Canon

https://global.canon/calmanual

F-789SGA

SCIENTIFIC CALCULATOR
USER INSTRUCTIONS

E-IE-522

ENGLISH

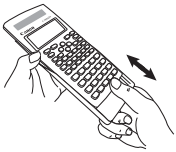
Contents

Important Precautions Before Use

• Before using the product, please read this manual carefully. And keep it on hand for future reference.

How to Use the Slide Cover

Open or close the cover by sliding as shown in the figure.



Display

<Status Indicators>

S	: Shift key
A	: Alpha key
M	: Independent Memory
STO	: Store Memory
RCL	: Recall Memory
STAT	: 1-Var & 2-Var Statistics Mode
CPLX	: Complex Number Calculation Mode
MATX	: Matrix Calculation Mode
VCTR	: Vector Calculation Mode
EQN	: Equation Calculation Mode
D	: Degree Mode
R	: Radian Mode
G	: Gradient Mode
FIX	: Fixed-decimal Setting
SCI	: Scientific Notation
LINE	: Line Display Mode
▲	: Up Arrow
▼	: Down Arrow
Disp	: Multi-statements Display

Getting Started

Power On, Off

■ **First time operation:**

1. Remove the battery insulation tab to load the battery.
2. Press [ON] [Shift] [CLR] [3] [=] [CA] to initialize the calculator.

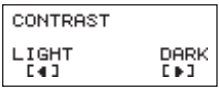
Power ON: When [ON] is pressed.

Power OFF: [Shift] [OFF] are pressed.

■ **Auto Power off Function:**
When the calculator is not used for approximately 7 minutes, it will automatically power off.

Display Contrast Adjustment

■ Press [Shift] [SET-UP] (▽) [6] (6: ◀CONT ▶), to enter the Display Contrast Adjustment screen.

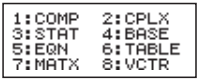


Press (▷) to darken the display contrast.
Press (◁) to lighten the display contrast.
Press [CA] or [ON] to confirm and clear the screen.

■ To initialize the LCD contrast, press [Shift] [CLR] [3] [=] [CA] outside the **Display Contrast Adjustment** screen.

Mode Selection

■ Press [MODE] to enter the Calculation Mode Selection screen.



Operation	Mode		LCD Indicator
MODE 1	COMP	Normal calculations	
MODE 2	CPLX	Complex number calculation	CPLX
MODE 3	STAT	Statistical and regression calculations	STAT
MODE 4	BASE	Calculations involving specific number systems	
MODE 5	EQN	Equation solution	EQN
MODE 6	TABLE	Function table generation	
MODE 7	MATX	Matrix calculations	MATX
MODE 8	VCTR	Vector calculations	VCTR

■ The default mode is COMP mode.

Application Function Menu (Apps Key)

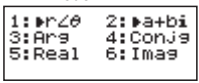
Apps

The Apps menu contains mathematical functions. In each Calculation Mode, the listed functions are different.

■ Press MODE and corresponding number to enter the calculation mode.
■ Press Apps to enter the Apps menu.
■ Press ⌄ / ⌃ for next / previous pages.

i) COMP Mode

ii) CPLX Mode

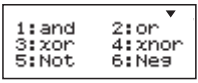


iii) STAT Mode

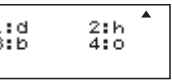
In SD mode

In REG mode

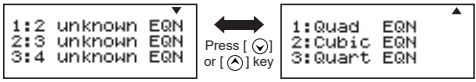
iv) BASE Mode



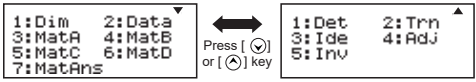
Press [⌄] or [⌃] key



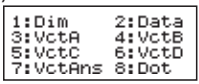
v) EQN Mode



vi) MATX Mode



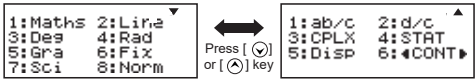
vii) VCTR Mode



■ Press Apps Apps to exit the Apps menu.

Calculator Set-up Menu

■ Press Shift SET-UP to enter the **Calculator Set-up Menu**; press ⌄ / ⌃ for next / previous page.



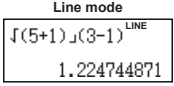
■ **To select the calculator input & output format [1] Maths or [2] Line**

[1] Maths – (Mathematics mode): The majority of calculation input and output (e.g. Fraction, pi, square root number) are shown in Mathematics textbook format.

Mathematics mode

[2] Line – (Line mode): The majority of calculation input and output are shown in the line format. The "LINE" icon will be shown.

Line mode



For the STAT, EQN, MATX, VCTR mode, the Input & Display format will switch to Line mode automatically.

■ **To select the angle unit [3] Deg, [4] Rad or [5] Gra**

[3] Deg: Angle unit in Degree
[4] Rad: Angle unit in Radian
[5] Gra: Angle unit in Gradient

$90^o = \frac{\pi}{2}$ radians = 100grads

■ **To select display digit or notation [6] Fix, [7] Sci or [8] Norm**

[6] Fix: Fixed Decimal, [Fix 0~9?] appears, specify the number of decimal places by pressing [0] – [9].
Example: 220 ÷ 7 = 31.4286 (FIX 4)
= 31.43 (FIX 2)

[7] Sci: Scientific Notation, [Sci 0~9?] appears, specify the number of significant digits by pressing [0] – [9].
Example: 220 ÷ 7 = 3.1429×10^1 (SCI 5)
= 3.143×10^1 (SCI 4)

[8] Norm: Exponential Notation, [Norm 1~2?] appears, specify the exponential notation format by pressing [1] or [2].

Norm 1: Exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than **TWO** decimal points.

Norm 2: Exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than **NINE** decimal places.

Example: 1 ÷ 1000 = 1×10^{-3} (Norm 1)
= 0.001 (Norm 2)

■ **To select the fraction format [1] a b/c or [2] d/c**

[1] a b/c: specify Mixed fraction display
[2] d/c: specify Improper fraction display

■ **To select the complex number display format [3] CLPX ([1] a+bi or [2] r<θ)**

[1] a+bi: specify Rectangular Coordinates
[2] r<θ : specify Polar Coordinates

■ **To select the statistical display format [4] STAT ([1] ON or [2] OFF)**

[1] ON: Show FREQ (Frequency) Column in Statistical Data Input Screen

[2] OFF: Hide FREQ (Frequency) Column in Statistical Data Input Screen

■ **To select the decimal point display format [5] Disp ([1] Dot or [2] Comma)**

[1] Dot: specify dot format for Decimal point result display

[2] Comma: specify comma format for Decimal point result display

■ **To Adjust Display contrast [6] ◁ CONT ▷**

Refer to the “Display Contrast Adjustment” section.

Before Using the Calculator

■ **Check the current Calculation Mode**

Be sure to check the status indicators that indicate the current calculation mode (COMP, STAT, TABLE), display formats setting, and angle unit setting (Deg, Rad, Gra).

■ **Return to initial setup**

Press Shift CLR 1 = (YES) CA to return the initial calculator setup:

Calculation mode	: COMP
Input/Output Format	: Maths
Angle unit	: Deg
Display Digits	: Norm 1
Fraction Display Format	: d/c
Statistical Data Input	: OFF
Decimal Point format	: Dot

This action will not clear the variable memories.

■ **Initialize the calculator**

When you are not sure of the current calculator setting, you are recommended to initialize the calculator (resets calculation mode to "COMP", angle unit to "Degree", clears replay and variable memories, and resets LCD contrast) by performing the following key operations:

Shift CLR 3 (All) = (YES) CA.

