values.



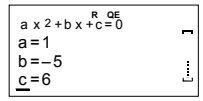
If the " = " symbol becomes " -= " , " -=- " or " =- ", it means there are more entries hidden the right or left of the screen, or both. Pressing [◀] or [▶] can move the cursor through an entry in a memory area.

(Example) : $x^2 - 5x + 6 = 0 \Rightarrow$ X = 2 or 3

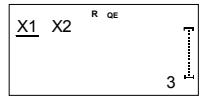
[MODE] [MODE] 1



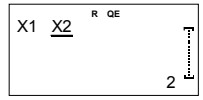
1 [EXE] [(–)] 5 [EXE] 6



[EXE]



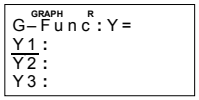
[▶]



Chapter 4 Graphing

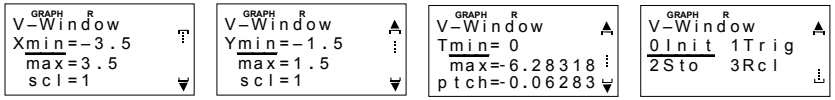
4 – 1 Before Trying To Draw A Graph

In the working mode menu, select the GRAPH item to enter the GRAPH mode. When you do, the Graph function (G–Func) menu appears on the screen.



4 – 2 V–WIN. (V–Window) Settings

You should always set the V–Window parameters you want to use before drawing a graph. Press [V–WIN.] in the GRAPH or MAIN mode to display the V–Window setting menus.



X–axis

min ... Minimum x–axis value
max ... Maximum x–axis value
scl ... Scale of x–axis

Y–axis

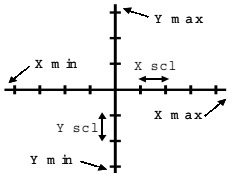
min ... Minimum y–axis value
max ... Maximum y–axis value
scl ... Scale of y–axis

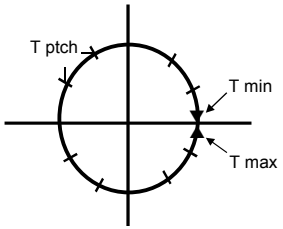
T– value

min ... T minimum value
max ... T maximum value
ptch ... T pitch

Init ... V–Window initial settings
Trig ... V–Window initial settings using specified angle unit
Sto ... Store V–Window settings to memory.
Rcl ... Recall V–Window settings from memory.

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





4 – 2 – 1 To Initialize And Standardize The V–Window

(A) To Initialize the V–Window

Pressing [V–WIN.] [▲] 0 (Init) can initialize the V–Window to the following settings.

Xmin = – 3.5 , Xmax = 3.5 , Xscl = 1
Ymin = – 1.5 , Ymax = 1.5 , Yscl = 1
Tmin = 0 , Tmax = 6.28318, Tptch = 0.0628318

(B) To Standardize the V–Window

Pressing [V–WIN.] [▲] 1 (Trig) can standardize the V–Window to the following settings.

Deg Mode : Xmin = – 360 , Xmax = 360 , Xscl = 90
Ymin = – 1.1 , Ymax = 1.1 , Yscl = 0.5
Rad Mode : Xmin = – 6.28318530718 , Xmax = 6.28318530718 ,
Xscl = 1.570796326795 , Ymin = – 1.1 , Ymax = 1.1 , Yscl = 0.5
Grad Mode : Xmin = – 400 , Xmax = 400 , Xscl = 100
Ymin = – 1.1 , Ymax = 1.1 , Yscl = 0.5

(Note): The settings for Tmin, Tmax, and Tptch remain unchanged when you press [V–WIN.] [▲] 1 (Trig).

4 – 2 – 2 V–Window Memory

You can store a set of V–Window settings in the V–Window memory for recall when you need them.

(A) To store V–Window settings

While the V–Window setting menu is on the display, press [V–WIN.] [▲] 2 (Sto) to store the current settings.

(Note): Whenever you store V–Window settings, any settings previously stored in memory are replaced.

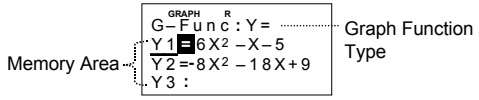
(B) To recall V–Window settings

While the V–Window setting menu is on the display, press [V–WIN.] [▲] 3 (Rcl) to recall the V–Window settings stored in memory.

(Note): Whenever you recall V–Window settings, the settings on the V–Window are replaced by the recalled settings.

4 – 3 Graph Function Operations

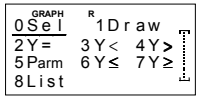
You can store up to 20 functions to the memory areas Y1 through Y20. Functions in memory can be edited, recalled, and graphed.



If the " = " symbol becomes " -= " , " -=- " or " =- ", it means there are more entries hidden the right or left of the screen, or both. Pressing [◀] or [▶] can move the cursor through an entry.

4 – 3 – 1 To Specify The Graph Type

While the Graph function (G–Func) menu is on the display, you can press [FUNC.] to display the menu.



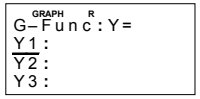
Y = ... Rectangular coordinate graph
Y < ... Y < f (x) inequality
Y ≤ ... Y ≤ f (x) inequality
Y > ... Y > f (x) inequality
Parm ... Parametric graph
Y ≥... Y ≥ f (x) inequality

(A) To store a rectangular coordinate function (Y =)

(Example): To store the following expression in memory area Y1 : Y = 6 X² – X– 5

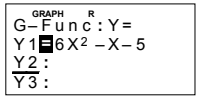
(Step 1) : While the memory area you want is underlined, press [FUNC.] 2 (Y=) to specify its graph type.

[FUNC.] 2 (Y =)



(Step 2) : Input the expression and press [EXE] to store it. The independent variable X in the function can be defined by pressing [X, T].

6 [X ,T] [X ²] [–] [X ,T] [–] 5 [EXE]



(Note): You will not be able to store the expression in an area that already contains a parametric function. Select another area to store your expression or delete the existing parametric function first. This also applies when storing inequalities.

(B) To store an inequality (Y <, Y ≤, Y ≥, Y >)

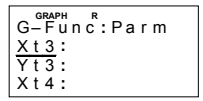
Use the same procedures as that for the an inequality. The only difference is to specify an inequality type. (Y <, Y ≤, Y ≥, Y >)

(C) To store a parametric function (Parm)

(Example): To store the following functions in memory areas Xt3 and Yt3 : X = 5 sin T , Y = 4 cos T

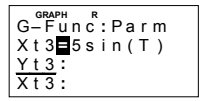
(Step 1) : While the memory area you want is underlined, press [FUNC.] 5 (Parm) to specify its graph type.

[FUNC.] 5 (Parm)

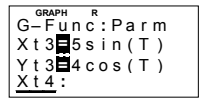


(Step 2) : Input the expression and press [EXE] to store it. The independent variable T in the function can be defined by pressing [X, T].

5 [SIN] [X ,T] [EXE]



4 [COS] [X ,T] [EXE]



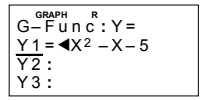
4 – 3 – 2 To Edit Functions In Memory Area

(A) To edit a function in memory

(Example): To change the expression in memory area Y1 from Y = 6 X² – X – 5 to Y = 6 X² – 4 X – 5

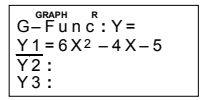
(Step 1) : While the memory area you want is underlined, press [▶] to display the cursor.

[▶]



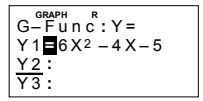
(Step 2) : Correct contents you want.

[▶] [▶] [▶] [▶] 4



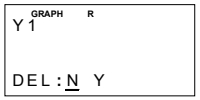
(Step 3) : Press [EXE] to store it.

[EXE]



(B) To delete a function

While the memory area you want to delete is underlined, press [DEL]. A message appears on the display to confirm whether you want to delete the function or not.



Move the cursor to " Y " to delete the function or " N " to abort the procedure without

deleting anything.

4 – 3 – 3 To Draw A Graph

Before actually drawing a graph, you should first make the draw/non-draw status.

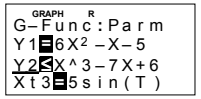
(A) To specify the draw / non-draw status of a graph

By [FUNC.] 0 (Sel), you can specify which functions out of those stored in memory should be used for a draw operation.

(Example):To select the following functions for drawing :
$Y1 = 6X^2 – X – 5$
$X_{t3} : X = 5 \sin(T)$, $Y_{t3} : Y = 4 \cos(T)$
Use the following V–Window parameters.
Xmin = – 5 , Xmax = 5 , Xscl = 1
Ymin = – 5 , Ymax = 5 , Yscl = 1
Tmin = 0 , Tmax = 6.2832 , Tptch = 0.0629

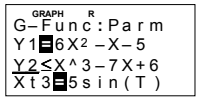
(Step 1) : Select a memory area that contains a function for which you want to specify non-draw.

[▼]



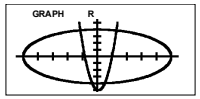
(Step 2) : Specify non-draw. The " = " symbol of the selected function becomes unlighted on the display.

[FUNC.] 0 (Sel)



(Step 3) : Press [EXE] or [FUNC.] 1 (Draw) to draws graphs.

[EXE]

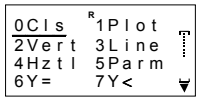


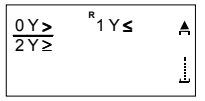
(Step 4) : Pressing [G↔T] can return to the graph function menu.

(Note): A parametric graph will appear coarse if the settings you make in the V–Window cause the pitch value to be too large, relative to the differential between the min and max settings. If the settings you make cause the pitch value to be too small relative to the differential between the min and max settings, on the other hand, the graph will take a very long time to draw.

4 – 4 Drawing Graphs Manually

In the MAIN mode, you can draw graphs manually. First press [GRAPH] to recall the graph command menu, and then input the graph function.





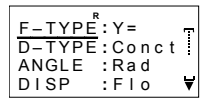
Parm... Parametric graph
Y = ... Rectangular coordinate graph
Y >... Y > f (x) inequality
Y >.... Y > f (x) inequality
Y<... Y < f (x) inequality
Y <... Y < f (x) inequality

(A) To graph using rectangular coordinates (Y =)

(Example):To graph $Y = X^3 + 3X^2 – 6X – 8$
Use the following V–Window parameters.
Xmin = – 8 , Xmax = 8 , Xscl = 2
Ymin = – 15 , Ymax = 15 , Yscl = 5

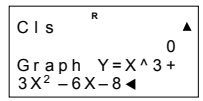
(Step 1) : In the set-up screen, specify the appropriate graph type for F-TYPE.

[2nd] [SYSTEM] (F–TYPE) [EXE] 0 (Y =)



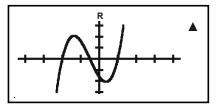
(Step 2) : Input the expression. The independent variable X in the function can be defined by pressing [X, T].

[EXIT] [GRAPH] 0 (Cls) [EXE] [GRAPH]
6 (Y =) [X , T] [^] 3 [+] 3 [X , T] [X^2] [–] 6
[X , T] [–] 8



(Step 3) : Press [EXE] to draw the graph.

[EXE]



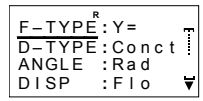
(B) Built–in graphs

This unit contains a total of 19 built–in graphs marking it possible to produce the graphs of basic functions : sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, $\sqrt{\ }$, x^2, log, ln, 10^x, e^x, x^{-1}.

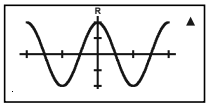
(Note): V–Window settings are automatically set to their optimum, and any graph previously on the display is cleared.

(Example):To graph the graph of cosine

[2nd] [SYSTEM] (F–TYPE) [EXE] 0 (Y =)



[EXIT] [GRAPH] 0 (Cls) [EXE] [GRAPH]
6 (Y =) [COS] [EXE]



(C) To graph parametric functions

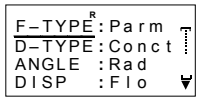
You can graph parametric functions that can be expressed in the following format.

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

(Example):To graph the following parametric functions:
f (T) = sin (2T) , g (T) = cos (3T)
Use the following V–Window parameters.
Xmin = – 1 , Xmax = 1 , Xscl = 0.5
Ymin = – 1.5 , Ymax = 1.5 , Yscl = 1
Tmin = 0 , Tmax = 6.2832 , Tptch = 0.01

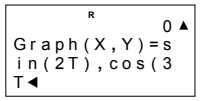
(Step 1) : In the set-up screen, specify the appropriate graph type for F–TYPE. Set the default angle unit to radians (Rad).

[2nd] [SYSTEM] (F–TYPE) [EXE] 1(Parm)



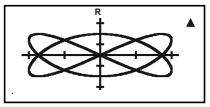
(Step 2) : Input the expression. The independent variable T in the function can be defined by pressing [X, T].

[EXIT] [GRAPH] 0 (Cls) [EXE] [GRAPH] 5
(Parm) [SIN] 2 [X , T] [▶] [,] [COS] 3
[X , T]



(Step 3) : Press [EXE] to draw the graph.

[EXE]



(D) To graph inequalities

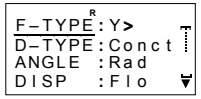
You can graph inequalities that can be expressed in the following four formats.

• y > f (x) • y < f (x) • y > f (x) • y < f (x)

(Example):To graph the inequality Y > X 2 – X – 6
Use the following V–Window parameters.
Xmin = –6 , Xmax = 6 , Xscl = 2
Ymin = – 8 , Ymax = 8 , Yscl = 2

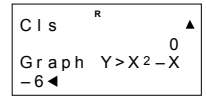
(Step 1) : In the set-up screen, specify the appropriate graph type for F-TYPE.

[2nd] [SYSTEM] (F–TYPE) [EXE] 2 (Y >)



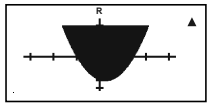
(Step 2) : Input the expression. The independent variable X in the function can be defined by pressing [X, T].

[EXIT] [GRAPH] 0 (Cls) [EXE] [GRAPH]
[GRAPH] 0 (Y >) [X , T] [X^2] [–] [X , T]
[–] 6



(Step 3) : Press [EXE] to draw the graph.

[EXE]



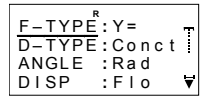
(E) Graph overdraw

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

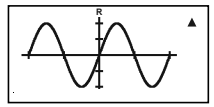
Be sure to input variable X into the second graph when using built-in graphs for overdraw. If variable X is not included in the second expression, the second graph is produced after clearing the first graph.

(Example):To overdraw for Y = cos (x) on the graph Y = sin (X)

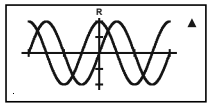
[2nd] [SYSTEM] (F–TYPE) [EXE] 0 (Y =)



[EXIT] [GRAPH] 0 (Cls) [EXE] [GRAPH] 6
(Y =) [SIN] [EXE]



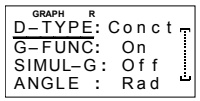
[EXIT] [GRAPH] 6 (Y =) [COS] [X, T] [EXE]



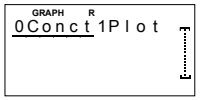
4 – 5 Other Graphing Functions

4 – 5 – 1 Graph Draw Type (D–TYPE)

In the MAIN or GRAPH mode, the graph draw type for connecting or plotting (Conct, Plot) is set by pressing [2nd] [SYSTEM] and selecting " D–TYPE " to display the menu . (The default setting is " Conct ")



[EXE]



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

Plot ... Points are plotted without being connected.

4 – 5 – 2 Graph Function Display (G–FUNC)

In the GRAPH mode, the graph function display (On, Off) is set by pressing [2nd] [SYSTEM] and selecting " G–FUNC " to display the menu . (The default setting is " On ")

[EXE]

On ... Turns on display of function during graph drawing and trace.

Off ... Turns off display of function during graph drawing and trace.

4 – 5 – 3 Simultaneous Graph Mode (SIMUL–G)

In the GRAPH mode, the simultaneous graph mode (On, Off) is set by pressing [2nd] [SYSTEM] and selecting " SIMUL–G " to display the menu. (The default setting is " Off ")

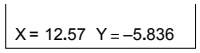
[EXE]

On ... Turns on simultaneous graphing of all functions in memory.

Off ... Simultaneous graphing off (graphs drawn one-by-one).

4 – 5 – 4 Trace

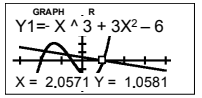
With trace, you can move a flashing pointer along a graph by the cursor keys and obtain readouts of coordinates at each point. Trace can be used only immediately after a graph is drawn. It cannot be used after changing the settings of a graph.



(Example): Use trace function to determine the points of intersection for graphs produced by the following functions:
$Y1 : Y = X^3 + 3X^2 - 6X - 8$
$Y2 : Y = - X + 2$
Use the following V–Window parameters.
Xmin = – 8 , Xmax = 8 , Xscl = 2
Ymin = – 15 , Ymax = 15 , Yscl = 5

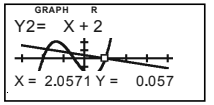
(Step 1) : After drawing the graphs, press [TRACE] to make the pointer appear at the screen. Use [▶] or [◀] to move the pointer to the first intersection.

[TRACE] [▶] ~ [▶]



(Step 2) : Use [▲] and [▼] to move the pointer between the two graphs.

[▼]



(Step 3) : To quit the trace operation, press [TRACE] again.

(Note): As you can see, the trace function can be used to move at a fixed interval and locate the pointer at an approximate point. Due to limitations caused by the resolution of the display, the actual position of the pointer can be only approximate.

4 – 5 – 5 Scroll

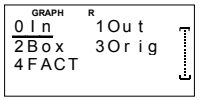
You can scroll a graph along its x– or y–axis. Each time you press [◀], [▶], [▲] or [▼], the graph scrolls in the corresponding direction.

4 – 5 – 6 Zoom

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

(A) Before using zoom

Immediately after drawing a graph, press [ZOOM] to display the Zoom menu.