Inputting Expressions and Values

Input Capacity

F-789SGA allows you to input a single calculation with up to 99 bytes. Normally, one byte is used each time you press one of the numeric keys, arithmetic keys, scientific function keys or [Ans] . Some functions require 4 – 13bytes. [Shift], [Alpha], and the direction keys will not use up any bytes.
When the remaining input capacity is less than 10bytes, the input cursor will change from " ▌ " to " ▉" signaling that the memory is running now.

Input Editing

- New Input begins on the left of display. When the input data is more than 15 characters (Line Mode) / 16 characters (Math mode), the line will scroll to the right consecutively. You can scroll back to the left by using (◄) and (►) to review the input.
- In Line mode, press (▲) to let the cursor jump to the beginning of input, press (▼) to jump to the end.
- In Mathematics mode, press (►) to let the cursor jump to the beginning of input when it is at the end of the input calculation. Or press (◄) to let the cursor jump to the end of input when it is at the beginning of the input calculation.
- Omit the multiplication sign and final close parenthesis.

Example: 2 x log 100 x (1+3) = 16

	Operation 1:	**Display 1**
Including [×] *1, [)] *2, [)] *3	[2] [×] [log] [1] [0] [0] [)] [×] *2 *1 [(] [1] [+] [3] [)] [=] *3	2xlog(100) x (1+3) 16
	Operation 2:	**Display 2**
Omitting [×] *1, [)] *3	[2] [log] [1] [0] [0] [)] [(] [1] [+] [3] [=]	2log(100)(1+3) 16

*1. Omit multiplication sign (x)
- Input before an open parentheses [(]: 1 x (2+3)
- Input before scientific functions that includes parentheses: 2 x cos(30)
- Input before Random number function [Rand]
- Input before Variable (A, B, C, D, X, Y, M), π, θ

*2. Scientific functions come with the open parenthesis. Example: sin(, cos(, Pol(, LCM(….. You need to input the argument and the close parenthesis [ )].
*3. Omit the last close parenthesis before the [=], [M+], [M-], [Shift] and [STO].

■ Insert and Overwrite Input mode

In Line mode, you can use INSERT [Insert] or overwrite mode for inputting.

- In Insert mode (Default input mode), the cursor is a vertical flashing line " ▮ " for inserting a new character.
- In Overwrite mode, press [Shift] [Insert] key to switch the cursor to a flashing horizontal " _ " and replace the character at the current cursor position.

In Mathematics mode, you can only use the Insert mode.

Whenever the display format changes from Line mode to Mathematics mode, it will automatically switch to the Insert mode.

■ Deleting and Correcting an Expression

In Insert mode: Move the cursor to the right of the character or function that needs to be deleted, then press [DEL].

In Overwrite mode: Move the cursor under the character or function being deleted, then press [DEL].

Example: 1234567 + 889900

(1) Replace an entry (1234567 → 1234560)

Mode Setting	Key In operation	Display (input Line only)
Method 1: Line/Maths mode - Insert mode	1234567 [+] 889900 [◄] 7 times	1234567▮+889900
	[DEL] [0]	1234560▮+889900
Method 2: Line mode - Overwrite mode	[Shift] [SET-UP] [2] 1234567 [+] 889900 [Shift] [Insert]	1234567+889900_
	[◄] 8 times	1234567+889900
	[0]	1234560+889900

(2) Deletion (1234567 → 134567)

Method 1: Line/Maths mode - Insert mode	[◄] 12times	12▮34567+889900
	[DEL]	1▮34567+889900
Method 2: Line mode - Overwrite mode	[Shift] [Insert]	1234567+889900_
	[◄] 13times	1234567+889900
	[DEL]	134567+889900

(3) Insertion (889900 → 2889900)

Line/Maths mode -	◄ 6times	1234567+|889900
Insert mode	2	1234567+2|889900

Inputting and Display Result in Mathematics Mode

■ In Mathematic Mode, the input and display result of fraction or certain functions (log, x^2, x^3, $x^{\blacksquare}$, $\sqrt{\blacksquare}$, $\sqrt[3]{\blacksquare}$, $\sqrt[\blacksquare]{\square}$, x^{-1}, $10^{\blacksquare}$, $e^{\blacksquare}$, Abs) is shown in Handwriting/Mathematics format.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
$\left\|\sqrt{3}-\frac{2}{\sqrt{2}}\right\|$	Abs √□ 3 ► − 2 $\frac{\blacksquare}{\square}$ √□ 2 =	$\left\|\sqrt{3}-\frac{2}{\sqrt{2}}\right\|$ $\sqrt{3}-\sqrt{2}$

NOTE

(1) Some input expressions cause the height of a calculation expression to be greater than one display screen. Maximum input capacity: 2 display screens (31 dots x 2).

(2) Calculator memory limits how many functions or parentheses can be input in any single expression. In this case, divide the expression into multiple parts and calculate separately.

(3) If part of the expression you input is cut off after calculation and in the result display screen, you can press ◄ or ► to view the full expression.

Input Range and Error Messages

Calculation Precision, Input Range

Number of Digits for Internal Calculation	Up to 18 digits
Precision	±1 at the 10th digit for a single calculation. ±1 at the least significant for exponential display
Calculation Range	$\pm 1 \times 10^{-99}$ to $\pm 9.999999999 \times 10^{99}$ or 0

■ Function Calculation Input Ranges

Functions	Input Range	
sinx	DEG	$0 \leqq \|x\| < 9\times10^{9}$
	RAD	$0 \leqq \|x\| <$ 157 079 632.7
	GRA	$0 \leqq \|x\| < 1\times10^{10}$
cosx	DEG	$0 \leqq \|x\| < 9\times10^{9}$
	RAD	$0 \leqq \|x\| <$ 157 079 632.7
	GRA	$0 \leqq \|x\| < 1\times10^{10}$
tanx	DEG	Same as sinx, except when $\|x\| = (2n-1)\times90$
	RAD	Same as sinx, except when $\|x\| = (2n-1)\times \pi/2$
	GRA	Same as sinx, except when $\|x\| = (2n-1)\times100$
$\sin^{-1}x$	$0 \leqq \|x\| \leqq 1$	
$\cos^{-1}x$		
$\tan^{-1}x$	$0 \leqq \|x\| \leqq 9.999\ 999\ 999\times10^{99}$	
sinhx	$0 \leqq \|x\| \leqq$ 230 258 509 2	
coshx		
$\sinh^{-1}x$	$0 \leqq \|x\| \leqq 4.999\ 999\ 999\times10^{99}$	
$\cosh^{-1}x$	$1 \leqq x \leqq 4.999\ 999\ 999\times10^{99}$	
tanhx	$0 \leqq \|x\| \leqq 9.999\ 999\ 999\times10^{99}$	
$\tanh^{-1}x$	$0 \leqq \|x\| \leqq 9.999\ 999\ 999\times10^{-1}$	
logx/lnx	$0< x \leqq 9.999\ 999\ 999\times10^{99}$	
10^{x}	$-9.999\ 999\ 999\times10^{99} \leqq x \leqq 99.999\ 999\ 99$	
e^{x}	$-9.999\ 999\ 999\times10^{99} \leqq x \leqq$ 230.258 509 2	
$\sqrt{x}$	$0 \leqq x < 1\times10^{100}$	
x^{2}	$\|x\|<1\times10^{50}$	
x^{3}	$\|x\| \leqq$ 2.154 434 69$\times10^{33}$	
x^{-1}	$\|x\|<1\times10^{100}, x \neq 0$	
$\sqrt[3]{x}$	$\|x\|<1\times10^{100}$	
x!	$0 \leqq x \leqq 69$ (x is an integer)	
nPr	$0 \leqq n < 1\times10^{10}$, $0 \leqq r \leqq n$ (n,r are integers)	
	$1 \leqq \{n!/(n-r)!\} < 1\times10^{100}$	
nCr	$0 \leqq n < 1\times10^{10}$, $0 \leqq r \leqq n$ (n,r are integers)	
	$1 \leqq n!/r! < 1\times10^{100}$ or $1 \leqq n!/(n-r)! < 1\times10^{100}$	

Functions	Input Range
Pol(x,y)	$\|x\|,\|y\| \leq 9.999\ 999\ 999 \times 10^{99}$ $\sqrt{x^2+y^2} \leq 9.999\ 999\ 999 \times 10^{99}$
Rec(r,θ)	$0 \leq r \leq 9.999\ 999\ 999 \times 10^{99}$ θ : Same as sinx
°′″	$\|a\|,b,c < 1 \times 10^{100}$ $0 \leq b,c$ The display seconds value is subject to an error of +/-1 at the second decimal place
◀ °′″	$\|x\| < 1 \times 10^{100}$ Deciaml ↔ Sexagesimal Conversions $0°0'0'' \leq \|x\| \leq 9999999°59'59''$
^(x^y)	x>0: $-1 \times 10^{100} <$ ylog x < 100 x=0: y>0 x<0: y=n,m/(2n+1) (m,n are integers) However: $-1 \times 10^{100} <$ ylog|x| < 100
x√y	y>0: $x \neq 0$, $-1 \times 10^{100} < 1/x$ logy < 100 y=0:x>0 y<0:x=2n+1,(2n+1)/m (m≠0;m,n are integers)
a b/c	Total of integer, numerator, and denominator must be 10 digits or less (including division marks).
i~Rand(a,b)	$0 \leq a < 1 \times 10^{10}$, $0 \leq b < 1 \times 10^{10}$ (a,b should be positive integers or 0)
Rand	Result generates a 3 digits pseudo random number(0.000~0.999)
LCM(x,y,z)	$0 < x, y, z \leq 9.999\ 999\ 999 \times 10^{12}$ (positive integers) Default result when x, y, z=0
GCD(x,y,z)	$0 < x, y, z \leq 9.999\ 999\ 999 \times 10^{12}$ (positive integers) Default result when x, y, z=0
Q…r(x,y)	$0 < x,y \leq 9.999\ 999\ 999 \times 10^{12}$ (positive integers) $0 \leq Q \leq 999\ 999\ 9999$, $0 \leq r \leq 999\ 999\ 9999$ (Q,r are integers) Default result when x=0

Functions	Input Range
Mod(x,y)	$0<\|x,y\| \leqq 9.999999999 \times 10^{12}$ Default result=x when y=0
Single-variable	$\|x\|<1 \times 10^{100}$ $\|FREQ\|<1 \times 10^{100}$
Paired-variable	$\|x\|<1 \times 10^{100}$ $\|y\|<1 \times 10^{100}$ $\|FREQ\|<1 \times 10^{100}$
ABS	$\|x\|<1 \times 10^{100}$
Pfact	$x \leqq 9999999999$ (positive integers)
BIN	Positive: 0~0111 1111 1111 1111 1111 1111 1111 1111 Negative: 1000 0000 0000 0000 0000 0000 0000 0000~ 1111 1111 1111 1111 1111 1111 1111 1111
DEC	Positive: 0~2147483647 Negative: -2147483648~-1
OCT	Positive: 0~177 7777 7777 Negative: 200 0000 0000~377 7777 7777
HEX	Positive: 0~7FFF FFFF Negative: 8000 0000~FFFF FFFF
$\sum$ *(f(x),a, b)*	*a* and *b* are integers in the range of –1 • 10^10 < $a \leqq b$ <1 • 10^10.
$\prod$ *(f(x),a, b)*	*a* and *b* are integers in the range of –1 • 10^10 < $a \leqq b$ <1 • 10^10.

- Errors are cumulative in the case of consecutive calculations, this is also true as internal consecutive calculation are performed in the case of ^(x^y), $\sqrt[x]{y}$, $\sqrt[3]{}$, x!, nPr, nCr , etc. and may become large.

■ Display of results using $\sqrt{}$

Calculation results may be displayed using $\sqrt{}$ in all of the following cases:

1. When intermediate and final calculation results are displayed in the following form:

$$\pm\frac{a\sqrt{b}}{c}\pm\frac{d\sqrt{e}}{f}$$

$$0 \leq a < 100, \quad 1 \leq d < 100$$
$$0 \leq b < 1000, \quad 1 \leq e < 1000$$
$$1 \leq c < 100, \quad 1 \leq f < 100$$

2. When the number of terms in the intermediate and final calculation result involving $\sqrt{}$ is one or two.

Order of Operations

This calculator will automatically determine the operation priority of each individual command as follows:-

1st Priority	Recall memory (A, B, C, D, E, F, 0-9), Rand
2nd	Calculation within parentheses ( ).
3rd	Function with parenthesis that request the input argument to the right Pol(, Rec(, d/dx, ∫dx, P(, Q(, R(, Det(, Trn(, Ide(, Adj(, Inv(, Arg(, Conjg(, Real(, Imag(, sin(, cos(, tan(, $\sin^{-1}$(, $\cos^{-1}$(, $\tan^{-1}$(, sinh(, cosh(, tanh(, $\sinh^{-1}$(, $\cosh^{-1}$(, $\tanh^{-1}$(, log(, ln(, e^(, 10^(, $\sqrt{}$(, $\sqrt[3]{}$(, Abs(, ROUND(, LCM(, GCD(, Q…r(, i~Rand(,
4th	Functions that come after the input value preceded by values, powers, power roots: x^2, x^3, x^{-1}, x!, ° ' ", °, r, g, ^(, $\sqrt[x]{}$(, Percent %, $\log_a b$, EXP, ▶t
5th	Fractions: a b/c, d/c
6th	Prefix symbol: (–) (negative sign), base-n symbols (d, h, b, o, Neg, Not)
7th	Statistical estimated value calculation: x̂, ŷ, x̂1, x̂2 Metric conversion commands (cm → in, etc)
8th	Multiplication where sign is omitted: Multiplication sign omitted immediately before π, e, variables (2π, 5A, πA, etc.), functions with parentheses ($2\sqrt{}(3)$, Asin(30), etc.)
9th	Permutations, combinations: nPr, nCr Complex number polar coordinate symbol (<)
10th	Dot: ▪
11th	Multiplication and division: ×, ÷
12th	Addition and subtraction: +, –
13th	Logical AND (and)
14th	Logical OR, XOR, XNOR (or, xor, xnor)
15th	Calculation ending instruction: =, M+, M- STO (store memory), ▶r<θ, ▶a+bi

- In the same precedence level, calculations are performed from left to right.
- Operations enclosed within parentheses are performed first. When a calculation contains an argument that is a negative number, the negative number must be enclosed within the parentheses.

Example:

(−) 2 x^2 = $-2^2 = -4$

((−) 2) x^2 = $(-2)^2 = 4$

- When same priority commands are mixed into one calculation:

Example 1:

1 ÷ 2 Shift π = $1 \div 2\pi = 0.1591549431$

Example 2:

2 Shift STO (−) $2 \rightarrow A$

1 ÷ 2 Alpha A = $1 \div 2A = \frac{1}{4}$

Calculation Stacks

- This calculator uses memory areas, called “stacks”, to temporarily store numeric value (numbers) commands (+, –, x…) and functions according to their precedence during calculations.
- The numeric stack has 10 levels and the command stack has 128 levels. A stack error [Stack ERROR] occurs whenever you try to perform a calculation that exceeds the capacity of stacks.
- Calculations are performed in sequence according to “Order of Operations”. After the calculation is performed, the stored stack values will be released.