In ... Enlarges graph using zoom factors

Out... Reduces graph using zoom factors

Box... Graph enlargement using zoom box **Orig**... Original size

FACT... Displays screen for specification of zoom factors

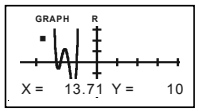
(B) To use zoom box

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

(Example): To use zoom box to enlarge a portion of the graph
Y = (X + 5) (X + 7) (X + 9) (X + 10)
Use the following V–Window parameters.
Xmin = – 20 , Xmax = 20 , Xscl = 5
Ymin = – 15 , Ymax = 15 , Yscl = 5

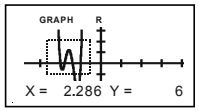
(Step 1) : After graphing the function, press [ZOOM] 2 (Box), and then use the cursor keys to move the pointer (■) to the location of one of the corners of the box you want to draw on the screen. Press [EXE] to specify the location of the corner.

[ZOOM] 2 [▲] ~ [◀] [EXE]



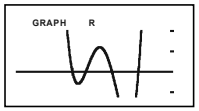
(Step 2) : Use the cursor keys to move the pointer (■) to the location of the corner that is diagonally across from the first corner.

[▶] ~ [▼]



(Step 3) : Press [EXE] to specify the location of the second corner. When you do, the part of the graph inside the box is immediately enlarged so it fills the entire screen.

[EXE]



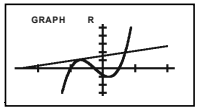
(Step 4) : To return to the original graph, press [ZOOM] 3 (Orig).

(C) To use zoom factor, zoom in, zoom out

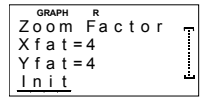
With zoom factor, you can zoom in or zoom out on the display, with the current pointer location being at the center of the new display.

(Example):To graph the below two functions, and enlarge them in order to determine whether or not they are tangential:
Y1 : $Y = X^3 + 3X^2 - 6X - 8$
Y2 : Y = 1.5 X + 17
Use the following V–Window parameters.
Xmin = – 10 , Xmax = 8 , Xscl = 4
Ymin = – 30 , Ymax = 50 , Yscl = 10

(Step 1) : After graphing the functions, press [ZOOM] 4 (FACT) to display the factor specification screen, and input the factor for the x– and y–axis. (The default setting : Xfat : 2, Yfat : 2)

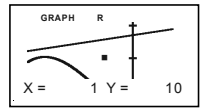


[ZOOM] 4 (FACT) 4 [EXE] 4 [EXE]



(Step 2) : Press [EXIT] 0 (In) to enlarge them. This enlarged screen makes it clear that the graphs of the two expressions are not tangential.

[EXIT] 0 (In)



(Note): The above procedure can also be used to reduce the size of a graph (zoom out). In step 2, press 1 (Out).

(D) To initialize the zoom factor

Press [ZOOM] 4 (FACT) and select " Init " to initialize the zoom factor to the default settings : Xfat : 2, Yfat : 2.

4 – 5 – 7 Sketch Function

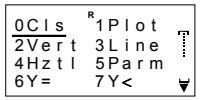
The sketch function lets you draw lines and plot points on a graph that is already on the screen.

(Note): Sketch function operation in the STAT, GRAPH or TABLE mode is different from Sketch function operation in the MAIN mode.

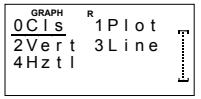
(A) Before using the sketch function

While a graph is shown on the screen, you can press [GRAPH] to display the sketch menu.

• In the MAIN mode



• In the STAT, GRAPH or TABLE mode



Cls ... Clears drawn line and point
Vert ... Vertical line
Hztl ... Horizontal line
Plot ... Displays plot menu
Line ... Displays line menu

(B) To plot points and draw a line between two plotted points

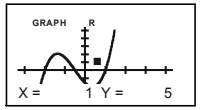
• In the STAT, GRAPH or TABLE mode

(Example):To plot two points on the graph of $Y1 = X^3 + 3X^2 - 6X - 8$ and draw a line between two plotted points
Use the following V–Window parameters.
Xmin = – 6 , Xmax = 8 , Xscl = 2
Ymin = –15 , Ymax = 25 , Yscl = 5

(Step 1) : After graphing the function, perform the following operation to let the pointer

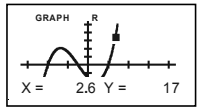
appear on the graph screen.

[GRAPH] 1 (Plot)



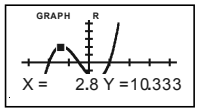
(Step 2) : Use the cursor keys to move the pointer (■) to the locations of the points you want to plot and press [EXE] to plot.

[▶] ~ [▲] [EXE]



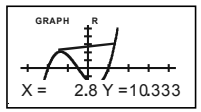
(Step 3) : Use the cursor keys to move the pointer (■) to the other point.

[◀] ~ [▼]



(Step 4) : Press [GRAPH] to display the menu and perform the following operation to draw a line between the two points.

[GRAPH] 3 (Line)



• In the MAIN mode

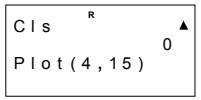
The following is the syntax for plotting points in this mode.

[GRAPH] 1 (Plot) < X-coordinate > [,] < Y-coordinate> [EXE]

(Example): To plot a point (4 , 15), use the following V–Window parameters.
Xmin = – 6 , Xmax = 8 , Xscl = 2
Ymin = –15 , Ymax = 25 , Yscl = 5

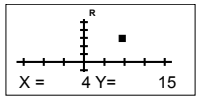
(Step 1) : Perform the following operation to let the pointer appear on the graph screen.

[GRAPH] 0 (Cls) [EXE] [GRAPH] 1 (Plot)
4 [,] 15



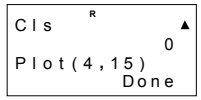
(Step 2) : Press [EXE] to plot the point.

[EXE]



(Step 3) : Pressing [G↔T] can return to the Graph Function menu.

[G↔T]



(Note): If the coordinates you specify are outside the range of the V–Window parameters, the pointer will not be shown on the display.

(C) To draw vertical and horizontal lines

• In the STAT, GRAPH or TABLE mode

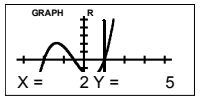
(Example): To draw a vertical and horizontal lines on the graph of $Y1 = X^3 + 3X^2 – 6X – 8$, Use the following V–Window parameters.
Xmin = – 6 , Xmax = 8 , Xscl = 2
Ymin = –15 , Ymax = 25 , Yscl = 5

(Step 1) : After graphing the function, perform the following operation to display the pointer and draw a vertical line through its current location.

[GRAPH] 2 (Vert)

(Step 2) : Use the [◀] and [▶] cursor keys to move the line left and right, and press [EXE] to draw the line at the current location.

[▶] ~ [▶] [EXE]



(Note): To draw a horizontal line, simply press 4 (Hztl) in place of 2 (Vert), and use the [▲] and [▼] cursor keys to move the horizontal line on the display.

• In the MAIN mode

The following is the syntax for plotting lines in this mode.

Vertical line : ***[GRAPH] 2 (Vert) < X–coordinate > [EXE]***

Horizontal line : ***[GRAPH] 4 (Hztl) < Y–coordinate > [EXE]***

(D) To clear drawn lines and points

The following operation clears all drawn lines and points from the screen.

• In the STAT, GRAPH or TABLE mode

Lines and points drawn using sketch menu functions are temporary. Display the sketch menu and press [GRAPH] 0 (Cls) to clear drawn lines and points, leaving only the original graph.

• In the MAIN mode

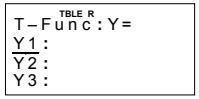
The following is the syntax for clearing drawn lines and points, as well as the graph itself.

[GRAPH] 0 (Cls) [EXE]

Chapter 5 Table Functions

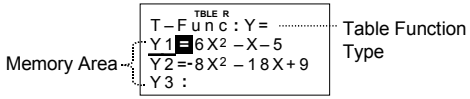
5 – 1 Before Using TABLE Mode

In the working mode menu, select the TABLE item to enter the TBLE mode. When you do, a table home screen appears on the display.



5 – 2 Storing A Function

You can store up to 20 table functions to the memory areas Y1 through Y20. Functions in memory can be edited, recalled, and graphed.

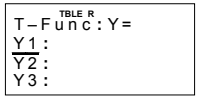


If the " = " symbol becomes " -= " , " -=- " or " =- ", it means there are more entries hidden the right or left of the screen, or both. Pressing [◀] or [▶] can move the cursor through an entry.

(Example): To store the function Y = 6 X² – X – 5 in memory area Y1

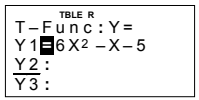
(Step 1) : Use [▼] and [▲] to make the memory area where you want underlined.

[▲] ~ [▲]



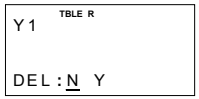
(Step 2) : Next, input the function and press [EXE] to store it.

6 [X,T] [X²] [–] [X,T] [–] 5 [EXE]



5 – 3 Deleting A Function

Use [▲] and [▼] to make a memory area where you want underlined, then press [DEL]. A message appears on the display to confirm whether you want to delete the function or not.



Move the cursor to " **Y** " to delete the function or " **N** " to abort the procedure without deleting anything.

5 – 4 Assigning Values To A Variable

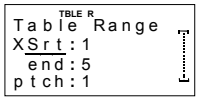
Before generating a table, you must first assign values to a variable. You can use either one of the below two methods :

- Automatic assignment within a specified range
- Assignment of values from a list.

The default method is automatic assignment within a specified range.

(A) To assign values automatically within a specified range

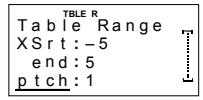
Before generating a table, press [FUNC.] 2 (RANGE) to display the table range menu.



Srt ... Variable X start value **end** ... Variable X end value
ptch ... Variable X pitch value

(Example):To assign values from – 5 to 5, in increments of 1 (eleven values total)

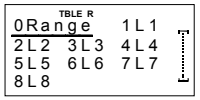
[FUNC.] 2 (RANGE) [(–)] 5 [EXE] 5 [EXE]
1 [EXE]



(B) To assign values from a list

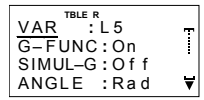
The method for assigning values from a list (L1~ L8) is set by pressing [2nd] [SYSTEM] and selecting " VAR " to display the menu. (The default setting is " Range ")

[EXE]



(Example): To assign values from L5

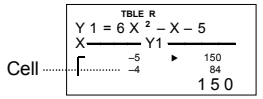
[2nd] [SYSTEM] (VAR) [EXE] 5 (L5)



(Note): After making a list for assigning selected, pressing [FUNC.] 2 (RANGE) becomes inactive.

5 – 5 Generating A Numeric Table

The below is the display for a generated numeric table :



- Each cell can hold up to six digits.(negative sign, decimal point or exponential symbol takes up one digit)
- The value contained in the currently selected cell appears at the bottom of the display.

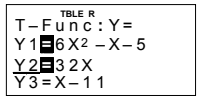
• You can use [◀] [▶] to move between columns, and [▲] [▼] to move between cells inside of a table. The screen automatically scrolls when the cursor is located at the edge of the screen.

Before actually generating a numeric table, you must first select the functions you want to use.

Use the [▲] and [▼] cursor keys to move the cursor to the function you want to use. Press [FUNC.] 0 (Sel) to highlight the " = " symbol for a selected function or abort the highlighted one for non–selected functions. You can select more than one function for a numeric table generation.

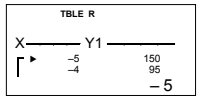
(Example): Use the following functions to generate a numeric table.
$Y1 = 6X^2 - X - 5$
$Y2 = 32X$
Use the following Range parameters.
Srt = – 5, end = 5, ptch = 1

(Step 1) : After storing the functions, specify the draw / non–draw status of a functions. In this display, Y1 and Y2 are selected.



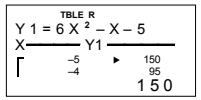
(Step 2) : Press [FUNC.] 1 (Table) or [EXE] to generate a numeric table. This display shows the generated numeric table.

[FUNC.] 1 (Table)

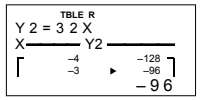


(Step 3) : You can move the cursor around the table using the cursor ([◀] [▶] [▲] [▼]) keys. Moving the cursor off the screen causes the table to scroll when there are cells off the top, bottom, left, or right .

[▶]

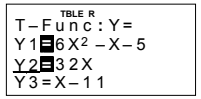


[▶] [▼] [▼]



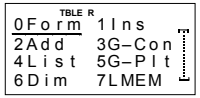
(Step 4) : To return to the T – Func list, press [FUNC.] 0 (Form).

[FUNC.] 0 (Form)



5 – 6 Editing A Table

After generating a numeric table, you can add, insert or delete lines from an existing table by pressing [FUNC.]



Ins ... Inserts new line where cursor is located.

Add ... Insert new line below line where cursor is located.

To delete a line where cursor is located, press [DEL].

5 – 7 Graphing A Function

You can use the two following function to produce a graph using the numeric table currently on the screen.

G–Con ... Graph with connected plot points

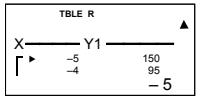
G–Plt ... Graph with plotted points

Graphing a table whose values were generated using more than one function causes the graphs of all the functions to be drawn at the same time. You can set x– and y–axis parameters using the View Window.

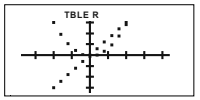
Press [G↔T] to return to the numeric table screen from a graph. You can use [G↔T] to switch between the graph and its table as long as you do not clear the graph.

To return to the table home screen, press [2nd] [QUIT].

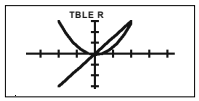
(Example): To graph the function $Y1 = 6X^2 - X - 5$ and $Y2 = 32X$, whose table of numeric values are currently on the screen
Use the following range and V–Window parameters.
Srt = – 5, end = 5, ptch = 1
Xmin = – 10 , Xmax = 10 , Xscl = 2.5
Ymin = – 150 , Ymax = 150 , Yscl = 50



[FUNC.] 5 (G–Plt)



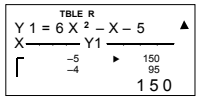
[FUNC.] 3 (G–Con)



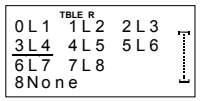
5 – 8 Assigning Numeric Table Contents To A List

You can assign a column of values from a table into a specified list. Simply use [◀] and [▶] to move the cursor into the column whose values you want to copy. The cursor can be in any row of the column. The copy operation is performed by pressing [FUNC.] 7 (LMEM).

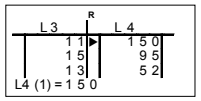
(Example):To copy all values in Y1 column to L4



[FUNC.] 7 (LMEM) [▼]



[EXE] [MODE] 4 [▶] [▶] [▶]

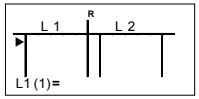


(Note): When you assign numeric table contents to a list which has stored numbers, the previous contents of the list will be replaced.

Chapter 6 List Functions

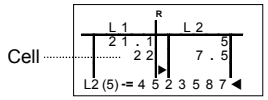
6 – 1 Before Using The List Mode

In the working mode menu, select the LIST item to enter the LIST mode. When you do, the display for inputting data into a list is on the screen.



6 – 2 Assigning Values To A List

A list is a kind of container that you can use to store multiple data items. This calculator lets you have up to eight lists (L1 ~ L8) in memory, and each lists can use up to 256 cells. Their contents can be used in arithmetic calculations, statistical calculations and for graphing.



- Each cell can hold up to six digits.(negative sign, decimal point or exponential symbol takes up one digit)
- The value contained in the currently selected cell appears at the bottom of the display.
- You can use [◀] [▶] to move between lists, and [▲] [▼] to move between cells inside of a list. The screen automatically scrolls when the cursor is located at the edge of the screen.

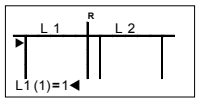
If the " = " symbol becomes " -= " , " -=- " or " =- ", it means there are more entries hidden the right or left of the screen, or both. Pressing [◀] or [▶] can move the cursor through an entry.

6 – 2 – 1 To Input Values One–By–One

(Example):To assign values { 1 , 2 , 3 } to the L1 Cells

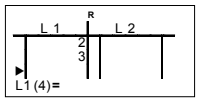
(Step 1) : Input a value.

1



(Step 2) : Press [EXE] to store it in the list. The cursor automatically moves down to the next cell for input. Continue to input the values 2 and 3.

[EXE] 2 [EXE] 3 [EXE]

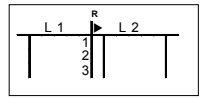


6 – 2 – 2 To Batch Input A Series Of Values

(Example):To input the following series of values to the L2 Cells { 5 , 6 , 7 , 8 }

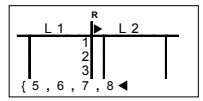
(Step 1) : Use the cursor keys to move the pointer to the list name.

[▶]



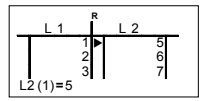
(Step 2) : Press [2nd] [**{ }**], and then input the values you want, Remember to press [,] between each one.

[2nd] [**{ }**] 5 [,] 6 [,] 7 [,] 8



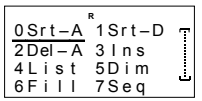
(Step 3) : Press [EXE] to store all of the values in your list.

[EXE]



6 – 3 Editing And Rearranging Lists

After inputting, pressing [FUNC.] can display the menu to edit and rearrange lists.



Srt – A ... Sort lists into ascending order
Srt – D ... Sort lists into descending order
Del – A ... Delete all cells in a list
Ins ... Insert a new cell

6 – 3 – 1 To Edit List Values

(A) To change a cell value

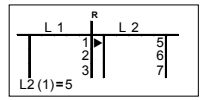
Use [◀] or [▶] to move the cursor to the cell whose value you want to change. Input the new value and press [EXE] to replace the old data with the new one.

(B) To delete a cell

(Example): To delete L2 (1) = 5

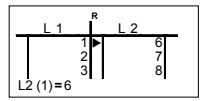
(Step 1) : Use the cursor keys to move the pointer to the cell you want to delete.

[▶]



(Step 2) : Press [DEL] to delete the selected cell and everything below it is shifted up.

[DEL]



(Note): The above cell delete operation does not affect cells in other lists. If the data in the list whose cell you delete is somehow related to the data in neighboring lists,

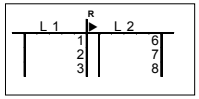
deleting a cell can cause related values to become misaligned.