Error Messages and Error Locator

The calculator is locked up when an error message is shown on the display indicating the cause of the error.

- Press CA to clear the error message, then return to the initial display of the latest mode.
- Press ◄ or ► to display the input expression with the cursor positioned next to the error.
- Press ON to clear the error message, replay memory history and return to the initial display of the latest mode.

Error Message	Cause	Action
Math ERROR	• The intermediate or final result is outside the allowable calculation range. • An attempt to perform a calculation using a value that exceeds the allowable input range. • An attempt to perform an illogical operation (division by zero, etc.)	• Check the input values and make sure they are all within the allowable ranges, Pay special attention to values in any using memory areas
Stack ERROR	• The capacity of the numeric stack or operator stack is exceeded.	• Simplify the calculation. • Divide the calculation into two or more separate parts.
Syntax ERROR	• An attempt to perform an illegal mathematical operation.	• Press ◄ or ► to display the cursor at the location of the error, make appropriate corrections
Insufficient MEM	• The calculation result of Function Table mode parameters caused more than 30 x-values to be generated for a table	• Narrow the table calculation range by changing the start, end, and step values, and try again.
Dimension ERROR (only in Matrix or Vector)	• The dimension (row column) is over. • An attempt to perform an illegal matrix/vector operation.	• Press ◄ or ► to display the location of the cause of an error and make required corrections.
Can't Solve ERROR (only in SOLVE function)	• The calculator could not obtain a solution.	• Check for errors in the equation that you input. • Input a value for the solution variable that is close to the expected solution and try again.
Variable ERROR (only in SOLVE function)	• Equation is not a correct equation. • Equation does not include variable X. • The solution variable is not similar to the specified variable in the expression.	• Correct the equation to include variable X. • Correct the equation to match the solution variable and expression. (refer to P.49)
Time Out ERROR (only in Differential or integration Calculations	• The calculation ends without the ending condition being fulfilled.	• Revise the ending condition and try again. (refer P.51-52)
Argument ERROR	• Improper use of an argument.	• Press ◄ or ► to display the location of the cause of an error and make required corrections.

Basic Calculations

- Press [MODE] [1] to enter COMP mode.
- As the calculation is busy processing, the calculator shows the message [PROCESSING] (without any calculation result). Press [CA] key to interrupt the calculating operation.

Arithmetic Calculations [+] [−] [×] [÷]

- To calculate the negative values (exclude the negative exponent) enclose then within the parentheses.
- This calculator supports 99 levels of parenthetical expression.

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
$(-2.5)^2$	[(] [(−)] [2] [•] [5] [)] [x^2] [=]	$(-2.5)^2$ $\frac{25}{4}$
$(4 \times 10^{75})(-2 \times 10^{-79})$	[4] [EXP] [7] [5] [×] [(−)] [2] [EXP] [(−)] [7] [9] [=]	$4_E75\times$ $-\frac{1}{1250}$

Memory Calculations [Ans] [M-] [M+] [M] [STO] [RCL]

Memory Variables

- There are 19 memory variables (0 – 9, A – F, M, X and Y), which store data, results, or dedicated values.
- Store values into memory by pressing [Shift] [STO] + Memory variable.
- Recall memory values by pressing [RCL] + Memory variable.
- Memory content can be cleared by pressing [0] [Shift] [STO] + Memory variable.

Example: 23 + 7 → A (30 store into A), calculate 2 sinA and clear memory A.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
23 + 7 → A	2 3 + 7 Shift STO A	23+7→A 30
2 x sin A = 1	2 sin Alpha A =	2sin(A 1
Clear memory	0 Shift STO A	0→A 0

Independent Memory

- Independent memory M uses the same memory area as variable M. It is convenient for calculating cumulative totals by pressing M+ (add to memory) or M- (subtract from memory).
- Memory contents are retained even when the calculator is powered off.
- Clear independent memory (M) by pressing 0 Shift STO M
- Clear all memory values by pressing Shift CLR 2(MCL) = CA.

Answer Memory

- The input values or the most recent calculation result will be automatically stored into Answer memory whenever you press =, Shift =, M+, Shift M-, Shift STO. Answer memory can hold up to 18 digits.
- Recall and use the latest stored Answer memory by pressing Ans.
- Answer memory is not updated when an error operation has been performed.
- Answer memory contents can be maintained even after pressing CA, changing the calculation mode, or turning off the calculator.

Example	Key in operation	Display
123 + 456 → M+, Ans^2 = 335,241	1 2 3 + 4 5 6 M+ x^2 =	Ans^2 335241
789900 – Ans = 454,659	7 8 9 9 0 0 − Ans =	789900-Ans 454659

Fraction Calculations

The calculator supports Fraction calculation and the conversions between Fraction, Decimal point, Mixed fraction and Improper fraction.

- Specify the fraction calculation result display format by selecting either **mixed fraction (■$\frac{■}{■}$)** or **improper fraction ($\frac{■}{■}$)** in set-up menu.
- At the default setting, fractions are displayed as improper fractions ($\frac{■}{■}$).
- Mixed Fraction display results are only available after selecting (■$\frac{■}{■}$) in the setup menu.

	Improper Fraction (d/c)	Mixed Fraction (a b/c)
Maths Mode	$\frac{11}{3}$	$3\frac{2}{3}$
Line Mode	11_|3	3_|2_|3

- Press [F↔D] to switch a calculation result between fraction and decimal format.
- Press [Shift] [a b/c↔d/c] to switch a calculation result between improper fraction and mixed fraction format.
- Results will be displayed in decimal format automatically whenever the total digits of a fractional value (integer + numerator + denominator + separator marks) exceeds 10.
- When a fraction calculation is mixed with decimal values, the result will be displayed in decimal format.

Fraction ⟷ Decimal point conversion

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
$1\frac{1}{2}+\frac{5}{6}=\frac{7}{3}$	[1] [Shift] [■$\frac{■}{■}$] [1] [→] [2] [→] [+] [5] [$\frac{■}{■}$] [6] [=]	$1\frac{1}{2}+\frac{5}{6}$ $\frac{7}{3}$
$\frac{7}{3}$ ↔ 2.333333333 (Fraction ⟷ Decimal)	[F↔D]	$1\frac{1}{2}+\frac{5}{6}$ 2.333333333
2.333333333 ↔ $2\frac{1}{3}$ (Decimal ⟷ Mixed Fraction)	[Shift] [a b/c↔d/c]	$1\frac{1}{2}+\frac{5}{6}$ $2\frac{1}{3}$

Display Values Exchange

- In Maths mode, press [F↔D] to change the calculation result value between fraction form ⇔ Decimal form, π form ⇔ Decimal form, √ form ⇔ Decimal form.
- In Line mode, press [F↔D] to **ONLY** change the calculation result value between fraction form ⇔ Decimal form, the other π and √ calculation will display the decimal value only.

LINE MODE: [Shift] [SET-UP] [2]

Example	Key in operation	Display
$\frac{2}{3}+2=\frac{8}{3}=2.666666667$	[2] [$\frac{\square}{\square}$] [3] [+] [2] [=]	2⌟3+2 8⌟3
	[F↔D]	2⌟3+2 2.666666667

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
$\frac{2}{3}+2=\frac{8}{3}=2.666666667$	[2] [$\frac{\square}{\square}$] [3] [▶] [+] [2] [=]	$\frac{2}{3}$+2 $\frac{8}{3}$
	[F↔D]	$\frac{2}{3}$+2 2.666666667
$\tan 30=\frac{\sqrt{3}}{3}$ =0.5773502692	[tan] [3] [0] [=]	tan(30 $\frac{\sqrt{3}}{3}$
	[F↔D]	tan(30 0.5773502692
$\pi\div 8=\frac{1}{8}\pi$ =0.3926990817	[Shift] [π] [÷] [8] [=]	$\pi\div 8$ $\frac{1}{8}\pi$
	[F↔D]	$\pi\div 8$ 0.3926990817

NOTE:

- In some Calculation results, pressing [F↔D] will not convert the display value.
- Some display result conversions may take a long time.

Percentage Calculations

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
To calculate 25% of 820	8 2 0 × 2 5 Shift % =	820x25% 205
The percentage of 750 against 1250	7 5 0 ÷ 1 2 5 0 Shift % =	750÷1250% 60

Degree-Minutes-Seconds Calculations

Use the degrees (hours), minutes and seconds key to perform a sexagesimal (base-60 notational system) calculation or convert the sexagesimal value into decimal value.

Degree-Minutes-Seconds ⟷ Decimal points

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
86º37'34.2" ÷ 0.7 = 123º45'6"	8 6 ° ' " 3 7 ° ' " 3 4 • 2 ° ' " ÷ 0 • 7 =	86º37 º 34.2 º ÷ 0.7 123º45'6"
123º45'6" → 123.7516667	° ' "	86º37 º 34.2 º ÷ 0.7 123.7516667
2.3456 → 2º20'44.16"	2 • 3 4 5 6 = ° ' "	2.3456 2º20'44.16"

Replay & Multi-statements

■ Replay Memory Function

- Replay memory is only available in COMP mode.
- After the calculation is executed, the calculation input and result will be stored in the replay memory automatically.
- Pressing ⊙ (or ⊙) can replay the performed calculation input and result history.
- After obtaining the calculation result on the display, press ⊙ or ⊙ to edit the input expression of that result.
- If the ▷ Indicator is on the right side of a calculation result display, you need to press [CA] and then ⊙ or ⊙ to scroll through the calculation.
- Replay memory is cleared when you:
  1. Initialize calculator setting by Shift CLR 3 = CA
  2. Change from one calculation mode or display mode to another.
  3. Press [ON] key.
  4. Press Shift OFF to power off the machine.

■ Multi-statements Function

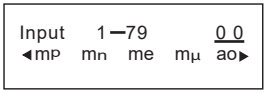
- Use a colon ⁝ to put two or more calculation expressions together.
- The first executed statement will have “Disp” indicator; and the “Disp” icon will disappear after the last statement is executed.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
1x12=12 2+25=27 using a multi-statement	1 × 1 2 Alpha ⁝ 2 + 2 5	1x12:2+25
	=	▲ Disp 1x12 12
	=	▲ 2+25 27
Replay the previous calculation history (1 x 12 = 12)	⊙	▼ 1x12 12

Constant Value Calculations

F-789SGA has total of 79 built-in constant values, you can enter (or exit) the constant value selection menu by pressing Shift C-VALUE, the following display will be shown:



- You can go to the next or previous value selection pages by pressing ^ or v.
- To select a constant value simply press < or > . The selection cursor will shift left or right to underline a constant symbol and the lower line display will show the value of the underlined constant symbol.
- The underlined constant symbol will be selected as you press [=] .
- You can instantly get the constant value if you input the constant value item number and press [=] when the selection cursor is underlining 0 0.

Key in Operation	Display
Shift C-Value (menu selection page)	Input 1—79 0 0 ◀mP mn me mμ ao▶
[3] [5] [=]	g
[+] [3] [5] [=]	g+35 44.80665
[=] [=] [×] [5] [0] [=]	Ansx50 2240.3325

Constant Table

NO.	Constant	Symbol	Value	Unit
1.	Proton mass	m_p	$1.672621777 \times 10^{-27}$	kg
2.	Neutron mass	m_n	$1.674927351 \times 10^{-27}$	kg
3.	Electron mass	m_e	$9.10938291 \times 10^{-31}$	kg
4.	Muon mass	m_μ	$1.883531475 \times 10^{-28}$	kg
5.	Bohr radius $\alpha / 4\pi R\infty$	a_0	$0.52917721092 \times 10^{-10}$	m
6.	Planck constant	h	$6.62606957 \times 10^{-34}$	J s
7.	Nuclear magneton $e \hbar / 2m_p$	μ_N	$5.05078353 \times 10^{-27}$	$J T^{-1}$
8.	Bohr magneton $e \hbar / 2m_e$	μ_B	$927.400968 \times 10^{-26}$	$J T^{-1}$
9.	$h / 2\pi$	$\hbar$	$1.054571726 \times 10^{-34}$	J s
10.	Fine-structure constant $e^2 / 4\pi\varepsilon_0 \hbar c$	α	$7.2973525698 \times 10^{-3}$	
11.	Classical electron radius $\alpha^2 a_0$	r_e	$2.8179403267 \times 10^{-15}$	m
12.	Compton wavelength $h / m_e c$	λ_c	$2.4263102389 \times 10^{-12}$	m
13.	Proton gyromagnetic ratio $2\mu_p / \hbar$	γ_p	$2.675222005 \times 10^{8}$	$s^{-1} T^{-1}$
14.	Proton Compton wavelength $h / m_p c$	$\lambda_{c,p}$	$1.32140985623 \times 10^{-15}$	m
15.	Neutron Compton wavelength $h / m_n c$	$\lambda_{c,n}$	$1.3195909068 \times 10^{-15}$	m
16.	Rydberg constant $\alpha^2 m_e c / 2h$	$R\infty$	10973731.568539	m^{-1}
17.	(unified) atomic mass unit	u	$1.660538921 \times 10^{-27}$	kg
18.	Proton magnetic moment	μ_p	$1.410606743 \times 10^{-26}$	$J T^{-1}$
19.	Electron magnetic moment	μ_e	$-928.476430 \times 10^{-26}$	$J T^{-1}$
20.	Neutron magnetic moment	μ_n	$-0.96623647 \times 10^{-26}$	$J T^{-1}$
21.	Muon magnetic moment	μ_μ	$-4.49044807 \times 10^{-26}$	$J T^{-1}$
22.	Faraday constant $N_A e$	F	96485.3365	$C mol^{-1}$
23.	Elementary charge	e	$1.602176565 \times 10^{-19}$	C
24.	Avogadro constant	NA	$6.02214129 \times 10^{23}$	mol^{-1}
25.	Boltzmann constant R / N_A	k	$1.3806488 \times 10^{-23}$	$J K^{-1}$
26.	Molar volume of ideal gas RT / p T=273.15 K, p=101.325 kPa	Vm	22.413968×10^{-3}	$m^3 mol^{-1}$
27.	Molar gas constant	R	8.3144621	$J mol^{-1} K^{-1}$
28.	Speed of light in vacuum	c_0	299792458	$m s^{-1}$
29.	First radiation constant $2\pi hc^2$	c_1	$3.74177153 \times 10^{-16}$	$W m^2$
30.	Second radiation constant hc/k	c_2	1.4387770×10^{-2}	m K