(C) To delete all cells in a list

(Example): To delete all cells in L2

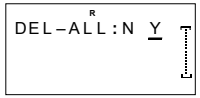
(Step 1) : Use the cursor keys to move the pointer to the name of the list whose cells you want to delete.

[▶]



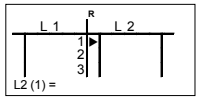
(Step 2) : Press [FUNC.] 2 (Del – A). It changes to confirm whether you really want to delete all the cells in the list. Select " Y " to delete or " N " to abort the operation without deleting anything.

[FUNC.] 2 (Del – A) [▶]



(Step 3) : Press [EXE] to delete all the cells in the L2

[EXE]

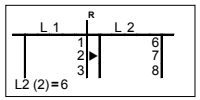


(D) To insert a new cell

(Example): To insert a new value 6.5 to L2 (2)

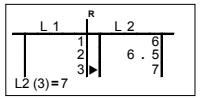
(Step 1) : Use the cursor keys to move the pointer to the location where you want to insert.

[▼]



(Step 2) : Press [FUNC.] 3 (Ins), input the value and press [EXE]. Everything below it is shifted down.

[FUNC.] 3 (Ins) 6.5 [EXE]



(Note):The above cell insert operation does not affect cells in other lists. If the data in the list where you insert a cell is somehow related to the data in neighboring lists, inserting a cell can cause related values to become misaligned.

6 – 3 – 2 To Sort List Values

You can sort lists into either ascending order or descending order. The current cursor location does not matter in the following procedures.

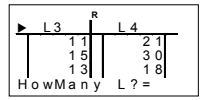
(A) To sort a single list

• Ascending order

(Example): To sort the cells in the L3 (11, 15, 13) into ascending order.

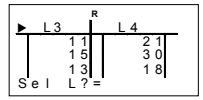
(Step 1) : While the lists are on the screen, press [FUNC.] 0 (Srt–A). The prompt " HowMany L ? = " appears to ask how many lists you want to sort.

[FUNC.] 0 (Srt – A)



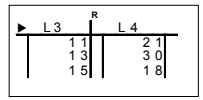
(Step 2) : Input 1 to indicate we want to sort only one list. In response to the " Sel L ? =" prompt, it asks you to select the list you want to sort.

1 [EXE]



(Step 3) : Here we will input 3 to specify sorting of List 3. The values in List 3 are sorted into ascending order.

3 [EXE]



• Descending order

Use the same procedure as that for the ascending order sort. The only difference is that you should press 1 (Srt–D) in place of 0 (Srt–A).

(B) To sort multiple lists

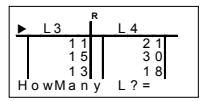
You can link multiple lists together for a sort so that all of their cells are rearranged in accordance with the sorting of a base list. The base list is sorted into either ascending order or descending order, while the cells of the linked lists are arranged so that the relative relationship of all the rows is maintained.

• Ascending order

(Example):To sort the cells in the L3 (11, 15, 13) into ascending order and rearrange the cells in the L4 (21, 30, 18)

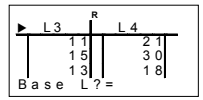
(Step 1) : While the lists are on the screen, press [FUNC.] 0 (Srt–A). The prompt " HowMany L ? = " appears to ask how many lists you want to sort.

[FUNC.] 0 (Srt – A)



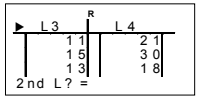
(Step 2) : We want to sort one base list linked to one other list, so input 2. In response to the " Base L ? = " prompt, it asks you to select the base list you want to sort.

2 [EXE]



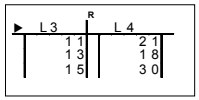
(Step 3) : Input 3 to specify the base list. In response to the " 2nd L ? = " prompt, it asks you to select the list you want to link to the base list.

3 [EXE]



(Step 4) : Here we will specify List 4. The values in List 3 are sorted into ascending order, and the cells of List 4 are also rearranged to keep the same relationship with the List 3 cells.

4 [EXE]



• Descending order

Use the same procedure as that for the ascending order sort. The only difference is that you should press 1 (Srt–D) in place of 0 (Srt–A).

6 – 4 Manipulating List Data

List data can be used in arithmetic and function calculations. There is also a collection of powerful list data manipulation functions that let you do the following.

- Count the dimension in a list (Dim)
- Replace all cell values with the same value (Fill)
- Generate a sequence of numbers (Seq)
- Find the minimum value in a list (Min)
- Find the maximum value in a list (Max)
- Find which of two lists contains the minimum value (Min)
- Find which of two lists contains the maximum value (Max)
- Calculate the average of list values (Avg)
- Calculate the average of values of specified frequency (Avg)
- Calculate the median of values in a list (Med)
- Calculate the median of values of specified frequency (Med)
- Calculate the sum of values in a list (Sum)

You can use list data manipulation functions in the MAIN, STAT, LIST, TABLE, or PROG mode.

All of the following examples are performed after entering the MAIN mode.

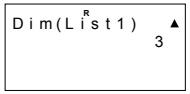
(A) To count the number of values (Dim)

[FUNC.] 1 (Dim) [FUNC.] 0 (List) < list number 1–8 > [EXE]

• The number of cells that contain data in a list is called its " Dimension.(Dim)"

(Example):To count the number of values in List 1 (1, 2 , 3)

[ON/CL] [FUNC.] 1 (Dim) [FUNC.] 0 (List) 1
[EXE]



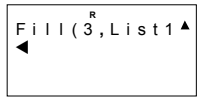
(B) To replace all cell values with the same value (Fill)

[FUNC.] 2 (Fill) < value > [,] [FUNC.] 0 (List) < list number 1–8 > [EXE]

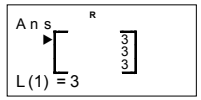
(Note) : The result of this operation is also stored in Ans Memory.

(Example):To replace all values in List 1 (1, 2, 3) with 3

[ON/CL] [FUNC.] 2 (Fill) 3 [,] [FUNC.] 0
(List) 1



[EXE]



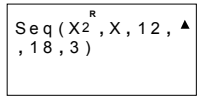
(C) To generate a sequence of numbers (Seq)

[FUNC.] 3 (Seq) < expression > [,] < variable name > [,] < start value > [,] < end value > [,] < pitch value > [EXE]

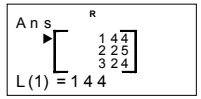
(Note): The result of this operation is also stored in Ans Memory.

(Example): To input the number sequence 12^2 , 15^2 , 18^2 into a list
Use the following settings.
Variable : x Starting value : 12
Ending value : 18 Pitch value : 3

[ON/CL] [FUNC.] 3 (Seq) [X , T] [X^2] [,]
[X , T] [,] 12 [,] 18 [,] 3



[EXE]

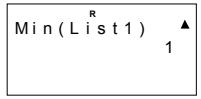


(D) To find the minimum value in a list (Min)

[MATH] 0 (Min) [FUNC.] 0 (List) < list number 1 > [EXE]

(Example):To find the minimum value in List 1 (1 , 2 , 3)

[ON/CL] [MATH] 0 (Min) [FUNC.] 0 (List) 1
[EXE]



(E) To find the maximum value in a list (Max)

Use the same procedure as when finding the minimum value, except press 1 (Max) in place of 0 (Min).

(F) To find which of two lists contains the minimum value (Min)

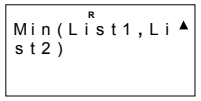
[MATH] 0 (Min) [FUNC.] 0 (List) < list number 1–8 > [,] [FUNC.] 0 (List) < list number 1 > [EXE]

The two lists must contain the same number of values. If they don't, an error occurs.

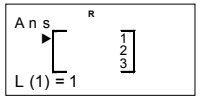
(Note) : The result of this operation is also stored in Ans Memory.

(Example):To find whether List 1 (1, 2, 3) or List 2 (5, 6, 7) contains the minimum value

[ON/CL] [MATH] 0 (Min) [FUNC.] 0 (List) 1
[,] [FUNC.] 0 (List) 2



[EXE]



(G) To find which of two lists contains the maximum value (Max)

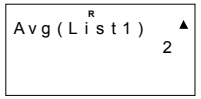
Use the same procedure as that for the minimum value, except press 1 (Max) in place of 0 (Min).

(H) To calculate the average of list values (Avg)

[MATH] 4 (Avg) [FUNC.] 0 (List) < list number 1–8 > [EXE]

(Example):To calculate the average of values in List 1 (1, 2, 3)

[ON/CL] [MATH] 4 (Avg) [FUNC.] 0 (List) 1
[EXE]



(I) To calculate the average of values of specified frequency (Avg)

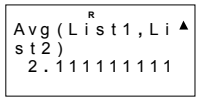
[MATH] 0 (Avg) [FUNC.] 0 (List) < list number 1 (data) > [,] [FUNC.] 0 (List) < list number 1 (frequency) > [EXE]

This procedure uses two lists : one that contains values and one that contains the frequency of each value.

The two lists must contain the same number of values. If they don't, an error occurs.

(Example):To calculate the mean of values in List 1 (1 , 2 , 3), whose frequency is indicated by List 2 (5 , 6 , 7)

[ON/CL] [MATH] 4 (Avg) [FUNC.] 0 (List) 1
[,] [FUNC.] 0 (List) 2 [EXE]

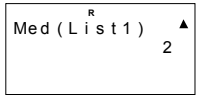


(J) To calculate the median of values in a list (Med)

[MATH] 2 (Med) [FUNC.] 0 (List) < list number 1 > [EXE]

(Example):To calculate the median of values in List 1 (1 , 2 , 3)

[ON/CL] [MATH] 2 (Med) [FUNC.] 0 (List) 1
[EXE]



(K) To calculate the median of values of specified frequency (Med)

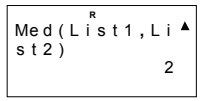
[MATH] 2 (Med) [FUNC.] 0 (List) < list number 1 (data) > [,] [FUNC.] 0 (List) < list number 1 (frequency) > [EXE]

This procedure uses two lists: one that contains values and one that contains the frequency of each value.

The two lists must contain the same number of values. If they don't, an error occurs.

(Example): To calculate the median of values in List 1 (1 , 2 , 3), whose frequency is indicated by List 2 (5 , 6 , 7)

[ON/CL] [MATH] 2 (Med) [FUNC.] 0 (List) 1
[,] [FUNC.] 0 (List) 2 [EXE]

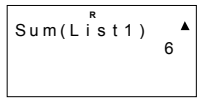


(L) To calculate the sum of values in a list (Sum)

[MATH] 3 (Sum) [FUNC.] 0 (List) < list number 1 > [EXE]

(Example):To calculate the sum of values in List 1 (1 , 2 , 3)

[ON/CL] [MATH] 3 (Sum) [FUNC.] 0 (List) 1
[EXE]



6 – 5 Arithmetic Calculations Using Lists

You can perform arithmetic calculations using two lists or one list and a numeric value.

List Numeric Value { + , − , x , ÷ } List Numeric Value = (List)

A calculation involving two lists performs the operation between corresponding cells. Because of this, an error occurs if the two lists do not have the same number of values.

6 – 5 – 1 To Input A List Into A Calculation

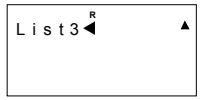
There are two methods you can use to input a list into a calculation.

(A) To input a specific list by name

Press [FUNC.] 0 (List) and input the number of the list you want to specify.

(Example):To input List 3

[FUNC.] 0 (List) 3

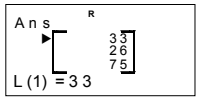


(B) To directly input a list of values

You can also directly input a list of values using [2nd] [{ }] , and [,]. The resulting list is stored in Ans Memory.

(Example):To multiply List 3 (11 , 13 , 15) by the List (3 , 2 , 5)

[ON/CL] [FUNC.] 0 (List) 3 [x] [2nd] [{ }] 3
[,] 2 [,] 5 [EXE]

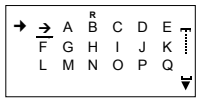


(C) To assign the contents of one list to another list

Use " ➔ " to assign the contents of one list to another list.

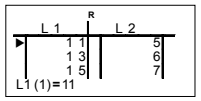
(Example):To assign the contents of List 3 (11 , 13 , 15) to List 1

[FUNC.] 0 (List) 3 [SAVE]



[EXE] [FUNC.] 0 (List) 1 [EXE]

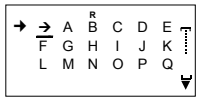
[MODE] 4



(Note): In place of [FUNC.] 0 (List) 3 operation in the above procedure, you could input [2nd] [{ }] 11 [,] 13 [,] 15 [▶].

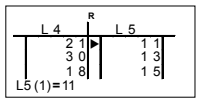
(Example):To assign the list (11 , 13 , 15) in Ans Memory to List 5

[FUNC.] 0 (List) [2nd] [Ans] [SAVE]



[EXE] [FUNC.] 0 (List) 5 [EXE]

[MODE] 4 [▶] [▶] [▶] [▶]

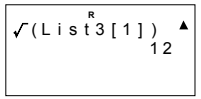


(D) To input a single list cell value into a calculation

You can extract the value in a specific cell of a list and use it in a calculation. Specify the cell number by enclosing it between square brackets([ ]).

(Example):To calculate the square root of the value stored in L3(1) = 144

[√] [FUNC.] 0 (List) 3 [2nd] [[ ]] 1 [EXE]

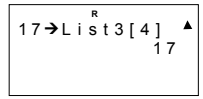


(E) To replace a specific cell

You can replace a specific cell inside a list. When you do, the value that was previously stored in the cell is replaced with the new value you input.

(Example):To replace the cell 4 of List 3 as the value 17

[ON/CL] 17 [SAVE] (➔) [EXE] [FUNC.] 0
(List) 3 [2nd] [[ ]] 4 [EXE]



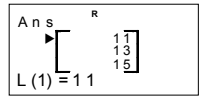
6 – 5 – 2 To Recall List Contents

(A) To recall a specific list by name

Press [FUNC.] 0 (List) and input the number of the list you want to recall. The operation displays the contents of the list you specify and also stores them in Ans Memory. You can then use the Ans Memory contents in a calculation.

(Example):To recall the contents of List 3 (11, 13, 15)

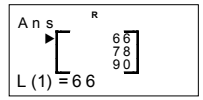
[FUNC.] 0 (List) 3 [EXE]



(B) To use list contents in Ans Memory in a calculation

(Example):To multiply the list contents in Ans Memory by 6

[FUNC.] 0 (List) [2nd] [Ans] [x] 6 [EXE]

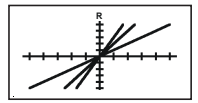


6 – 5 – 3 To Graph A Function Using A List

When using the graphing functions of this calculator, you can input a function such as Y1 = List1 X. If List 1 contains the values 1, 2, 3, this function will produces three graphs: Y = X, Y = 2 X, Y = 3 X.

(Example):Use the following V–Window parameters to graph Y1 = List1 X, where List1 (1 , 2 , 3).
Xmin = – 10 , Xmax = 10 , Xscl = 2
Ymin = – 10 , Ymax = 10 , Y scl = 2

[GRAPH] 0 (Cls) [EXE] [GRAPH] 6 (Y =)
[FUNC.] 0 (List) 1 [X , T] [EXE]



6 – 5 – 4 To Input Scientific Calculations Into A List

You can use the numeric table in the TABLE mode to input values that result from certain scientific function calculations into a list. To do this, first generate a table and then use

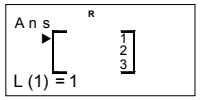
the list copy function to copy the values from the table to the list. See« 5 – 8 Assigning Numeric Table Contents To A List ».

6 – 5 – 5 To Perform Scientific Function Calculations Using A List

Lists can be used just as numeric values are in scientific function calculations. When the calculation produces a list as a result, the list is stored in Ans Memory.

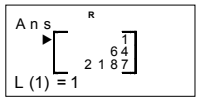
(Example):To use List 3 (10 , 100 , 1000) to perform log (List 3)

[LOG] [FUNC.] 0 (List) 3 [EXE]



(Example):To use List 1 (1 , 2 , 3) and List 2 (5 , 6 , 7) to perform List1 List2 (This creates a list with the results of 1^5 , 2^6 , 3^7)

[FUNC.] 0 (List) 1 [^] [FUNC.] 0 (List) 2 [EXE]



Chapter 7 Base-n Mode Calculations

7 – 1 Before Beginning A Binary, Octal, Decimal, Or Hexadecimal Calculation

You can use the Base–n mode to perform calculations for binary, octal, decimal and hexadecimal values. You can also convert between number systems and perform logical operations.

If you attempt to enter a value that is invalid for the number system (binary, octal, decimal, hexadecimal) you are using, the calculator will display an error message (SYNTAX Er).

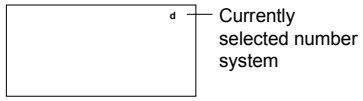
The following shows the numerals that can be used in each number system.

Binary base : 0, 1
Octal base : 0, 1, 2, 3, 4, 5, 6, 7
Decimal base : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9
Hexadecimal base : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, /A, IB, IC, ID, IE, IF

In the Base–n mode, you can enter the alphabetic characters (/A, IB, IC, ID, IE, IF) used in the hexadecimal number by pressing [A] ~ [F]. The alphabetic characters (/A, IB, IC, ID, IE, IF) appear differently on the display to distinguish them from text characters.

Normal Text : A, B, C, D, E, F
Hexadecimal Values: /A, IB, IC, ID, IE, IF

Select the Base–n mode in the working mode to enter the Base–n mode. When you do, the screen appears the below screen.



(A) To specify a current number system

Press [2nd] [SYSTEM] to display the menu.

Dec ... Specify decimal as default
Bin ... Specify binary as default
Hex ... Specify hexadecimal as default
Oct ... Specify octal as default

(B) To specify a number system for value for an input

Press [dhbo] to display a menu of number system symbols.

d ... Specify Decimal base for input value
h ... Specify Hexadecimal base for input value
b ... Specify Binary base for input value
o ... Specify Octal base for input value

Use them to specify a number system for each individual value you input.

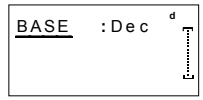
(C) Number of digits displayed in each number system

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

7 – 2 Converting A Displayed Value From One Number System To Another

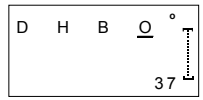
(Example):To convert " 1 IF_{16} " to its decimal, and octal, when the default number system is decimal.