NO.	Constant	Symbol	Value	Unit
31.	Stefan-Boltzmann constant	σ	5.670373×10^{-8}	$W\ m^{-2}\ K^{-4}$
32.	Electric constant $1 / \mu_0 c^2$	ε_0	$8.854187817 \times 10^{-12}$	$F m^{-1}$
33.	Magnetic constant	μ_0	$12.566370614 \times 10^{-7}$	$N A^{-2}$
34.	Magnetic flux quantum $h / 2e$	Φ_0	$2.067833758 \times 10^{-15}$	Wb
35.	Standard acceleration of gravity	g	9.80665	$m s^{-2}$
36.	Conductance quantum $2e^2/h$	G_0	$7.7480917346 \times 10^{-5}$	S
37.	Characteristic impedance of vacuum $\sqrt{\mu_0} / \varepsilon_0 = \mu_0 c$	Z_0	376.730313461	Ω
38.	Celsius temperature	t	273.15	
39.	Newtonian constant of gravitation	G	6.67384×10^{-11}	$m^3\ kg^{-1}\ s^{-2}$
40.	Standard atmosphere	atm	101325	Pa
41.	Proton g-factor $2 \mu_p / \mu_N$	g_p	5.585694713	
42.	$\lambda_{c,n} / 2\pi$	$\lambda\!\!\!^{-}_{c,n}$	$0.21001941568 \times 10^{-15}$	m
43.	Planck length $\hbar / m_P c = (\hbar G / c^3)^{1/2}$	l_P	1.616199×10^{-35}	m
44.	Planck time $l_P / c = (\hbar G / c^5)^{1/2}$	t_P	5.39106×10^{-44}	s
45.	Planck mass $(\hbar c / G)^{1/2}$	m_P	2.17651×10^{-8}	kg
46.	Atomic mass constant	m_u	$1.660538921 \times 10^{-27}$	kg
47.	Electron volt: (e/c) J	eV	$1.602176565 \times 10^{-19}$	J
48.	Molar planck constant	$N_A h$	$3.9903127176 \times 10^{-10}$	J s mol^{-1}
49.	Wien displacement law constant	b	2.8977721×10^{-3}	m K
50.	Lattice parameter of Si(in vacuum, 22.5°C)	a	$543.1020504 \times 10^{-12}$	m
51.	Hartree energy $e^2/4\pi\varepsilon_0 a_0$	Eh	$4.35974434 \times 10^{-18}$	J
52.	Loschmidt constant N_A / Vm	n_0	2.6867805×10^{25}	m^{-3}
53.	Inverse of conductance quantum	G_0^{-1}	12906.4037217	Ω
54.	Josephson constant $2e/h$	K_J	483597.870×10^9	Hz V^{-1}
55.	Von Klitzing constant h/e^2	R_K	25812.8074434	Ω
56.	$\lambda_c / 2\pi$	$\lambda\!\!\!^{-}_c$	$386.15926800 \times 10^{-15}$	m
57.	Thomson cross section $(8\pi/3) r_e^2$	σ_e	$0.6652458734 \times 10^{-28}$	m^2
58.	Electron magnetic moment anomaly $\lvert \mu_e \rvert / \mu_B - 1$	a_e	$1.15965218076 \times 10^{-3}$	
59.	Electron g-factor-2(1+ a_e)	g_e	-2.00231930436153	
60.	Electron gyromagnetic ratio $2 \lvert \mu_e \rvert / \hbar$	γ_e	$1.760859708 \times 10^{11}$	$s^{-1}\ T^{-1}$
61.	Muon magnetic moment anomaly	a_μ	$1.16592091 \times 10^{-3}$	
62.	Muon g-factor-2(1+ a_μ)	g_μ	-2.0023318418	

NO.	Constant	Symbol	Value	Unit
63.	Muon Compton wavelength $h / m_{\mu} c$	$\lambda_{c,\mu}$	$11.73444103 \times 10^{-15}$	m
64.	$\lambda_{c,\mu} / 2\pi$	$\lambda\!\!\!^{-}_{c,\mu}$	$1.867594294 \times 10^{-15}$	m
65.	Tau Compton wavelength $h / m_{\tau} c$	$\lambda_{c,\tau}$	0.697787×10^{-15}	m
66.	$\lambda_{c,\tau} / 2\pi$	$\lambda\!\!\!^{-}_{c,\tau}$	0.111056×10^{-15}	m
67.	Tau mass	m_{τ}	3.16747×10^{-27}	kg
68.	$\lambda_{c,p} / 2\pi$	$\lambda\!\!\!^{-}_{c,p}$	$0.21030891047 \times 10^{-15}$	m
69.	Shielded proton magnetic moment(H_2O, sphere, 25°C)	μ'_p	$1.410570499 \times 10^{-26}$	J T^{-1}
70.	Neutron g-factor $2 \mu_n / \mu_N$	g_n	-3.82608545	
71.	Neutron gyromagnetic ratio $2\lvert \mu_n \rvert / \hbar$	γ_n	1.83247179×10^{8}	s^{-1} T^{-1}
72.	Deuteron mass	m_d	$3.34358348 \times 10^{-27}$	kg
73.	Deuteron magnetic moment	μ_d	$0.433073489 \times 10^{-26}$	J T^{-1}
74.	Helion mass	m_h	$5.00641234 \times 10^{-27}$	kg
75.	Shielded helion magnetic moment(gas, sphere, 25°C)	μ'_h	$-1.074553044 \times 10^{-26}$	J T^{-1}
76.	Shielded helion gyromagnetic ratio $2\lvert \mu'_h \rvert / \hbar$ (gas, sphere, 25°C)	γ'_h	$2.037894659 \times 10^{8}$	s^{-1} T^{-1}
77.	Alpha particle mass	m_{α}	$6.64465675 \times 10^{-27}$	kg
78.	Shielded proton gyromagnetic ratio $2 \mu'_p / \hbar$ (H_2O, sphere, 25°C)	γ'_p	$2.675153268 \times 10^{8}$	s^{-1} T^{-1}
79.	Proton magnetic shielding correction $1-\mu'_p / \mu_p$(H_2O, sphere, 25°C)	σ'_p	25.694×10^{-6}	

! Constant values cannot perform rounding.

Source: CODATA Internationally 2010
http://physics.nist.gov/constants

Metric Conversions

The calculator has 172 conversion pairs which allows you to convert a number to and from the specified metric units.

- Press CONVT enter the conversion menu.
- There are 8 category pages (distance, area, temperature, capacity, weight, energy, pressure and speed) containing 36 metric symbols, you can press ▲ or ▼ to change the category selection page.
- In a category page, you can shift the selection cursor left or right by pressing ◄ or ►.

Page	Symbol	Unit
1	feet	feet
1	m	meter
1	mil	milliliter
1	mm	millimeter
1	in	inch
1	cm	centimeter
1	yd	yard
1	mile	mile
1	km	kilometer
2	ft^2	square foot
2	yd^2	square yard
2	m^2	square meter
2	$mile^2$	square mile
2	km^2	square kilometer
2	hectares	hectare
2	acres	acre
3	°F	degree Fahrenheit
3	°C	degree Celsius
4	gal	gallon (U.K.)
4	liter	liter
4	B.gal	gallon (U.S.)
4	pint	pint
4	fl.oz	fluid ounces (U.S.)
5	Tr.oz	ounce (troy or apothecary)
5	oz	ounces
5	lb	libra
5	Kg	kilogram
5	g	gram
6	J	joule
6	cal.f	calorie
7	atm	standard atmosphere
7	Kpa	kilopascal
7	mmHg	millimeter of mercury
7	cmH_2O	centimeter of water
8	m/s	Meter per second
8	km/h	Kilometer per hour

- Go back to the calculation mode by pressing [CONVT] within the category selection menu. After the base conversion unit, [▲], [▼] or [CONVT] keys will be invalid.
- If the converted result overflows, [ERROR] will be shown in the lower display. Press [=] to select the overflow value; the following scenarios are valid:
  - Scenario A - Keep selecting the other conversion value by pressing [◄] or [►].
  - Scenario B - Clear the screen and jump out of the selection by pressing [ON] or [CA].
  - Scenario C - Jump back to the previous calculation screen by pressing [CONVT].

Example: Convert 10 + (5 $ft^2 \rightarrow m^2$) = 10.4645152

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Key in Operation	Display
[1] [0] [+] [5] (menu selection menu)	Unit (distance) ▲▼ feet m mil mm in cm yd mile km
[▼] [=] (confirm selection ft^2)	ft^2 yd^2 m^2 $mile^2$ km^2 ha acres 5
[►] [►] [=] (confirm the value convert into m^2)	$10+5ft^2 \blacktriangleright m^2$
[=]	$10+5ft^2 \blacktriangleright m^2$ ▲ 10.4645152

Functional Scientific Calculations

- Press [MODE] [1] to enter COMP mode.
- π = 3.1415926535897932324
- e = 2.7182818284590452324

Square, Root, Cube, Cube Root, Power, Power Root, Reciprocal and Pi

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
$\left(\sqrt[3]{2^2+5^3}\right)^{-1} \times \pi$ = 0.6217559776	[(] [Shift] [$\sqrt{\square}$] [2] [x^2] [+] [5] [Shift] [x^{-1}] [►] [)] [x^{-1}] [×] [Shift] [π] [=]	$\left(\sqrt[3]{2^2+5^3}\right)^{-1} \times \pi$ 0.6217559776
$\left(\sqrt[6]{2^6}+\sqrt[5]{243}\right)$ = 7	[(] [Shift] [$\sqrt{\square}$] [2] [$x^{\square}$] [6] [►] [►] [+] [Shift] [$\sqrt[6]{\square}$] [5] [►] [2] [4] [3] [►] [)] [=]	$\left(\sqrt[6]{2^6}+\sqrt[5]{243}\right)$ 7

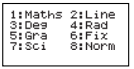
Logarithm, Natural Logarithm, Antilogarithm and $\text{Log}_a b$

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
$e^{-3} + 10^{1.2} + \ln 3 =$ 16.99733128	Shift $e^{\square}$ (−) 3 → + Shift $10^{\square}$ 1 • 2 → + ln 3 =	$e^{-3} + 10^{1.2} + \ln(3$ 16.99733128
$\log_3 81 - \log 1 = 4$	Alpha $\log_{a}\square$ 3 → 8 1 → − log 1 =	$\log_3(81) - \log(1$ 4

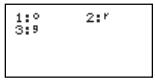
Angle Unit Conversion

The default calculator angle unit setting is “Degree”. Press Shift SET-UP to enter the setup menu to change the unit to “Radian” or “Gradient”,:



Press the corresponding number key 3 , 4 or 5 for the angle unit you need. Then the display will show the D , R , G Indicator accordingly.

Convert an angle unit between “Degree”, “Radian” and “Gradient” by pressing Shift DRG▸



Then, pressing 1 , 2 , or 3 will convert the displayed value into the selected angle unit.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
Convert 180 degree into radian and gradient ($180^{\circ} = \pi^{\text{Rad}} = 200^{\text{Gad}}$)	Shift SET-UP 4 1 8 → 0 Shift DRG▸ 1 =	180° R π
	Shift SET-UP 5 =	180° 200

Trigonometry Calculations

■ Before using the trigonometric functions (except hyperbolic calculations), select the appropriate angle unit (Deg/Rad/Gra) by pressing Shift SET-UP .

Angle Unit Setting	Angle Value Input	Input Value Range for √ form result
Deg	Units of 15º	$\lvert\pi\rvert < 9\times10^{9}$
Rad	Multiples of $\frac{1}{12}\pi$ radians	$\lvert\pi\rvert < 20\pi$
Gra	Multiples of $\frac{50}{3}$ grads	$\lvert\pi\rvert < 10000$

■ 90º = $\frac{\pi}{2}$ Radians = 100 Gradients.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
Degree Mode	Shift SET-UP 3	D
Sin 60 = $\frac{\sqrt{3}}{2}$	sin 6 0 =	sin(60 $\frac{\sqrt{3}}{2}$
$\frac{1}{\text{Sin}45^{\circ}}$=Cosec 45º = $\sqrt{2}$	sin 4 5) x^{-1} =	sin(45)$^{-1}$ $\sqrt{2}$

■ Hyperbolic (sinh/ cosh/ tanh), Inverse Hyperbolic (sinh^{-1}/cosh^{-1}/tanh^{-1}) functions

■ Press hyp to enter the sub-hyperbolic menu.

```
1:sinh  2:cosh
3:tanh  4:sinh-1
5:cosh-1 6:tanh-1
```

Example	Key in operation	Display
sinh2.5 – cosh 2.5 = -0.082084998	hyp 1 2 • 5) − hyp 2 2 • 5) =	sinh(2.5) – cosh(▷ -0.08208499862
Cosh^{-1}45 = 4.499686191	hyp 5 4 5 =	cosh^{-1}(45 4.499686191

Permutation, Combination, Factorials and Random Number Generation

■ Permutation: $ {}_{n}\mathrm{Pr} = \frac{n!}{(n-r)!} $

■ Combination: $ {}_{n}Cr = \frac{n!}{r!(n-r)!} $

■ Factorial: $ x! = x(x-1)(x-2)\ldots(2)(1) $

Example	Key in operation	Display
${}_{10}P_3 = 720$	1 0 Shift nPr 3 =	10P3 720
${}_{5}C_2 = 10$	5 Shift nCr 2 =	5C2 10
5! = 120	5 Shift x! =	5! 120

■ **Random Number Generation**

Shift Rand : Generate a random number between 0.000 and 0.999. The display result will be in fraction format in Maths mode.

Alpha i-Rand : Generate a random number between two specified positive integers. The entry is divided by "."

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
Generate a random number between 0.000 & 0.999	Shift Rand =	Rand $\frac{139}{1000}$
Generate an integer from a range of 1 to 100	Alpha i-Rand 1 Shift , 1 0 0 =	i~Rand(1,100 33

*The value shown here is only a sample, results will differ each time.

Product (Π) Calculation

■ Press [MODE] [1] to enter COMP mode.

■ **a** = start , **b** = end, **c** = formula

Math mode: $\prod_{x=a}^{b}(c)$ Line mode: Π (**c**, **a**, **b**)

Example: Product of (x+1) from 0 to 5

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Key in operation	Display
[Apps] [1] [Alpha] [x] [+] [1] [▷] [0] [▷] [5] [=]	$\prod_{x=0}^{5}(x+1)$ 720

Summation (∑) Calculation

■ Press [MODE] [1] to enter COMP mode.

■ **a** = start , **b** = end, **c** = formula

Math mode: $\sum_{x=a}^{b}(c)$ Line mode: ∑ (**c**, **a**, **b**)

Example: Summation of (x+1) from 1 to 5

LINE MODE: [Shift] [SET-UP] [2]

Key in operation	Display
[Apps] [2] [Alpha] [x] [+] [1] [Shift] [,] [1] [Shift] [,] [5] [=]	∑ (x+1, 1,5 20

Maximum Value and Minimum Value Calculation

■ Press [MODE] [1] to enter COMP mode.