[2nd] [SYSTEM] [EXE] 0 (Dec)



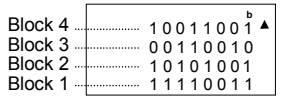
[EXIT] [dhbo] 1 (h) 1 [F] [EXE]

[dhbo] [▶] [▶] [▶]

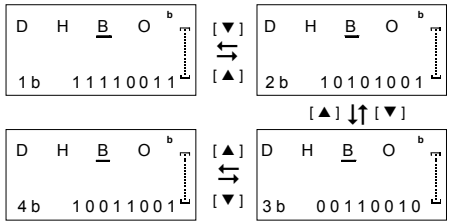


7 – 3 Block Function

For a result in binary base, which exceeds 8 digits, it will be displayed using block function. The maximum of 32 digits is displayed in 4 blocks of 8 digits.



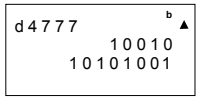
In the binary mode, the block 1(1b) is displayed immediately after calculation. Other blocks (2b ~ 4b) are displayed by pressing [▲]. To reverse the order (shift from the block 4 to the block 1), press [▼]



(Example): 4777_{10} = 1001010101001_{2}

[2nd] [SYSTEM] [EXE] 2 (Bin)

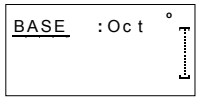
[EXIT] [dhbo] 0 (d) 4777 [EXE]



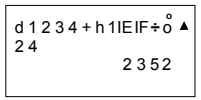
7 – 4 Arithmetic Operations

(Example): To calculate " 1234_{10} + $1IEIF_{16}$ ÷ 24_{8} " and display the result as an octal value

[2nd] [SYSTEM] [EXE] 3 (Oct)

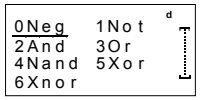


[EXIT] [dhbo] 0 (d) 1234 [+] [dhbo] 1 (h) 1
[E] [F] [÷] [dhbo] 3 (o) 24 [EXE]



7 – 5 Negative Values And Logical Operations

While binary, octal, decimal, or hexadecimal is set as the default number system, press [2nd] [TEST] to display a menu of negation and logical operators.

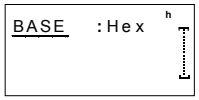


Neg ... Negation **Not** ... Logical NOT **And** ... Logical AND
Or ... Logical OR **Nand** ... Logical NAND **Xor** ... Logical XOR
Xnor ... Logical XNOR

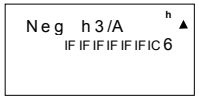
(A) Negative Values

(Example): To determine the negative of $3/A_{16}$

[2nd] [SYSTEM] [EXE] 1 (Hex)



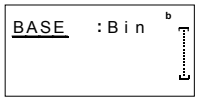
[EXIT] [2nd] [TEST] 0 (Neg) [dhbo] 1 (h) 3 [A] [EXE]



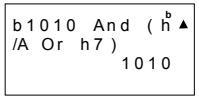
(B) Logical Operations

(Example): To display the result of " 1010_{2} And (A_{16} Or 7_{16}) " as an binary value

[2nd] [SYSTEM] [EXE] 2 (Bin)



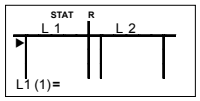
[EXIT] [dhbo] 2 (b) 1010 [2nd] [TEST] 2 (And)
[( )] [dhbo] 1 (h) [A] [2nd] [TEST] 3 (Or)
[dhbo] 1 (h) 7 [EXE]



Chapter 8 Statistical Calculations And Graphs

8 – 1 Before Performing Statistical Calculations

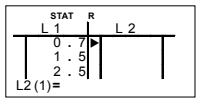
In the working mode menu, select the STAT item to enter the STAT mode. When you do, a statistical data list appears on the display.



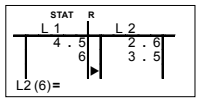
You can use the statistical data list to input data and to perform statistical calculations and graphs.

(Example): To input the following two data groups
List 1 (0.7 , 1.5 , 2.5 , 4.5 , 6)
List 2 (– 2.5 , 0.5 , 1.8 , 2.6 , 3.5)

0.7 [EXE] 1.5 [EXE] 2.5 [EXE] 4.5 [EXE] 6 [EXE] [▶]

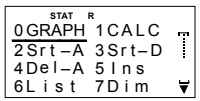


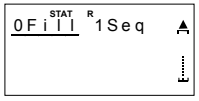
[(–)] 2.5 [EXE] 0.5 [EXE] 1.8 [EXE] 2.6 [EXE] 3.5 [EXE]



The STAT mode uses the same data lists that the LIST mode uses, so there is no need to input the same data in different modes.

Press [FUNC.] to display the below menus.





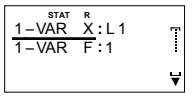
GRAPH ... Graph menu
CALC ... Statistical calculation menu
Srt – A ... Ascending sort
Srt – D ... Descending sort
Del – A ... Delete all cells in a list
Ins ... Insert a new cell
List ... Input a specific list by name
Dim ... Count the dimension in a list
Seq ... Generate a sequence of numbers
Fill ... Replace all cell values with the same value

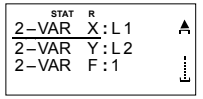
The procedures you should use for data editing and rearranging are identical to those you use with the list function. For details, see « Chapter 6 List Functions » .

8 – 2 Specifying Statistical Data And Parameters

(A) To specify statistical data

You have to input the statistical data for the calculation or graph you want to perform and specify where it is located before you start a calculation or graph. While the statistical data list is on the display, press [FUNC.] 1 (CALC) 9 (SET) to display the following menus.



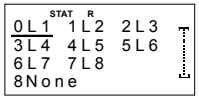


1–VAR X ... Specify list for 1–VAR data
1–VAR F ... Specify list for 1–VAR frequency values
2–VAR X ... Specify list for 2–VAR statistical data
2–VAR Y ... Specify list for 2–VAR statistical data
2–VAR F ... Specify list for 2–VAR frequency values

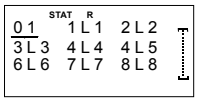
The initial default settings for statistical data list are List 1 for single-variable statistical data, List 1 and List 2 for paired-variable statistical data, 1 for the frequency value.

You can specify which statistical data list for 1–VAR X / 2–VAR X / 2–VAR Y, or which values for 1–VAR F / 2–VAR F. Use [▲] and [▼] to make a item you want underlined, and press [EXE]. From the following menus, you can specify the name of the statistical data list you want .

(1–VAR X / 2–VAR X / 2–VAR Y)



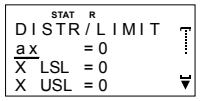
(1–VAR F / 2–VAR F)

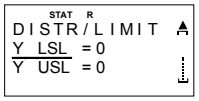


L1 ~ L8 ... List 1~ List 8 **None** ... None of the lists **1** ... Plot all data (1–to–1)

(B) To set parameters for normal distribution and process capability

For normal distribution and process capability, you need to input the following parameters. While the statistical data list is on the display, press [FUNC.] 1 (CALC) 8 (L/D SET) to display the following menus.



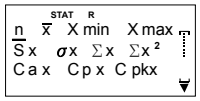


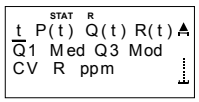
ax ... Specify a random value in the normal distribution
X LSL ... Specify a lower specification limit value for x–data
X USL ... Specify an upper specification limit value for x–data
Y LSL ... Specify a lower specification limit value for y–data
Y USL ... Specify an upper specification limit value for y–data

8 – 3 Performing Statistical Calculations

8 – 3 – 1 Single–Variable Statistical Calculation

Pressing [FUNC.] 1 (CALC) 0 (1–VAR) can display the result menus of the single–variable statistical calculation.





n ... Number of data items **x** ... Mean of x–data
X min ... Minimum of x–data **X max** ... Maximum of x–data
Sx ... Sample standard deviation for x–data
σx ... Population standard deviation for x–data
Σx ... Sum of data for x–data **Σx²** ... Sum of squares for x–data

Cax ... Capability accuracy for x–data, $C_{ax} = \dfrac{\left|\left(\frac{x_{USL}+x_{LSL}}{2} - \bar{x}\right)\right|}{\frac{x_{USL}-x_{LSL}}{2}}$

Cpx ... Potential capability precision for x–data, $C_{px} = \dfrac{x_{USL}-x_{LSL}}{6\sigma_x}$

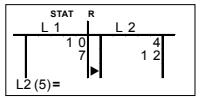
Cpkx ... Minimum (C_{PU}, C_{PL}) for x–data, where C_{PU} is upper specification limit of capability precision and C_{PL} is lower specification limit of capability precision
C_{pkx} = Min (C_{PUX}, C_{PLX}) = C_{px}(1–C_{ax})

t ... Test value
P(t) ... Represent the cumulative fraction of the standard normal distribution that is less than the value t
R(t) ... Represent the cumulative fraction of the standard normal distribution that lies between the value t and 0 R (t) = 1 – P (t)
Q(t) ... Represent the cumulative fraction of the standard normal distribution that is greater than the value t Q (t) = | 0.5 – R (t) |
Q1 ... First quartile **Med** ... Median
Q3 ... Third quartile **Mod** ... Mode
CV ... Coefficient of variation **R** ... Range
ppm ... Parts per million, Defection Per Million Opportunities

(Example):To find out n , Cax , Q (t) , Mod,
Use the following SET and L/ D SET parameters.
1–VAR X = L1 , where List 1 (3 , 2 , 10 , 7)
1–VAR F = L2 , where List 2 (5 , 9 , 4 , 12)
ax = 6 , X LSL= 1 , X USL= 13

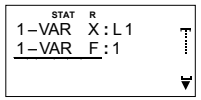
(Step 1) : Input the List 1 and List 2 data groups.

3 [EXE] 2 [EXE] 10 [EXE] 7 [EXE] [▶] 5
[EXE] 9 [EXE] 4 [EXE] 12 [EXE]

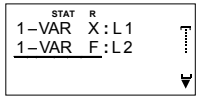


(Step 2) : Specify statistical data lists to 1–VAR X and 1–VAR F

[FUNC.] 1 (CALC) 9 (SET) [▼]

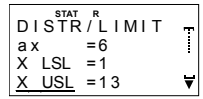


[EXE] 2 (L2)



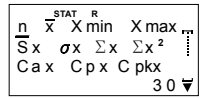
(Step 3) : Specify values to ax, X LSL, X USL

[EXIT] 8 (L/D SET) 6 [EXE] 1 [EXE] 13 [EXE]

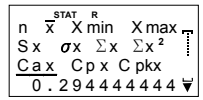


(Step 4) : Press [FUNC.] 1 (CALC) 0 (1–VAR) to display the result menus and you can use the cursor keys to view variable characteristics.

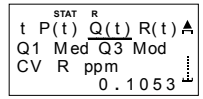
[EXIT] 0 (1–VAR)



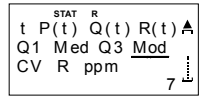
[▼] [▼]



[▼] [▶] [▶]

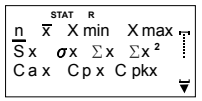


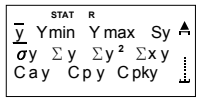
[▶] [▶] [▶] [▶] [▶]



8 – 3 – 2 Paired–Variable Statistical Calculation

Pressing [FUNC.] 1 (CALC) 1 (2–VAR) can display the result menus of the paired–variable statistical calculation.





n ... Number of data items **x** ... Mean of x–data
X min ... Minimum of x–data **X max** ... Maximum of x–data
Sx ... Sample standard deviation for x–data
σx ... Population standard deviation for x–data
Σx ... Sum of data for x–data **Σx²** ... Sum of squares for x–data

Cax ... Capability accuracy for x–data, $C_{ax} = \dfrac{\left|\left(\frac{x_{USL}+x_{LSL}}{2} - \bar{x}\right)\right|}{\frac{x_{USL}-x_{LSL}}{2}}$

Cpx ... Potential capability precision for x–data, $C_{px} = \dfrac{x_{USL}-x_{LSL}}{6\sigma_x}$

Cpkx ... Minimum (C_{PU}, C_{PL}) for x–data, where C_{PU} is upper specification limit of capability precision and C_{PL} is lower specification limit of capability precision
C_{pkx} = Min (C_{PUX}, C_{PLX}) = C_{px}(1 – C_{ax})

y ... Mean of y–data **Y min** ... Minimum of y–data
Y max ... Maximum of y–data **Sy** ... Sample standard deviation for y–data

σy ... Population standard deviation for y–data
Σy ... Sum of data for y–data **Σxy** ... Sum of x • y
Σy² ... Sum of squares for y–data

Cay ... Capability accuracy for y–data, $C_{ay} = \dfrac{\left|\left(\frac{y_{USL}+y_{LSL}}{2} - \bar{y}\right)\right|}{\frac{y_{USL}-y_{LSL}}{2}}$

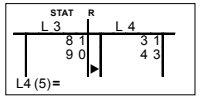
Cpy ... Potential capability precision for y–data, $C_{py} = \dfrac{y_{USL}-y_{LSL}}{6\sigma_y}$

Cpky ... Minimum (C_{PU}, C_{PL}) for y–data, where C_{PU} is upper specification limit of capability precision and C_{PL} is lower specification limit of capability precision
C_{pky} = Min (C_{PUY}, C_{PLY}) = C_{py}(1–C_{ay})

(Example):To find out n, Ymin, Cpy, Mod,
Use the following SET and L/D SET parameters.
2–VAR X = L3, where List 3 (63, 57, 81, 90)
2–VAR Y = L4, where List 4 (18, 22, 31, 43)
2–VAR F = 1
X LSL= 55 , X USL= 95 , Y LSL= 15 , Y USL= 44

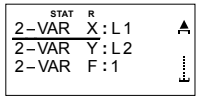
(Step 1) : Input the List 3 and List 4 data groups.

63 [EXE] 57 [EXE] 81 [EXE] 90 [EXE]
[▶] 18 [EXE] 22 [EXE] 31 [EXE] 43 [EXE]

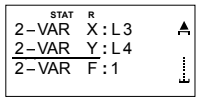


(Step 2) : Specify statistical calculation data lists to 2–VAR X, 2–VAR Y, 2–VAR F.

[FUNC.] 1 (CALC) 9 (SET) [▼] [▼]

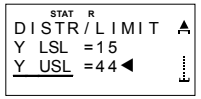


[EXE] 2 (L3) [▼] [EXE] 3 (L4)



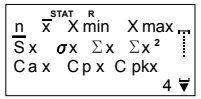
(Step 3) : Specify values to X LSL, X USL, Y LSL, Y USL

[EXIT] 8 (L/D SET) [▼] 55 [EXE] 95 [EXE] [▼]
15 [EXE] 44

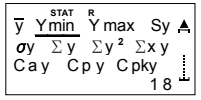


(Step 4) : Press [FUNC.] 1 (CALC) 1 (2–VAR) to display the result menus and you can use the cursor keys to view variable characteristics.

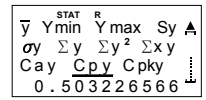
[EXE] [EXIT] 1 (2–VAR)



[▼] [▼] [▼] [▶]



[▼] [▼] [▶]



8 – 3 – 3 Regression Calculation

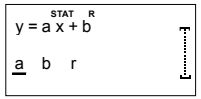
(A) To display regression results

In CALC menu (press [FUNC.] 1(CALC)), there are six regression types as follow :

Regression type	Formula
Linear regression (X)	y = ax + b
Med-Med regression (MED)	y = ax + b
Logarithmic regression (LOG)	y = a + b ln x
Quadratic regression (X^2)	$y = ax^2 + bx + c$
Exponential regression (EXP)	$y = a \cdot e^{bx}$
Power regression (PWR)	$y = a \cdot x^b$

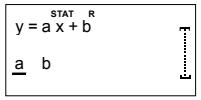
Regression calculations are available only when paired–variable statistical data have been specified. If you select any of six regression types from CALC menu, the following regression coefficients and results are displayed on the screen.

(Linear)



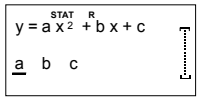
a ... Regression coefficient (slope)
b ... Regression constant term (intercept)
r ... Correlation coefficient

(Med–Med)



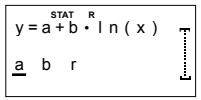
a ... Med–Med graph slope
b ... Med–Med graph intercept

(Quad)



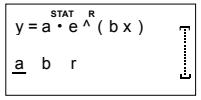
a ... Regression second coefficient
b ... Regression first coefficient
c ... Regression constant term (intercept)

(Logarithmic)



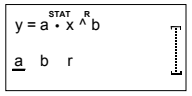
a ... Regression constant term (intercept)
b ... Regression coefficient (slope)
r ... Correlation coefficient

(Exponential)



a ... Regression coefficient
b ... Regression constant term
r ... Correlation coefficient

(Power)



a ... Regression coefficient
b ... Regression power
r ... Correlation coefficient

(B) To calculate estimated values

In the STAT and MAIN mode, you can press [VARS] to find out the below items to calculate estimated values for the regression's x and y parameters.

x ' ... Estimated x values given y value

y ' ... Estimated y value given x value

If you don't want to exit the STAT mode to calculate estimated values, the result for estimated values will be automatically inserted into one cell where the current cursor is.

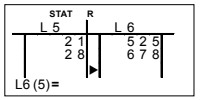
(Note):You can't calculate estimated values for Med–Med and Quadratic regression.

(Example):To perform linear regression using the following data and estimate the values of and when x_i = 19 and y_i = 573

x_i	15	17	21	28
y_i	451	475	525	678

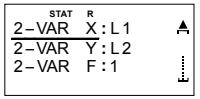
(Step 1) : Input x_i and y_i values into L5 and L6.

15 [EXE] 17 [EXE] 21 [EXE] 28 [EXE]
[▶] 451 [EXE] 475 [EXE] 525 [EXE] 678
[EXE]

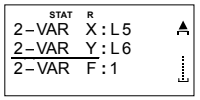


(Step 2) : Specify statistical calculation data lists to 2–VAR X, 2–VAR Y, 2–VAR F.

[FUNC.] 1 (CALC) 9 (SET) [▼] [▼]

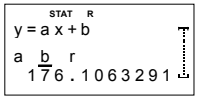


[EXE] 4 (L5) [▼] [EXE] 5 (L6)



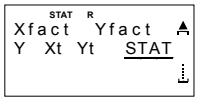
(Step 3) : Press 2 (X) to display the linear regression menu and you can press the cursor keys ([◀] [▶] [▲] [▼]) to view variable characteristics.

[EXIT] 2 (X) [▶]

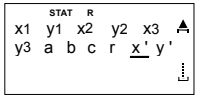


(Step 4) : In the STAT mode to find out " x' " and " y' " and estimate value calculation.

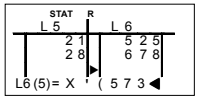
[VARS] [VARS] [VARS] [▼] [▶] [▶] [▶]



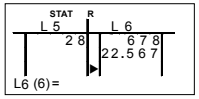
[EXE] [▶] (2–VAR) [EXE] [◀] [◀]



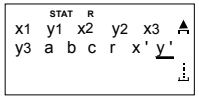
[EXE] 573



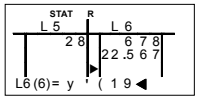
[EXE]



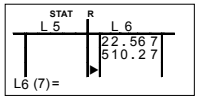
[VARS] [VARS] [VARS] [▼] [▶] [▶] [▶]
[EXE] [▶] (2–VAR) [EXE] [◀]



[EXE] 19



[EXE]

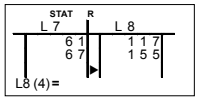


(Example):To perform power regression using the following data and estimate the values of and when y_i = 143

x_i	57	61	67
y_i	101	117	155

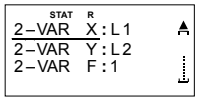
(Step 1) : Input x_i and y_i values into L7 and L8.

57 [EXE] 61 [EXE] 67 [EXE] [▶] 101 [EXE]
117 [EXE] 155 [EXE]

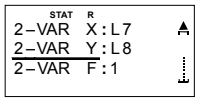


(Step 2) : Specify statistical calculation data lists to 2–VAR X, 2–VAR Y, 2–VAR F.

[FUNC.] 1 (CALC) 9 (SET) [▼] [▼]

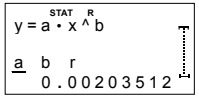


[EXE] 6 (L7) [▼] [EXE] 7 (L8)



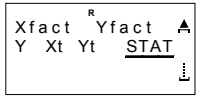
(Step 3) : Press 7 (PWR) to display the power regression menu and you can press the cursor keys ([◀] [▶] [▲] [▼]) to view variable characteristics.

[EXIT] 7 (PWR)

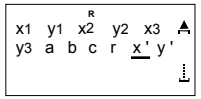


(Step 4): Enter the MAIN mode to find out " x' " and estimate value calculation.

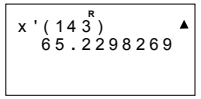
[MODE] 0 [VARS] [VARS] [VARS] [▼] [▶] [▶] [▶]



[EXE] [▶] (2–VAR) [EXE] [◀] [◀]



[EXE] 143 [EXE]



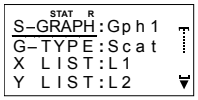
8 – 4 Statistical Graphs

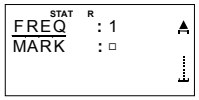
8 – 4 – 1 General Statistical Graph Settings

This section describes how to use the graph setting menus to make the following settings for each graph (Gph1, Gph2, Gph3).

(A) Graph setting menus

While the statistical data list is on the display, press [FUNC.] 0 (GRAPH) 3 (SET) to display the graph settings menus.



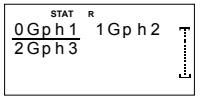


• The settings shown here are examples only. The settings on your graph settings screen may differ. Please check in this table.

G–TYPE	S–GRAPH	X LIST	Y LIST	T LIST	Y1~Y5 LIST	FREQ	MARK
Scat	☑	☑	☑	☐	☐	☑	☑
xyLin	☑	☑	☑	☐	☐	☑	☑
Hist	☑	☑	☐	☐	☐	☑	☐
Box	☑	☑	☐	☐	☐	☑	☐
N–Dist	☑	☑	☐	☐	☐	☑	☐
X	☑	☑	☑	☐	☐	☑	☐
Med	☑	☑	☑	☐	☐	☑	☐
Log	☑	☑	☑	☐	☐	☑	☐
X^2	☑	☑	☑	☐	☐	☑	☐
Exp	☑	☑	☑	☐	☐	☑	☐
Pwr	☑	☑	☑	☐	☐	☑	☐
T–Ser	☑	☑	☑	☑	☑	☑	☑
Spc	☑	☑	☐	☐	☐	☑	☐

(B) Statistical graph area (S–GRAPH)

While the graph setting menu is on the display, select " S–GRAPH " item, and press [EXE].

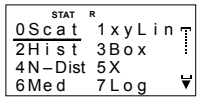


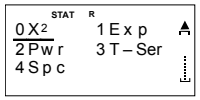
Gph1 ... Graph 1 **Gph2** ... Graph 2 **Gph3** ... Graph 3

(C) Graph type (G–TYPE)

The initial default graph type setting for all the graphs is scatter graph. You can select one of a variety of other statistical graph types for each graph.

While the graph setting menu is on the display, select " G–TYPE " item, and press [EXE].

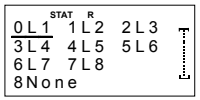




Scat ... Scatter diagram
Hist ... Histogram
N–Dist ... Normal distribution curve
Med ... Med-Med graph
X^2 ... Quadratic regression graph
Pwr ... Power regression graph
Spc ... Statistical process control graph
xyLin ... xy line graph
Box ... Box–Whisker graph
X ... Linear regression graph
Log ... Logarithmic regression graph
Exp ... Exponential regression graph
T–Ser ... Time–series graph

(D) Data list (X LIST, Y LIST, T LIST, Y1 LIST ~ Y5 LIST)

You can specify which statistical data list you want to use. While the graph setting menu is on the display, select " X LIST " item (or " Y LIST ", " T LIST ", " Y1 LIST " ~ " Y5 LIST "), and press [EXE].

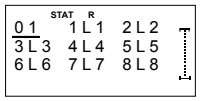


L1 ~ L8... List 1~ List 8 None ... None of the lists

(E) Frequency data list (FREQ)

Normally, each data item or data pair in the statistical data list is represented on a graph as a point. When you are working with a large number of data items however, this can cause problems because of the number of plot points on the graph. When this happens, you can specify a frequency list that contains values indicating the number of instances (the frequency) of the data items in the corresponding cells of the lists you are using for x-data and y-data. Once you do this, only one point is plotted for the multiple data items, which makes the graph easier to read.

While the graph setting menu is on the display, select " FREQ " item, and press [EXE].

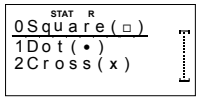


1 ... Plot all data (1– to –1) **L1 ~ L8** ... List 1~ List 8 data is frequency data.

(F) Plot mark type (MARK)

This setting lets you specify the shape of the plot points on the graph.

While the graph setting menu is on the display, select " MARK " item, and press [EXE].



Square (□) ... Plot using □ **Dot (•)** ... Plot using • **Cross (x)** ... Plot using X

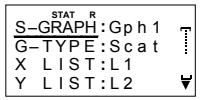
8 – 4 – 2 Statistical Graph Examples

The initial default graph type setting for all the graphs (Gph1 through Gph 3) is scatter diagram, but you can change to one of a number of other graph types.

(Example): According to the following settings, to draw a xyline graph into Gph 2
X LIST : L3, Y LIST : L4, FREQ : 1 , MARK : Cross
where List 3 (0.7 , 1.5 , 2.5 , 4.5 , 6) and List 4 (– 2.5 , 0.5 , 1.8 , 2.6 , 3.5)

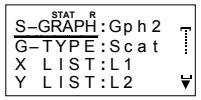
(Step 1) : After inputting the List 3 and List 4 data groups, press [FUNC.] 0 (GRAPH) 3 (SET) to display the graph setting.

[FUNC.] 0 (GRAPH) 3 (SET)



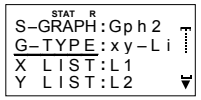
(Step 2) : Select the graph area you want to use.

[EXE] 1 (Gph2)



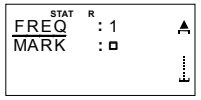
(Step 3) : Select the graph type you want to use.

[▼] [EXE] 1 (xyLin)



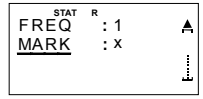
(Step 4) : Specify the data lists and the frequency data lists you want to use.

[▼] [EXE] 2 (L3) [▼] [EXE] 3 (L4) [▼] [EXE] 0 (1)



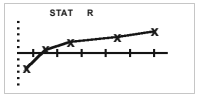
(Step 5) : Select the plot mark type you want to use.

[▼] [EXE] 2 (Cross)



(Step 6) : Press [EXIT] 1 (Gph2) to draw graph. The V–Window settings are adjusted automatically and the xyLine graph is displayed.

[EXIT] 1 (Gph2)



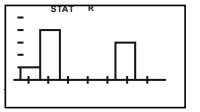
(Note): V–Window parameters are normally set automatically for statistical graphs. If you want to set V–Window parameters manually, you must change the " S–WIND " item to " Manual ". See « 8 – 8 Manual Graphing »

8 – 5 Single–Variable Statistical Graphs

8 – 5 – 1 Histogram (Hist)

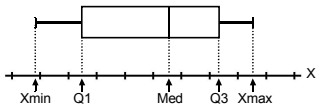
Histogram gives a graphical view of the distribution of x–data which often gives richer insights into the data than you get from numerical representations such as the mean, median or mode.

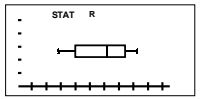
The horizontal of the axis is the x–data. The height of the axis is the number of times that a particular x–data occurs in the data.



8 – 5 – 2 Box–Whisker Graph (Box)

Box graph lets you see how a large number of data items are grouped within specific ranges. A box encloses all x–data in an area from the 25th percentile (First quartile, Q1) to the 75th percentile (Third quartile, Q3), with a line drawn at the 50th percentile (Median, Med). Lines (called whiskers) extend from either end of the box up to the minimum (X min) and maximum (X max)of the data.

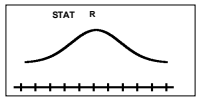




8 – 5 – 3 Normal Distribution Curve (N – Dist)

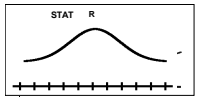
Normal distribution curve plots the relationship between the mean and the standard deviation of the x–data. The normal distribution curve is graphed using the following normal distribution function.

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



8 – 5 – 4 Statistical Process Control Graph (Spc)

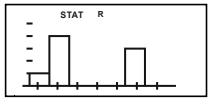
Statistical process control is a key tool for both management and workers to solve problems and monitor the performance of a process to assure that a process that is functioning in an acceptable fashion.



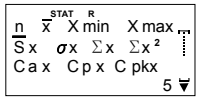
8 – 5 – 5 To Display Single–Variable Statistical Calculation Results

While a single–variable statistical graph is on the screen, the calculation results can be recalled immediately as soon as you press [FUNC.] 0 (1 –VAR) to view the result menus.

(Example): To view the single–variable statistical calculation results while a histogram graph is on the screen.



[FUNC.] 0 (1–VAR)

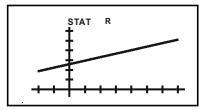


You can use the cursors keys to view variable characteristics.

8 – 6 Paired–Variable / Regression Statistical Graphs

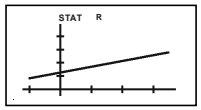
8 – 6 – 1 Linear Regression Graph (X)

Linear regression plots a straight line that passes close to as many data points as possible, and returns values for the slope and y-intercept (y-coordinate when x = 0) of the line.



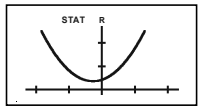
8 – 6 – 2 Med–Med Regression Graph (Med)

When it is suspected that there are a number of extreme values, a Med-Med graph can be used in place of the least squares method. This is also a type of linear regression, but it minimizes the effects of extreme values. It is especially useful in producing highly reliable linear regression from data that includes irregular fluctuations, such as seasonal surveys.



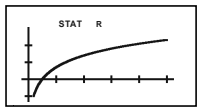
8 – 6 – 3 Quadratic Regression Graph (X^2)

A quadratic regression graph represents connection of the data points of a scatter diagram. It actually is a scattering of so many points that are close enough together to be connected. The formula that represents this is quadratic regression.



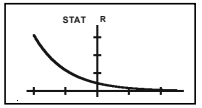
8 – 6 – 4 Logarithmic Regression Graph (Log)

Logarithmic regression expresses y as a logarithmic function of x. The standard logarithmic regression formula is y = a + b ln x, so if we say that X = ln x, the formula corresponds to linear regression formula y = a + b x.



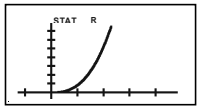
8 – 6 – 5 Exponential Regression Graph (Exp)

Exponential regression expresses y as a proportion of the exponential function of x. The standard exponential regression formula is $y = a \cdot e^{bx}$, so if we take the logarithms of both sides we get log y = log a + b x. Next, if we say Y = log y, and a = log a, the formula corresponds to linear regression formula Y = a + b x.



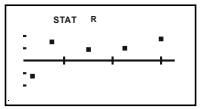
8 – 6 – 6 Power Regression Graph (Pwr)

Exponential regression expresses y as a proportion of the power of x. The standard power regression formula is $y = a \cdot x^{b}$, so if we take the logarithms of both sides we get log y = log a + b logx. Next, if we say X = log x, Y = log y, and a = log a, the formula corresponds to linear regression formula Y = a + b x.



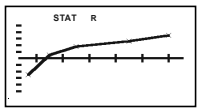
8 – 6 – 7 Scatter (Scat)

Scatter plots plot the data points from X List and Y List as coordinate pairs, showing each point as a Square (□), Cross (x), or Dot (•).



8 – 6 – 8 xy Line (xyLin)

xyLine is a scatter plot in which the data points are plotted and connected in order of appearance in X List and Y List.



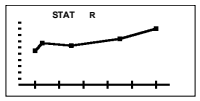
8 – 6 – 9 Time–Series Graph (T–Ser)

A time series is a sequence of observations that are ordered in time. If observations are made on some phenomenon throughout time, it is most sensible to display the data in the order in which they arose.

(A) For two–dimensional space

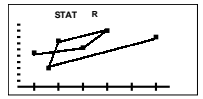
The two–dimensional for time–series graph plots the data points from T List and Y List.

The series data Y is plotted on the vertical axis and time t on the horizontal axis. The data points are plotted and connected in order of time list (T List).



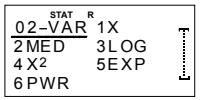
(B) For three–dimensional space

The three–dimensional for time–series graph plots plot the data points from X List and Y List (.or Y1 List ~ Y5 List). The series data Y is plotted on the vertical axis and data X on the horizontal axis. The data points are plotted and connected in order of time list (T List).



8 – 6 – 10 To Display Paired–Variable / Regression Statistical Calculation Results

While a paired–variable statistical graph is on the screen, the calculation results for paired–variable or any of six regression calculations can be recalled immediately as soon as you press [FUNC.] to display the below menu.



2–VAR ... Paired–variable statistics

X ... Linear regression graph

MED ... Med–Med graph

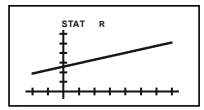
LOG ... Logarithmic regression graph

X ² ... Quadratic regression graph

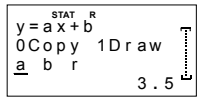
EXP ... Exponential regression graph

PWR ... Power regression graph

(Example):To display the regression calculation results while a linear regression graph is on the display

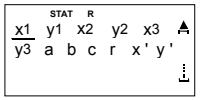


[FUNC.] 1(X)



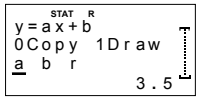
You can use the cursors keys to view variable characteristics.

For Med–Med regression graph, you can advanced to press [VARS] to find out the below menus to view summary points (x1, y1, x2, y2, x3, y3)



8 – 6 – 11 To Copy A Regression Graph Formula To The Graph Mode

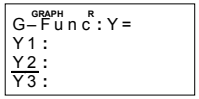
After you perform a regression calculation, you can copy its formula to the GRAPH mode.



Copy ... Store the displayed regression formula to the GRAPH Mode
Draw ... Graph the displayed regression formula

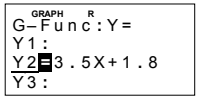
Press 0 (Copy) to copy the regression formula that produced the displayed data to the GRAPH mode. Use [▼] or [▲] to select a memory area you want.

0 (COPY) [▼]



Press [EXE] to save the copied graph formula and return to the previous regression calculation result display.

The following shows the contents in the GRAPH mode.

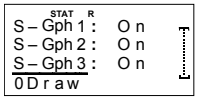


8 – 7 Multiple Graphs

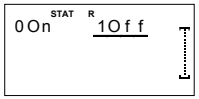
You can draw more than one graph on the same display by setting the statistical graphs draw (On) / non-draw (Off) status of two or all three of the graphs.

Press [FUNC.] 0 (GRAPH) 4 (SEL) to specify statistical graph area (S–Gph1 ~ S–Gph3) which is draw or non–draw.

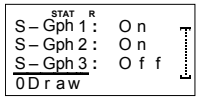
For example,



[EXE] [▶]

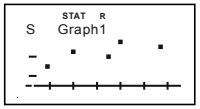


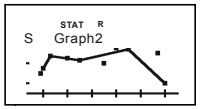
[EXE]



Press 0 (Draw) to display the multiple graphs. The text at the top of the screen indicates the currently selected graph (S–Graph1 = S–Gph 1, S–Graph 2 = S–Gph 2, S–Graph 3 = S–Gph 3).

0 (Draw)



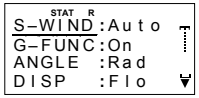


8 – 8 Manual Graphing

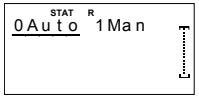
In all of the graphing examples up to this point, values were calculated in accordance with V–Window settings and graphing was performed automatically. This automatic graphing is performed when the " S–WIND " item of the V– Window is set to "Auto" (auto graphing). You can also produce graphs manually, when the automatic graphing capabilities of this calculator cannot produce the results you want.

8 – 8 – 1 To Set The Width Of A Histogram

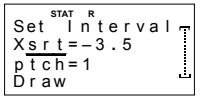
In the STAT mode, press [2nd] [SYSTEM]. When the " S–WIND " item of the View Window is set to "Man" (manual graphing), a screen appears so you can specify the starting point and spacing of histogram bars.



[EXE]



The following are the meanings of the items that appear in this screen.

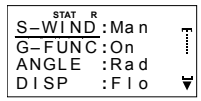


XStrt ... Histogram start point (x–coordinate)
ptch ... Bar spacing (specify as scale unit)

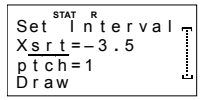
Here we will illustrate this operation by making histogram settings for Graph 1, where X Strt : 2, ptch : 4.

While the statistical data list is on the display, perform the following procedure.

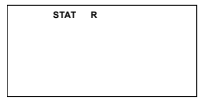
[2nd] [SYSTEM] (S–WIND) [EXE] 1 (Man)



[EXIT] [FUNC.] 0 (GRAPH) 0 (Gph 1)



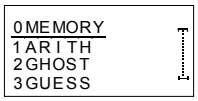
2 [EXE] 4 [EXE] [EXE]



Chapter 9 Games

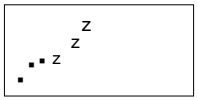
9 – 1 Before Playing Game

In the working mode menu, select the GAME item to enter the GAME mode. When you do, the game menu is on the screen.



There are four games : MEMORY, ARITH, GHOST, GUESS.

- When the period for waiting for a entry is over a period, the snooze screen appears on the screen.



Press any key to return the previous screen.

- If pass a round, you are advanced to the higher level automatically. If lost a round, you are reduced to the lower level automatically. The " LV : " indicator shown on the screen is to tell you what the current level is.

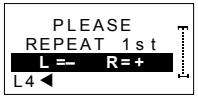
9 – 2 MEMORY

In the game main menu, press 0 (MEMORY) to enter the Memory menu. Select 1 (SET) to set the difficulty level of the game from 1 ~ 9 and the alphabetical type on / off status.

Press 0 (PLAY) to start the game.

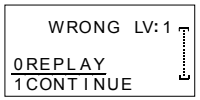
Rule :

- When the game starts, running questions composed of a series of numbers or letters are running in sequence. If your memory is really good, increase the difficulty for the running speed by [▼] or [+].
- After running, input the numbers of the first question and press [EXE].



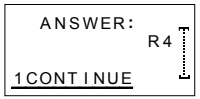
For the alphabetical type on status, to input the R character, press [+] ; To input the L character, press [–].

- Once your input an incorrect answer, a wrong message appears on the display. You can select " CONTINUE " to open a new round or " REPLAY " to replay the original question.



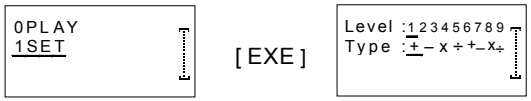
If you select " REPLAY " , a message appears on the display to confirm whether you want to replay the original question or not.

When " N " is selected, the correct answer will be shown on the display.



9 – 3 ARITH

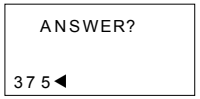
In the game main menu, press 1 (ARITH) to enter the Arith menu. Select 1 (SET) to set the difficulty level of the game from 1 ~ 9 and the arithmetic type(+, –, x, ÷ , +–, x÷) .



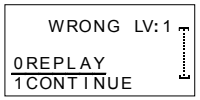
Press 0 (PLAY) to start the game.

Rule :

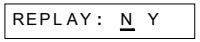
- When the game starts, successive calculations are running in sequence. If your arithmetic calculation really good, increase the difficulty for the running speed by [▼] or [+].
- After running, input the answer and press [EXE].



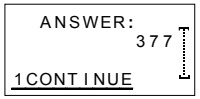
- Once your input an incorrect answer, a wrong message appears on the display. You can select " CONTINUE " to open a new round or " REPLAY " to keep on guessing.



If you select " REPLAY " , a message appears on the display to confirm whether you want to replay the original question or not.



When " N " is selected, the correct answer will be shown on the display.



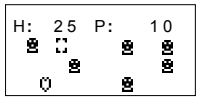
9 – 4 GHOST

In the game main menu, press 2 (GHOST) to enter the Ghost menu. Select 1 (SET) to set the difficulty level of the game from 1 ~ 9.

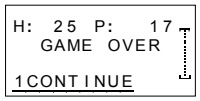
Press 0 (PLAY) to start the game.

Rule :

- The random ghosts ( ) appear your view around the playing area. Use the cursor keys ([▲] [▼] [◀] [▶]) to move the cursor ( ) to the location where a ghost is. Press [G↔T] or [GRAPH] to eliminate it and gain points.



- Each time when ten ghosts are eliminated, you will be rewarded a heat ( ). Please don't eliminate it, or your points will be deducted.
- Try to eliminate as many ghosts as possible. The best points (H) will be placed on the left side on the screen.
- To interrupt a game-in-progress, press [EXIT].
- If the number of all ghosts on the screen is over eighteen , the game is over. You can select " CONTINUE " to open a new round.



9 – 5 GUESS

In the game main menu, press 3 (GUESS) to enter the Guess menu. Select 2 (SET) to set the difficulty level of the game from 1 ~ 4 and the limit for incorrect guesses in a round (10, 20, 30).

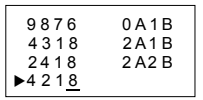
Press 0 (SINGLE) to play alone ; Press 1 (DOUBLE) to play with the calculator.

Rule :

(A) Single status

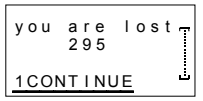
- After starting a new game, a secured code is placed in the calculator's memory. Use the possible numbers from 0 ~ 9 to input your permutation (The number for each digits can't be repeated), then press [EXE]. The calculator will reply with a number of " A " and " B " right next to your permutation.

For example, " 2A2B "
" 2A " means that two of the numbers is right and is in the right place.
" 2B " means that you have found two numbers but it is not in the right place.



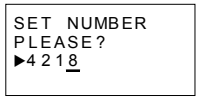
- Then the game goes on, You win if you find the secured code. You can select " CONTINUE " to open a new round

- According to your setting, there is a limit for the times of incorrect guesses in a round. When over the limit, the game is over and the secret code is displayed on the screen. You can select " CONTINUE " to open a new round.

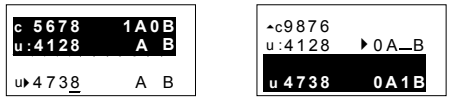


(B) Double status

- After starting a new game, set your secured code.

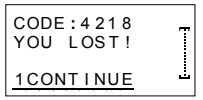


- The procedures and rules are similar to the single status, except you and the calculator make guess and reply by turns.



Remember not to make a incorrect reply to the calculator, or a warn message will appear on the screen.

- Then the game goes on, until you or the calculator find the secured code. If you lose, you can select " CONTINUE " to open a new round.

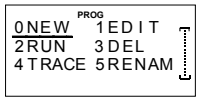


Chapter 10 Programming

10 – 1 Before Programming

The programming function helps to make complex, often-repeated calculations quick and easy. Commands and calculations are executed sequentially, just like the manual calculation multistatements. Multiple programs can be stored under file names for easy recall and editing.

In the working mode menu, select the PROG item to enter the PROG mode. When you do, a program main menu appears on the display.

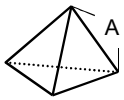


– Program Main Menu –

NEW ... New program
RUN ... Execute program
TRACE ... Trace program
EDIT ... Program edit
DEL ... Specific program delete
RENAM ... Rename program

10 – 2 Creating A New Program

(Example):To store a program that calculates the surface area (S) and volume (V) of a regular tetrahedron shown in the table below, which the length of one side (A) is known. Store the calculation formula under the file name TETRA



A	S	V
3.5	? cm ^{2}	? cm ^{3}
5	? cm ^{2}	? cm ^{3}
12	? cm ^{2}	? cm ^{3}

The following are the formulas used for calculating surface area (S) and volume (V) of a regular tetrahedron for which the length of one side (A) is known.

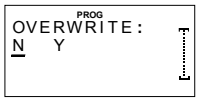
$$S = \sqrt{3}A^2 \qquad V = \frac{\sqrt{2}}{12}A^3$$

10 – 2 – 1 To Specify A Program Type And Register A File Name

PROG TYPE : Each program must be specified a working mode the calculator should enter when executing the program you are inputting. Besides normal function calculations in the MAIN (MA) mode, to perform binary, decimal and hexadecimal calculations and conversions, please choose Base–n (BA) mode.

Filename : When inputting a new program, you first register the file name and then input the actual program. The file name can be up to seven characters long and the characters you can use are A through Z, or 0 through 9.

A file name can be one to seven characters long. If you try to use a file name which is the same as those existing ones, a message appears on the display to confirm whether you want to overwrite the program or not.

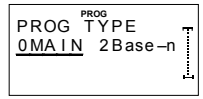


Move the cursor to " Y " to overwrite the program or " N " to abort the procedure without overwriting anything.

(Example):To register the file name TETRA, which the program type is MAIN.

(Step 1) : While the program main menu is on the display, press 0 (NEW) and specify a program type.

0 (NEW)



(Step 2) : Input the name of the file. The alpha–lock "A" is on. The cursor changes form to indicate alpha character input.

[EXE] [T] [E] [T] [R] [A]

(Step 3) : Press [EXE] to register the file name and change to the program input screen.

[EXE]

(Note) :

- You can delete a character while inputting a file name by moving the cursor to the character you want to delete and pressing [DEL].
- To exit the file name input screen and return to the program main menu without registering a file name, press [EXIT].

10 – 2 – 2 To Input Program Contents

Program contents are input using the same basic procedures that you use for manual calculations. Each command line is ended with a semicolon (**;**) while you press [EXE] . To enter more than one instruction or expression on a single command line, please separate each with a semicolon (**;**).

The following shows how you would input the required formulas as manual calculation and as a program.

• Manual Calculation

Surface Area (S) ... [$\sqrt{\ }$] 3 [▶] [x] < value of A > [X^2]
Volume (V) ... [$\sqrt{\ }$] 2 [▶] [÷] 12 [x] < value of A > [^] 3

You could also perform the above calculation by assigning the value for the length of the one side to variable A.

• Program
Surface Area (S) ... [$\sqrt{\ }$] 3 [▶] [x] [ALPHA] [A] [X^2]
Volume (V) ... [$\sqrt{\ }$] 2 [▶] [÷] 12 [x] [ALPHA] [A] [^] 3

(Example) : To input program contents for the file named TETRA

Follow the following steps to input the contents of the program.

Contents : ① ***Input A ;***

Steps : ① [2nd] [INST] 2 (Input) [ALPHA] [A] [EXE]

Contents : ② ***S = $\sqrt{\ }$ (3) x A ^{2} ;***

Steps : ② [ALPHA] [S] [ALPHA] [=] [$\sqrt{\ }$] 3 [▶] [x] [ALPHA] [A] [X^2] [EXE]

Contents : ③ ***V = $\sqrt{\ }$ (2) ÷ 12 x A ^ 3 ;***

Steps : ③ [ALPHA] [V] [ALPHA] [=] [$\sqrt{\ }$] 2 [▶] [÷] 12 [x] [ALPHA] [A] [^] 3 [EXE]

Contents : ④ ***Print " S = ", S ;***

Steps : ④ [2nd] [INST] [2nd] [INST] [2nd] [INST] 0 (Print) [ALPHA] ["] [ALPHA] [S] [ALPHA] [=] [ALPHA] ["] [,] [ALPHA] [S] [EXE]

Contents : ⑤ ***Print " V = ", V ;***

Steps : ⑤ [2nd] [INST] [2nd] [INST] [2nd] [INST] 0 (Print) [ALPHA] ["] [ALPHA] [V] [ALPHA] [=] [ALPHA] ["] [,] [ALPHA] [V] [EXE]

Contents : ⑥ ***End***

For more program examples, please see «10–13 Program Examples ».

10 – 2 – 3 To Run A Program

(Example): To run program contents for the file named TETRA
Let's try running the above program we input .

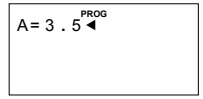
A	S	V
3.5	21.21762239272 cm ^{2}	5.052867207229 cm ^{3}
5	43.30127018922 cm ^{2}	14.73139127472 cm ^{3}
12	249.4153162899 cm ^{2}	203.6467529817 cm ^{3}

(Step 1) : While the program main menu is on the display, press 2 (RUN) and specify a file name. While the file name list is on the display, use [▲] or [▼] to move the cursor to the name of the program you want to run.

2 (RUN) [▼] ~ [▼]

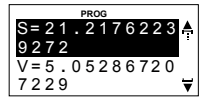
(Step 2) : Press [EXE] to run the program and input a value for A.

[EXE] 3.5



(Step 3) : Press [EXE] to run the program. The final result is on the display.

[EXE] [▲]



(Step 4) : To rerun the program from the beginning, please press [EXE] and input more the value A.

(Note): You can also run a program while in the MAIN mode by inputting : PROG < file name >.

10 – 3 Debugging A Program

A problem in a program that keeps the program from running correctly is called a " bug " and the process of eliminating such problems is called "debugging". Either of the following symptoms indicates that your program contains bugs and that debugging is required.

(A) To eliminate bugs that cause error messages

An error message, like the one shown below, appears about 5 seconds whenever something illegal occurs during program execution.

After an error message, the blinking cursor points out where the error was generated. Check the « 1 – 9 Error Conditions » and correct it.

You also can select " TRACE " in the program main menu to enter the TRACE mode for debugging. The system will check the program step by step and tell you where an error is, if it has.

(B) To eliminate bugs those cause bad results

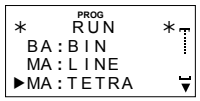
If your program produces results that are not what you normally expect, check the contents of the program and make necessary changes. See «10– 6 Editing Program Contents » for details on how to change program contents.

10 – 4 Searching For A File

You can search for a specific file name using any of the three following methods.

(A) Scroll Search

While the file name list is on the display, use [▲] or [▼] to move the pointer to the name of the program you want, and then press [EXE] to recall it.



(B) File Name Search

While the file name list is on the display, press [FUNC.] 0 (Search) to display the search screen and input the name of the file. After pressing [EXE], the contents of the program is recalled.

(Note) : If there is no program whose file name matches the one you input, the message " Not Found " appears on the display. If this happens, press [EXIT] to clear the error message and re-input a correct entry.

(C) Initial Character Search

While the file name list is on the display, press [FUNC.] 0 (Search) to display the search screen and input the initial characters of the file you want to find.

All files whose file names start with the characters you input are recalled.

[EXE]

Use [▲] or [▼] to move the pointer to the name of the program you want , and then press [EXE]. The contents of the program are recalled.

(Note): If there is no program whose file name starts with the characters you input, the message " Not Found " appears on the display. If this happens, press [EXIT] to clear the error message and re-input a correct entry.

10 – 5 Renaming A Program

(Example):To rename a TETRA file name.

(Step 1) : While the program main menu is on the display, press 5 (RENAM). Find the file name of the program you want in the file name list.

5 (RENAM) [▼]

(Step 2) : Make correction for the file name to rename it .

[EXE] [▶] ~ [▶] [H]

(Step 3) : Press [EXE] to store it.

10 – 6 Editing Program Contents

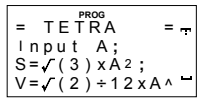
(Example):To edit program contents named TETRA

(Step 1) : While the program main menu is on the display, press 1 (EDIT). Find the file name of the program you want in the file name list.

1 (EDIT) [▼]

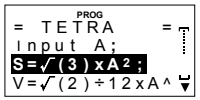
(Step 2) : Press [EXE] to recall the program.

[EXE]

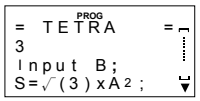


(Note):The procedures you use for editing program contents are identical to those used for editing manual calculations, except [$^{ON}/_{CL}$] becomes inactive. For details, see « 2 – 5 – 2 Making Corrections During Input ».

The " COPY " and " Paste " functions are also useful when editing program contents. In program contents, move the cursor to the location you want to begin, and then press [FUNC.] 6 (COPY) 0 (Begin). Continue moving the cursor to the location you want to end, then press [FUNC.] 6 (COPY) 1 (End). The selected command line is highlighted, as follow,



To paste the command line you just copy, move the cursor to a desired location and press [FUNC.] 7 (Paste) to paste it.



(Note): You can't copy command line from one existing program to paste it in another existing program.

10 – 7 Deleting A Program

While the program main menu is on the display, press 3 (DEL) to display the menu. There are two different ways to delete a file name and its program.

ONE ... Specific program delete **ALL** ... Program delete

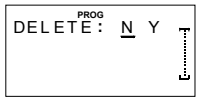
(A) To delete a specific program

(Step 1) : Press 0 (ONE) to display the list of the existing program. Use [▲] or [▼] to move the pointer to the name of the program you want to delete.

0 (ONE) [▼] ~ [▼]

(Step 2) : After pressing [EXE], a message appears on the display to confirm whether you want to delete the content of the program or not.

[EXE]



(Step 3) : Move the cursor to " Y " to delete the program or " N " to abort the procedure without deleting anything.

(B) To delete all programs

(Step 1) : After pressing 1 (ALL), a message appears on the display to confirm whether you want to delete all program or not.

1 (ALL)

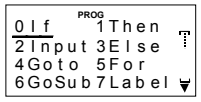
(Step 2) : Move the cursor to " Y " to delete all programs or " N " to abort the procedure without deleting anything.

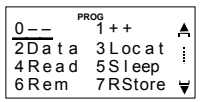
(Note): You can also delete all programs using the RESET mode. See « 1 – 10 Memory Status And Clear ».

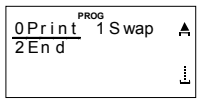
10 – 8 Useful Program Commands

In addition to calculation commands, this calculator also includes a variety of relational and jump commands that can be used to create programs that make repeat calculations quick and easy.

Press [2nd] [INST] to display the program command menus.







10 – 8 – 1 Basic Program Command

Command : **Input**

Function : Prompts for input of values for assignment to variables during program execution.

Syntax : **(1)** ***Input < variable name > ;***
(2) ***Input < variable name >, < variable name >, ..., < variable name > ;***

Example : **(1)** ***Input A ;***
(2) ***Input A , B , S ;***

Description :

1. This command momentarily interrupts program execution and prompts for input of a value or expression for assignment to a variable. When the Input command is executed, " < variable name > = " to appears on the display and the calculator stands by for input.
2. To input more than one variable name, please separate them with a comma (,).

Command : **If~Then~Else**

Function : A conditional branch is performed only if certain relational expressions are met.

Syntax : **(1)** ***If (< condition >) Then { < statement > } ;***
(2) ***If (< condition >) Then { < statement > }; Else { < statement > } ;***

Example : **(1)** ***If (A == 0) Then { B = 3C } ;***
(2) ***If (A == 0) Then { B = 3C } ; Else { S = 5C } ;***

Description :

1. For If–Then command, the Then-statement is executed only when the relational expressions are true. If not, the Then-statement is not executed.
2. For If–Then–Else command, the Then-statement is executed only when the relational expressions are true. If not, the Else-statement is executed.

Command : **Print**

Function : Print the text listed in the double quotation marks and the value of the variable name during program execution.

Syntax : **(1)** ***Print " < text > " ;***
(2) ***Print < variable name > ;***
(3) ***Print " < text > ", < variable name > ;***

Example : **(1)** ***Print " POWER = " ;***
(2) ***Print A ;***
(3) ***Print " POWER = " , A ;***

Description :

1. Multiple items in a Print command are separated by commas (,).

Command : **For**

Function : Often, programs need loops that process each data item from some known fixed size collection. This can be handled quite adequately using a standard For loop.

Syntax : ***For (start condition; continue condition ; re-evaluation)***
{ statements } ;

Example : ***For (A = 1 ; A ≤ 4 ; A + +)***

{ C = 3 x A ; Print " ANS = " , C } ;

Description :

The order of processing each part of a For loop :

1. The first part of the For loop, For (A = 1;, initializes the value of A to 1. A = 1 on the iteration. A ≤ 4 is true, so the statement block is executed, At the end of the iteration, A is incremented by 1.
2. Next, A = 2 on the iteration. A≤ 4 is still true, so the statement block is executed. At the end of the iteration, A is increased by 1. And so on.
3. A is incremented again, the condition re-evaluated etc., until A reaches a value of 5. When this occurs, A ≤ 4 is false, so the statement block isn't executed and terminates this program.

Command : **++ , – –**

Function : A memory variable is decreased or increased by one.

Syntax : **Post-fixed :** < *variable name* > + + ; **or** < *variable name* > – – ;
Pre-fixed : + + < *variable name* > ; **or** – – < *variable name* > ;

Example : **A ++ ; , A – – ; , ++ A ; , – – A ;**

Command : **Goto~Label**

Function : The Goto command performs an jump to a specified Label location.

Syntax : *Goto < value > ;*
Label < value > ;

Example : *Goto 1 ;*
Label 1 ;

Description :

1. When program execution reaches the statement " Goto n ", execution then jump to " Label n " (n is the same value as Goto n and is a value from 0 to 9). It is useful to return execution to the beginning for repetitive calculations, or to repeat calculations from a point within a program area.
2. If there is no Label–statement whose value matches that specified by the Goto-statement, an error (GOTO Er) occurs.

Command : **GoSub**

Function : This command specifies execution of another program as a subroutine.

Syntax : *GoSub PROG < file name > ;*

Example : *GoSub PROG ABC ;*

Description :

1. Some programming problems require that you write a program that references the same series of operations several times. References can be made to a group of operations if you write them as a subroutine.
2. You write the GoSub command as part of the main program (calling program). The main program (calling program) transfers control to the subprogram, the subprogram completes its operation and control is shifted back to the main program.
3. If a subroutine with the file name specified by the PROG command does not exist, an error (GOSUB Er) occurs.

Command : **Data ~ Read**

Function : The Read command reads the contents in the Data command.

Syntax : *Data (< data >, < data > , ... < data >) ;*
Read (< variable name > , < variable name > , ... , < variable name >)

Example : *Data (52 , 31, 23) ;*
Read (I ,A , Q) ;

Description :

1. When a large amount of data is to be processed, the use of Input command could be used, but it causes unnecessary typing for a user to have to enter values that are already known. In this time, you can use the Data / Read commands operate within the program to assign values to variables.
2. The Read command causes the reading of data provided by one or more Data commands.
3. When a Read command is executed the entire program is scanned, starting at the first line, for a Data command. When one is located as many data items as are needed are taken from data and stored in the variable names specified by the Read command. If there are not enough data items in the current Data command, another is sought.
4. If another Read statement is encountered, it continues to look for data items where the last Read left off. Data items are not reused. If the Read command cannot find enough data items to satisfy all its variables, it produces an error message and the program stops execution.

Command : **Restore**

Function : The command resets data items.

Syntax : *Restore ;*

Description :

1. Once a data item is READ it cannot be READ again, unless you use a Restore command. The Restore command resets data items, so that the next item that is READ is the first item of the first Data command in the program, regardless of how many items have been previously READ.

Command : **Rem**

Function : You may include comments in your program with the Rem statement. The

program completely ignores Rem lines, but they are intended to assist a person trying to understand how your program works.

Syntax : *Rem < statement > ;*

Example : *Rem PRESSURE CONVERSION ;*

Command : Locate

Function : This command displays the contents in the Input or Print command at a specific location on the text screen.

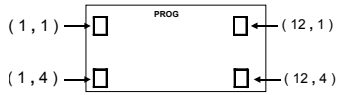
Syntax : **(1)** *Locate (< column number > , < row number >) ;*
Input < variable name > ;
(2) *Locate (< column number > , < row number >) ;*
Print " < text > " ;

Example : **(1)** *Locate (2 , 2) ;*
Input A ;
(2) *Locate (1 , 3) ;*
Print " ANSWER " ;

Description :

1. This command displays values (including variable contents) or text at a specific location on the text screen.

2. The row number is designated by an integer from 1 to 4, which the column number is designed by a integer from 1 to 12.



3. In some cases, the ClrText command should be executed before running the above program.

Command : Swap

Function : This command can swap the contents in two variables.

Syntax : *Swap (< variable nam e> ,< variable name >) ;*

Example : *Swap (A ,B) ;*

Command : Sleep

Function : This command can suspend execution of the program for a specified time. The maximum number of seconds is about 105 seconds. It is useful for displaying intermediate results and other information.

Syntax : *Sleep (< time>) ;*

Example : *Sleep (5) ;*

Command : End

Function : The End statement signifies the end of the program and should be the last statement executed when a program is RUN.

Syntax : *End ;*

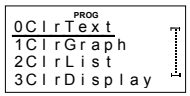
Example : *End ;*

1. End command must be the last statement in every program.

2. Normally, while creating a new program, the End command will be added and displayed automatically on the beginning of the program.

10 – 8 – 2 Clear Command

A clear command is entered by pressing [FUNC.] 0 (CLR) to display the below menu.



Command : ClrGraph

Function : This command clears the graph screen.

Syntax : *ClrGraph ;*

Description:
This command clears the graph contents and screen during program execution.

Command : ClrList

Function : This command clears list data.

Syntax : *ClrList ;*

Description:
This command clears the contents of the currently selected list (List 1 to List 8) during program execution.

Command : ClrText

Function : This command clears the text contents and screen.

Syntax : *ClrText ;*

Description:
This command clears text from the screen during program execution.

Command : ClrDisplay

Function : This command clears screen.

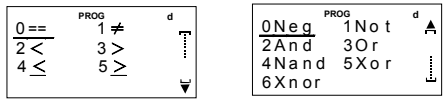
Syntax : *ClrDisplay ;*

Description:

This command clears the screen during program execution.

10 – 8 – 3 Relational And Logical Operators

Press [2nd] [TEST] to display the below menus.



The relational operators can be used with For loop and If command in your program.

== ... Equal to	**≠** ... Not equal to
< ... Less than	**>** ... Greater than
≤ ... Less than or equal to	**≥** ... Greater than or equal to

The logical operators can be used to perform Base-n calculations in your program.

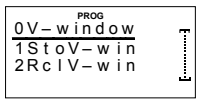
Neg ... Negation	**Not** ... Logical NOT
And ... Logical AND	**Or** ... Logical OR
Nand ... Logical NAND	**Xor** ... Logical XOR
Xnor ... Logical XNOR	

10 – 9 Using Graph Functions In A Program

You can incorporate graph functions into a program to draw complex graphs and to overlay graphs on top of each other. The following shows various types of syntax you need to use when programming with graph functions.

(A) View Window

Press [V–WIN.] to display the below menu.



• The V–Window command can set the V–Window parameters using the following syntax.

V iewWindow (< X min value > , < Xmax value > , < Xscl value>, < Ymin value>, < Ymax value> , < Yscl value >, < Tmin value > , < Tmax value > , < Tptch value >) ;

• The RclV–Win command can recall the V–Window settings stored in memory using the following syntax.

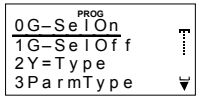
RclV–Win ;

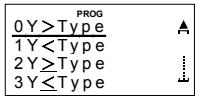
• The StoV–Win command can store the current V–Window setting using the following syntax.

StoV–Win ;

(B) Graph function

A command for graph function type (Y = Type, ParmType, Y > Type, Y < Type, Y ≥ Type, Y ≤ Type) is entered by pressing [FUNC.] 4 (GRAPH) to display the below menus.





(C) Expression input

< expression>➔ Y (< parameter >) ;

Where the parameter for the memory area is an integer from 1 to 20.

(D) Draw / non–draw status

The command for the draw or non–draw status (G–SelOn , G–SelOff) is entered by pressing [FUNC.] 4 (GRAPH) to display the menu.

Draw status : ***G–SelOn Y (< parameter >) ;***

Non–draw status : ***G–SelOff Y (< parameter >) ;***

Where the parameter for the memory area is an integer from 1 to 20.

(E) Graph type operation

Press [2nd] [SYSTEM] and find out " G–Con " and " G–Plot " commands. These commands graph functions in accordance with conditions defined within the program. " G–Con" produces a connect type graph, while " G–Plot " produces a plot type graph.

Connect type : ***G–Connect ;***

Plot type : ***G–Plot ;***

(F) Enlarge Factor operation

The Enlarge factor command (Factor) is entered by pressing [ZOOM] 0 (Factor).

Factor (< X factor > , < Y factor >) ;

(G) Graph draw operation

Press [FUNC.] 1 (DISP) and find out " DrawGraph" command. This command draws a graph in accordance with the drawing conditions defined within the program.

DrawGraph ;

(Example):To create a program which graph Y1 = $X^3 + 3X^2 - 6X - 8$
Use the following V–Window parameters.
Xmin = – 8 , Xmax = 8 , Xscl = 2
Ymin = – 15 , Ymax = 15 , Yscl = 5

Follow the following steps to input the contents of the program.

Contents : ① ***ClrGraph ;***

Steps : ① [FUNC.] 0 (CLR) 1 (ClrGraph) [EXE]

Contents : ② ***ViewWindow (– 8 , 8 , 2 , – 15 , 15 , 5) ;***

Steps : ② [V–WIN.] 0 (V–window) [(–)] 8 [,] 8 [,] 2 [,] [(–)] 15 [,] 15 [,] 5 [▶] [EXE]

Contents : ③ ***Y = Type ;***

Steps : ③ [FUNC] 4 (GRAPH) 2 (Y = Type) [EXE]

Contents : ④ ***X ^ 3 + 3X² – 6X – 8 → Y(1) ;***

Steps : ④ [ALPHA] [X] [^] 3 [+] 3 [ALPHA] [X] [X²] [–] 6 [ALPHA] [X] [–] 8 [SAVE] [VARS] [VARS] [VARS] [▼] (Y) [EXE] 1 [▶] [EXE]

Contents : ⑤ ***G–SelOn Y (1) ;***

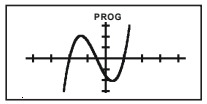
Steps : ⑤ [FUNC.] 4 (GRAPH) 0 (G–SelOn) 1 [▶] [EXE]

Contents : ⑥ ***DrawGraph ;***

Steps : ⑥ [FUNC.] 1 (DISP) 1 (DrawGraph) [EXE]

Contents : ⑦ ***End***

Executing this program produces the result shown here.

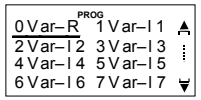


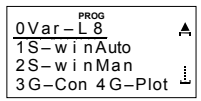
10 – 10 Using Table & Graph Functions In A Program

Table & Graph functions in a program can generate numeric tables and perform graphing operations. The following shows various types of syntax you need to use when programming with Table & Graph functions.

(A) Table range

The command for a table range is set by pressing [2nd] [SYSTEM] twice to display the below menus.





Specified range : ***VarRange ;***

From a list : ***VarL1 ~ VarL8 ;***

(B) Numeric table generation

Press [FUNC.] 1 (DISP) and find out " DispTable " command. It generates numeric tables during program execution in accordance with conditions defined within the program.

DispTable ;

(C) Generate / non–generate status

The command for the Generate / non–generate status (T–SelOn , T–SelOff) is entered by pressing [FUNC.] 5 (TABL) to display the menu.

Generate status : ***T–SelOn Y (< parameter >) ;***

Non–generate status : ***T–SelOff Y (< parameter >) ;***

Where the parameter for the memory area is an integer from 1 to 20.

(D) Table graph type operation

Press [FUNC.] 1 (DISP) and find out " DrawTG–Con" and " DrawTG–Plt " commands. These commands graph functions in accordance with conditions defined within the program. " DrawTG–Con" produces a connect type graph, while " DrawTG–Plt " produces a plot type graph.

Connect type : ***DrawTG–Con ;***

Plot type : ***DrawTG–Plt ;***

(Example): Use the function Y 2 = 6 X² – X – 5 to create a program which generate a numeric table. Use the following range parameters.
XSrt = – 5, Xend = 5, Xptch = 1
Use the following V–Window parameters.
Xmin = – 10 , Xmax = 10 , Xscl = 2.5
Ymin = – 150 , Ymax = 150 , Yscl = 50

After storing values in the range parameters, follow the following steps to input the contents of the program.

Contents : ① ***ClrGraph ;***

Steps : ① [FUNC.] 0 (CLR) 1 (ClrGraph) [EXE]

Contents : ② ***ClrText ;***

Steps : ② [FUNC.] 0 (CLR) 0 (ClrText) [EXE]

Contents : ③ ***ViewWindow (– 10 , 10 , 2.5 , – 150 , 150 , 50) ;***

Steps : ③ [V–WIN.] 0 (V–window) [(–)] 10 [,] 10 [,] 2.5 [,] [(–)] 150 [,] 150 [,] 50 [▶] [EXE]

Contents : ④ ***Y = Type ;***

Steps : ④ [FUNC.] 4 (GRAPH) 2 (Y = Type) [EXE]

Contents : ⑤ ***6X² – X – 5 → Y(2) ;***

Steps : ⑤ 6 [ALPHA] [X] [X²] [–] [ALPHA] [X] [–] 5 [SAVE] [VARS] [VARS] [VARS] [▼] (Y) [EXE] 2 [▶] [EXE]

Contents : ⑥ ***T–SelOn Y(2) ;***

Steps : ⑥ [FUNC.] 5 (TABL) 0 (T–SelOn) 2 [▶] [EXE]

Contents : ⑦ ***VarRange ;***

Steps : ⑦ [2nd] [SYSTEM] [2nd] [SYSTEM] 0 (VAR–R) [EXE]

Contents : ⑧ ***DispTable ;***

Steps : ⑧ [FUNC] 1 (DISP) [▲] (DispTable) [EXE] [EXE]

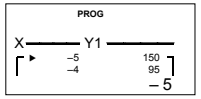
Contents : ⑨ ***DrawTG–Con ;***

Steps : ⑨ [FUNC.] 1 (DISP) 2 (DrawTG–Con) [EXE]

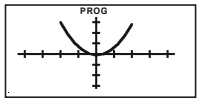
Steps : ⑩ ***End***

Executing this program produces the result shown here.

Numeric Table

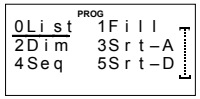


Graph



10 – 11 Using List Sort Functions In A Program

Press [FUNC.] 3 (LIST) to display the list sort functions.



(A) To input a specific list by name

This function let you specify the list you want by inputting the number (1 ~ 8).

List < number>

(B) To replace all cell values with the same value

This function let you replace all cells in a specified list with the same value according to the following syntax.

Fill (< value > , < list name>) ;

(C) To count the number of values

This function let you count the number of values in a specified list.

Dim (< list name >) ;

(D) Ascending order

This function let you sort the data in lists up to eight lists into ascending order.

Srt(< list name >, < list name > , ... , < list name >) ;

(E) Descending order

This function let you sort the data in lists up to eight lists into descending order.

Srt (< list name > , < list name > , ... , < list name >) ;

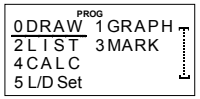
(F) To generate a sequence of numbers

This function let you generate a sequence of numbers according to the following syntax.

Seq (< expression> , < variable >, < start value> , < end value > ,< pitch value >) ;

10 – 12 Using Statistical Graphs And Calculations In A Program

Press [FUNC.] 2 (STAT) to display the below menu. Including statistical calculations and graphing operations into program lets you calculate and graph statistical data.



10 – 12 – 1 To Specify Statistical Data

(A) Statistical data input

{ < data> , < data> , < data> , ... , < data> } ➜ < List name > ;

Where the parameter for the list name is L1 ~ L8.

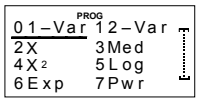
(B) L/ D Set data input

The L/D Set command can set the specification limit parameters for process capability and the a $_X$ value for normal distribution using the following syntax.

L/D set (< a_X value > , < X LSL value > , < X USL value > , < Y LSL value > , < Y USL value >) ;

10 – 12 – 2 Statistical Calculations

A command for the statistical calculation type is entered by pressing [FUNC.] 2 (STAT) 4 (CALC) to display the below menus.



(A) Single–Variable statistical calculation

Press 0 (1–Var) to perform the single–variable statistical calculation according to the following syntax.

1–Variable (< X–list name > , < frequency >) ;

Where the parameters for X–list name is L1 ~ L8

Where the parameters for frequency is 1, or L1 ~ L8

(B) Paired–Variable statistical calculation

2–Variable (< X–list name > , < Y–list name >, < frequency >) ;

Where the parameters for X– or Y–list name is L1 ~ L8

Where the parameters for frequency is 1, or L1 ~ L8

(C) Regression statistical calculation

LinearReg (< X–list name > , < Y–list name >, < frequency >) ;

Where the parameters for X– or Y–list name is L1 ~ L8

Where the parameters for frequency is 1, or L1 ~ L8

(Note): Any one of the following can be specified as a regression type.

Linear Regression (X) ... ***LinearReg***

Med–Med Regression(Med) ... ***Med-MedLine***

Quadratic Regression (X^2) ... ***QuadReg***

Logarithmic Regression (Log) ... ***LogReg***

Exponential Regression (Exp)... ***ExpReg***

Power Regression (Pwr) ... ***PowerReg***

(Example):To create a program which perform paired–variable calculation.
Use the following parameters.
X–list name : L1 , Y–list name : L2 , frequency : 1
where List 1 (63, 57, 81, 90), List 2 (18, 22, 31, 43)
ax = 6 , X LSL= 1 , X USL= 13 , Y LSL= 15 , Y USL= 44

Contents : ① ***{ 63 , 57 , 81 , 90 } ➔ List 1 ;***

Steps : ① [2nd] [{ }] 63 [,] 57 [,] 81 [,] 90 [▶] [SAVE] [FUNC.] 3 (LIST) 0 (List) 1 [EXE]

Contents : ② ***{ 18 , 22 , 31 , 43 } ➔ List 2 ;***

Steps : ② [2nd] [{ }] 18 [,] 22 [,] 31 [,] 43 [▶] [SAVE] [FUNC.] 3 (LIST) 0 (List) 2 [EXE]

Contents : ③ ***L/D set (6 , 1 , 13 , 15 , 44)***

Steps : ③ [FUNC.] 2 (STAT) 5 (L/D set) 6 [,] 1 [,] 13 [,] 15 [,] 44 [▶] [EXE]

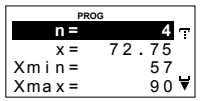
Contents : ④ ***2–Variable (L1 , L2 , 1) ;***

Steps : ④ [FUNC.] 2 (STAT) 4 (CALC) 1 (2–Var) [FUNC.] 2 (STAT) 2 (LIST) 0 (L1) [,] [FUNC.] 2 (STAT) 2 (LIST) 1 (L2) [,] 1 [▶] [EXE]

Contents : ⑤ ***End***

Executing this program produces the result shown here. You can press the cursor keys to view variable characteristics.

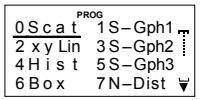
[▲] ~ [▲]



10 – 12 – 3 Statistical Graphs

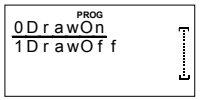
(A) Statistical graph area

The command for the statistical graph area (S–Gph1 , S–Gph2, S–Gph3) is entered by pressing [FUNC.] 2 (STAT) 1 (GRAPH) to display the below menu.



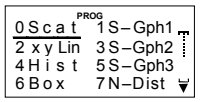
(B) Draw / non–draw status

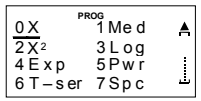
The command for the draw / non–draw status (DrawOn , DrawOff) is entered by pressing [FUNC.] 2 (STAT) 0 (DRAW) to display the below menu.



(C) Statistical graph type

A command for Statistical graph type (Scat, xyLin, Hist, Box, N–Dist, X, Med, X^2, Log, Exp, Pwr, T–Ser, Spc) is entered by pressing [FUNC.] 2 (STAT) 1 (GRAPH) to display the below menu.





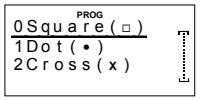
(D) X– and Y–list name, frequency (Except Time–series graph)

X – or Y–list name : *L1 ~ L8 , None*

Frequency : *1*, or *L1 ~L8*

(E) Mark type

A command for mark type (Square, Cross, Dot) is entered by pressing [FUNC.] 2 (STAT) 3 (MARK) to display the below menu.



(F) Graph draw operation

Press [FUNC.] 1 (DISP) and find out " DrawStat " command. This command draws a statistical graph in accordance with conditions defined within the program.

DrawStat ;

• The following is a typical graph condition specification for a histogram graph.

Contents : ① ***ClrGraph ;***

Steps : ① [FUNC.] 0 (CLR) 1 (ClrGraph) [EXE]

Contents : ② ***S–WinAuto ;***

Steps : ② [2nd] [SYSTEM] [2nd] [SYSTEM] [2nd] [SYSTEM] 1 (S– winAuto) [EXE]

Contents : ③ ***S–Gph1 DrawOn ;***

Steps : ③ [FUNC.] 2 (STAT) 1 (GRAPH) 1 (S–Gph1) [FUNC.] 2 (STAT) 0

(DRAW) 0 (DrawOn) [EXE]

Contents : ④ ***Hist (L1 , L2) ;***

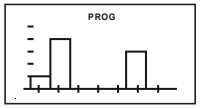
Steps : ④ [FUNC.] 2 (STAT) 1 (GRAPH) 4 (Hist) [FUNC.] 2 (STAT) 2 (LIST) 0 (L1) [,] [FUNC.] 2 (STAT) 2 (LIST) 1 (L2) [▶] [EXE]

Contents : ⑤ ***DrawStat ;***

Steps : ⑤ [FUNC.] 1 (DISP) 0 (DrawStat) [EXE]

Contents : ⑥ ***End***

Executing this program produces the histogram shown here.



(Note):The same format can be used for the following types of graphs, by simply replacing " Hist " in the above specification with the applicable graph type.

Box–Whisker Graph ... ***MedBox***

Normal Distribution Graph ... ***N–Dist***

Statistical Process Control Graph ... ***Spc***

• The following is a typical graph condition specification for linear regression graph.

Contents : ① ***ClrGraph ;***

Steps : ① [FUNC.] 0 (CLR) 1 (ClrGraph) [EXE]

Contents : ② ***S–winAuto ;***

Steps : ② [2nd] [SYSTEM] [2nd] [SYSTEM] [2nd] [SYSTEM] 1 (S– winAuto) [EXE]

Contents : ③ ***S–Gph1 DrawOn ;***

Steps : ③ [FUNC.] 2 (STAT) 1 (GRAPH) 1 (S–Gph1) [FUNC.] 2 (STAT) 0 (DRAW) 0 (DrawOn) [EXE]

Contents : ④ ***Linear (L1 , L2 , 1) ;***

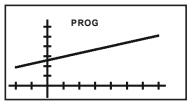
Steps : ④ [FUNC.] 2 (STAT) 1 (GRAPH) [▼] [▼] [▼] [▼] 0 (X) [FUNC.] 2 (STAT) 2 (LIST) 0 (L1) [,] [FUNC.] 2 (STAT) 2 (LIST) 1 (L2) [,] 1 [▶] [EXE]

Contents : ⑤ ***DrawStat ;***

Steps : ⑤ [FUNC.] 1 (DISP) 0 (DrawStat) [EXE]

Contents : ⑥ ***End***

Executing this program produces the linear regression shown here.



(Note): Any one of the following can be specified as a graph type.

Linear Regression (X) ... ***Linear***

Med–Med Regression (Med) ... ***Med–Med***

Quadratic Regression (X^2) ... ***Quad***

Logarithmic Regression (Log) ... ***Log***

Exponential Regression (Exp)... ***Exp***

Power Regression (Pwr) ... ***Power***

• The following is a typical graph condition specification for a scatter diagram.

Contents : ① ***ClrGraph ;***

Steps : ① [FUNC.] 0 (CLR) 1 (ClrGraph) [EXE]

Contents : ② ***S–WinAuto ;***

Steps : ② [2nd] [SYSTEM] [2nd] [SYSTEM] [2nd] [SYSTEM] 1 (S– winAuto) [EXE]

Contents : ③ ***S–Gph1 DrawOn ;***

Steps : ③ [FUNC.] 2 (STAT) 1 (GRAPH) 1 (S–Gph1) [FUNC.] 2 (STAT) 0 (DRAW) 0 (DrawOn) [EXE]

Contents : ④ ***Scatter (L1 , L2 , 1 , Dot) ;***

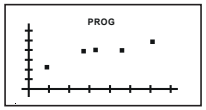
Steps : ④ [FUNC.] 2 (STAT) 1 (GRAPH) 0 (Scat) [FUNC.] 2 (STAT) 2 (LIST) 0 (L1) [,] [FUNC.] 2 (STAT) 2 (LIST) 1 (L2) [,] 1 [,] [FUNC.] 2 (STAT) 3 (MARK) 1 (Dot) [▶] [EXE]

Contents : ⑤ ***DrawStat ;***

Steps : ⑤ [FUNC.] 1 (DISP) 0 (DrawStat) [EXE]

Contents : ⑥ ***End***

Executing this program produces the scatter diagram shown here.



(Note): In the case of a xyLine graph, replace " Scatter " in the above specification with " *xy*Line " .

• The syntax for Time–Series graph is as follow :

T–Ser (< X–list name > , < Y–list name >, < Frequency > , < Y1–list name > , < Y2–list name > , < Y3–list name > , < Y4–list name > , < Y5–list name > , < T–list name > , < mark type>)

(A) The following is a typical graph condition specification for two–dimensional graph :

T–Ser (None ,< Y–list name > , < Frequency > , None , None , None , None , None , < T–list name > , < mark type>)

Where the parameters for Y– and T–list name is L1 ~ L8

Where the parameters for frequency is 1, or L1 ~ L8

Where the mark type is Square , Cross or Dot

(B) The following is a typical graph condition specification for three–dimensional graph :

T–Ser (< X–list name > , < Y–list name > , < Frequency > , < Y1–list name > , < Y2–list name > , < Y3–list name > , < Y4–list name > , < Y5–list name > , < T–list name > , < mark type>)

Where the parameters for X– and T–list name is L1 ~ L8,

Where the parameters for frequency is 1, or L1 ~ L8

Where the parameters for Y, Y1 ~ Y5– list name is L1 ~ L8 or None (To specify one of Y, Y1 ~ Y5 lists is necessary, the other four lists are optional)

Where the mark type is Square , Cross or Dot.

10 – 13 Program Examples

(Example):Create a program for common difference sequence and numbers, where A : First item, D : Common difference, N : number,

Sum : S (N) = A + (A + D) + (A + 2 D) + (A + 3 D) + ... =

$$\frac{N[2A + (N-1)D]}{2}$$

Nth item : A (N) = A + (N – 1) D

PROG TYPE : MAIN Filename : DIFFER

Content

```
Print " 1 : A ( N ) 2 : S ( N ) " ; Sleep ( 5 ) ;
Locate ( 1 , 3 ) ;
Input P , A , D , N ;
If ( P == 1 ) Then { Goto 1 } ;
S = N ( 2 A + ( N – 1 ) D ) ÷ 2 ; Rem SUM ;
Print " S ( " , N , " ) = " , S ;
Goto 2 ;
Label 1 : T = A + ( N – 1 ) D ; Rem NITEM ;
Print " A ( " , N , " ) = " , T ;
Label 2 : End
```

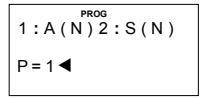
RUN

When the message " **1 : A (N) 2 : S (N)** " appears on the display, you can input a " P " value to any of the following values for specifying the type of operation to be performed.

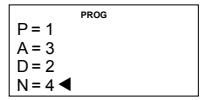
1 ... **A (N)** 2 ... **S (N)**

① A = 3 , D = 2, N = 4 ⇒ A (N) = A (4) = 9

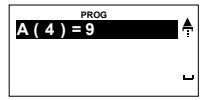
(5 Seconds) 1



[EXE] 3 [EXE] 2 [EXE] 4

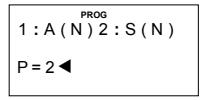


[EXE]

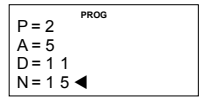


② A = 5 , D = 11, N = 15 ⇒ S (N) = S (15) = 168

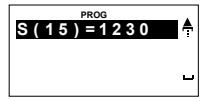
[EXE] (5 Seconds) 2



[EXE] 5 [EXE] 11 [EXE] 15



[EXE]



(Example):Create three subroutines to store the below formulas and use GoSub–PROG commands to write a main program (calling program) for executing

Subroutine 1 : CHARGE = N x 3

Subroutine 2 : POWER = I ÷ A

Subroutine 3 : VOLTAGE = I ÷ (B x Q x A)

PROG TYPE : MAIN Filename : CHARGE Note : Subroutine

Content

```
Q=Nx3;
Print "CHARGE=",Q;
End
```

PROG TYPE : MAIN Filename : POWER Note : Subroutine

Content

```
J=I÷A;
Print "POWER=",J;
End
```

PROG TYPE : MAIN Filename : VOLTAGE Note : Subroutine

Content

```
V=I÷(BxQxA);
Print "VOLTAGE=",V;
End
```

PROG TYPE : MAIN Filename : CALL Note : Calling program

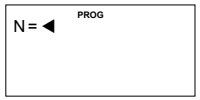
Content

```
Input N;
GoSub PROG CHARGE;
Input I,A;
GoSub PROG POWER;
B=27;
GoSub PROG VOLTAGE;
End
```

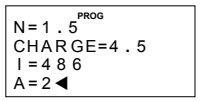
RUN

N = 1.5, I = 486, A = 2 ⇒ CHARGE = 4.5, POWER = 243, VOLTAGE = 2

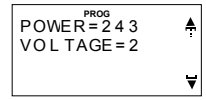
[EXE]



1.5 [EXE] 486 [EXE] 2



[EXE] [▲]



(Example):Use For command to create a program that calculate a multiplication table

9 x 1 = 9 8 x 1 = 8 ..... 2 x 1 = 2 1 x 1 = 1
9 x 2 = 18 8 x 2 = 16 ..... 2 x 2 = 4 1 x 2 = 2
⋮ ⋮ ⋮ ⋮
9 x 8 = 72 8 x 8 = 64 ..... 2 x 8 = 16 1 x 8 = 8
9 x 9 = 81 8 x 9 = 72 ..... 2 x 9 = 18 1 x 9 = 9

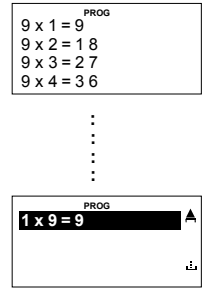
PROG TYPE : MAIN Filename : LOOP

Content

```
For(A=9;A≥1;A--);
{For(B=1;B≤9;B++)
{C=AxB;Print A,"x",B,"=",C}}
End
```

RUN

[EXE]



(Example):Set the program type of the program area as " Base–n " and create a program that calculate the following question :

ANS = 1010_{2} And (Y Or 7_{16})

PROG TYPE : Base–n (Decimal) Filename : LOGICAL

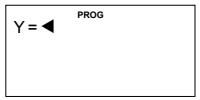
Content

```
Input Y;
C=b1010 And (Y Or h7);
Print "ANS=",C;
End
```

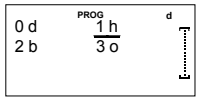
RUN

① Y = /A $_{16}$ ⇒ Ans = 10 $_{10}$

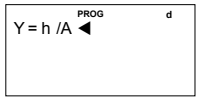
[EXE]



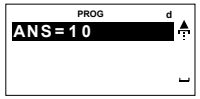
[dhbo][▶]



[EXE][A]

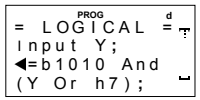


[EXE]

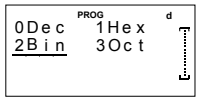


EDIT

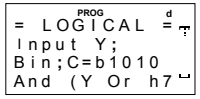
[EXE][▼]



[2nd][SYSTEM][▼]



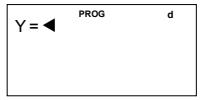
[EXE][ALPHA][;]



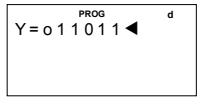
RUN

① Y = 11011 $_{8}$ ⇒ Ans = 1010 $_{2}$

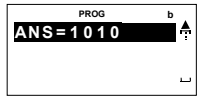
[EXE]



[dhbo]3(o)11011

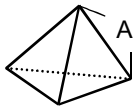


[EXE]



(Example): Use Data–Read commands to create a program that calculates the following formulas used for calculating surface area (S) and volume (V) of a regular tetrahedron for which the length of one side (A) are 3.5 , 5 , 12

$$S = \sqrt{3}A^2 \qquad V = \frac{\sqrt{2}}{12}A^3$$



A	S	V
3.5	? cm ^{2}	? cm ^{3}
5	? cm ^{2}	? cm ^{3}
12	? cm ^{2}	? cm ^{3}

PROG TYPE : MAIN Filename : TETRA

Content

```
Label 1:Read(A);
Data(3.5,5,12);
S=√(3)xA^2;
V=√(2)÷12xA^3;
Print "A=",A;
Print "S=",S;
Print "V=",V;
If (A≠12) Then {Goto 1};
Goto 2;
Label 2:End
```

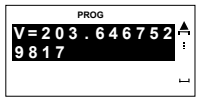
RUN

Executing this program produces the below results shown here.

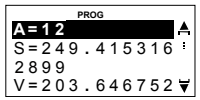
A	S	V
3.5	21.21762239272 cm ^{2}	5.052867207229 cm ^{3}
5	43.30127018922 cm ^{2}	14.73139127472 cm ^{3}
12	249.4153162899 cm ^{2}	203.6467529817 cm ^{3}

RUN

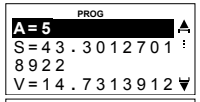
[EXE]



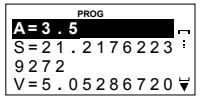
[▲] [▲]



[▲] [▲] [▲]



[▲] [▲] [▲]



(Example): Create a program that simulates a lottery game to draw a winning numbers of a lottery, where the winning numbers is a combination of 4 numbers that are randomly drawn from the possible 1 through 42 and each numbers can't be repeated

PROG TYPE : MAIN Filename : LOTTERY

Content

```
A=RandI(1,42);
Label 1:B=RandI(1,42);
If (B==A)Then{Goto 1};
Label 2:C=RandI(1,42);
If (C==A)Then{Goto 2};
If (C==B)Then{Goto 2};
Label 3:D=RandI(1,42);
If (D==A)Then{Goto 3};
If (D==B)Then{Goto 3};
If (D==C)Then{Goto 3};
Print "*LOTTERY*";
Print A," ",B," ",C," ",D;
End
```

RUN

[EXE] [▲]