■ At most five values can be calculated.

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
To calculate Maximum value of 3, sin30 and cos30	[Apps] [3] [3] [Shift] [,] [sin] [3] [0] [)] [Shift] [,] [cos] [6] [0] [=]	Max(3, sin(30), C▷ 3
To calculate Minimum value of 3, sin30 and cos30	[Apps] [4] [3] [Shift] [,] [sin] [3] [0] [)] [Shift] [,] [cos] [6] [0] [=]	Min(3, sin(30), C▷ $\frac{1}{2}$

Modulus After Division (Mod) Calculation

■ Press [MODE] [1] to enter COMP mode.

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
The modulus after division (Mod) of 23 and 5	[Apps] [6] [2] [3] [Shift] [,] [5] [=]	Mod(23, 5 3
The modulus after division (Mod) of -23 and 5	[Apps] [6] [(−)] [2] [3] [Shift] [,] [5] [=]	Mod(-23, 5 2

Least Common Multiple and Greatest Common Divisor

■ LCM: Calculate the least common multiple among (maximum) three positive integers.
■ GCD: Calculate the greatest common divisor among (maximum) three positive integers.

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
LCM(15, 27, 39) = 1755	[Apps] [7] [1] [5] [Shift] [,] [2] [7] [Shift] [,] [3] [9] [=]	LCM(15,27,39 1755

LINE MODE: [Shift] [SET-UP] [2]

Example	Key in operation	Display
GCD(12, 24, 60) = 12	[Apps] [8] [1] [2] [Shift] [,] [2] [4] [Shift] [,] [6] [0] [=]	GCD(12,24,60 12

Prime Factorization

PFact

- Factor a positive integer of up to 10 digits into prime factors of up to 3 digits.

  Ptact Number : 0 < X < 99999 99999 (X is integer)

- The reminder that cannot be factored will be enclosed in parentheses on the display.

Example: 99999 99999 = 3^2 x 11 x 41 x 271 x (9091)

MATHEMATICS MODE: Shift SET-UP 1

Key in Operation	Display
9 9 9 9 9 9 9 9 9 9 = Shift PFact	9999999999 3^2x11x41x271x(9▶
1 7 7 7 = Shift PFact	1777 (1777)

NOTE:

- During any calculation operations, pressing Shift PFact or = or ENG or ° ′ ″ key will exit the prime factorization result display.

- Use the setup menu to change the angle unit setting (Deg, Rad, Gra) or display digit setting (Fix, Sci, Norm).

- [Math ERROR] will be shown if decimal value, fraction, negative value calculation result, or Pol, Rec, Q...R is displayed.

Quotient and Remainder Calculations

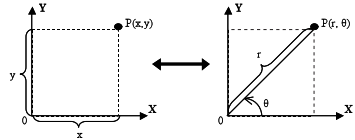
- "Quotient" (Q) is the result in a division problem, "Remainder" (r) is the value remaining in an integer division problem.
- The calculated quotient value (Q) and remainder (r) will be stored into memory variables "C" and "D", automatically assigned.
- In Maths mode, press ◄ or ► to scroll through a long calculation result.
- In Line mode, the quotient value (Q) and remainder (r) will be shown over 2 lines.
- Only the Quotient Value (Q) can continue to be used for the next calculation or be stored into memory variables.

LINE MODE: Shift SET-UP 2

Example	Key in operation	Display
35 ÷ 10 = 3 x 10 +5 Q=3 R=5	Apps 5 3 5 Shift , 1 0 =	Q…r(35, 10 Q= 3 R= 5
Quotient value (Q) + 3 = 6	+ 3 =	Ans+3 6
Recall Quotient value (Q)	RCL C	C 3
Recall Remainder value (r)	RCL D	D 5

Coordinate Conversion

- With polar coordinates, you can calculate and Display θ within the range of $-180^{o} < \theta \leq 180^{o}$. (Same as Radian and Gradient)
- In Maths mode, press ◄ or ► to scroll the through calculation result.
- In Line mode, (x,y) or (r, θ) will be shown over 2 lines.
- After conversion, the results will automatically be assigned to memory variables X and Y. Press RCL X or Y to show the results.



Rectangular Coordinates (Rec) Polar Coordinates (Pol)

Shift Pol(: Convert rectangular coordinates (x, y) to polar coordinates (r, θ); Press RCL X for r, or RCL Y for θ.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
With rectangular coordinate (x=1, y= √3). Find Polar coordinate (r, θ) at degree mode	Shift Pol(1 Shift , √□ 3 =	Pol(1, √3 r=2, θ=60
	RCL X	X 2
	RCL Y	Y 60

Shift Rec(: Convert polar coordinates (r, θ) to rectangular coordinates (x, y); Press RCL X for x, or RCL Y for y.

LINE MODE: Shift SET-UP 2

Example	Key in operation	Display
With Polar coordinate (r=2, θ=60º). Find Rectangular coordinate (x, y) at degree mode	Shift Rec(2 Shift , 6 0 =	Rec(2, 60 X= 1 Y= 1.732050808
	RCL X	X 1
	RCL Y	Y 1.732050808

Absolute Value Calculation

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
$\lvert\sin(60-5)\times(-\pi)\rvert$	Abs sin 6 0 — 5) × ((−) Shift π) =	$\lvert\sin(60-5)\times(-\pi)\rvert$ 2.573442045

Engineering Notation

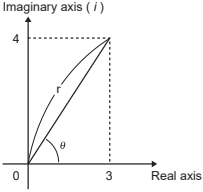
LINE MODE: Shift SET-UP 2

Example	Key in operation	Display
$1\div200 = 5\times10^{-3}$	1 ÷ 2 0 0 =	1÷200 5×10^{-3}
	ENG ENG	1÷200 5000×10^{-6}
	Shift ◂ENG	1÷200 5×10^{-3}

Complex Number Calculations

Abs ∠ i

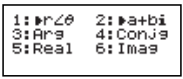
Complex numbers can be expressed in rectangular form (z = a + bi) or polar form (r∠θ). Where " a " is the real number, " bi " is the imaginary number (and i is the imaginary unit equal to the square root of –1, $\sqrt{-1}$), " r " is the absolute value, and " θ " is the argument of the complex number.



- Press MODE 2 to enter CPLX mode.
- Press Apps to select the calculation type.

Complex Number Type Selection

There are 6 types of complex number calculations in the Complex Number Type screen. Press the number to select the type of Complex Number Calculation:



- Check the current angle unit setting (Deg, Rad, Grad).
- [*i*] indicates the display result is the imaginary number; [∠] indicates the display value is the argument value θ.
- Imaginary numbers will use up replay memory capacity.

Rectangular Form and Polar Form Conversion

Pressing Apps 1 can convert rectangular form complex numbers into polar form; whereas pressing Apps 2 will convert polar form complex numbers into rectangular form.

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
3+4 *i* = 5∠53.13010235	3 + 4 ∠ *i* Apps 1 =	3+4 *i* ▶r∠θ 5∠53.13010235
√2<45=1+ *i*	√□ 2) ∠ 4 5 Apps 2 =	√2∠45=▶a+b*i* 1+ *i*

Absolute Value and Argument Calculation

With the rectangular form complex number, you can calculate the corresponding absolute value (r) or argument (θ) by pressing [Abs] or [Apps] [3] respectively.

LINE MODE: [Shift] [SET-UP] [2]

Example	Key in operation	Display
Absolute value (r) and argument (θ) if complex number is 6+8 *i*	[Abs] [6] [+] [8] [*i*] [)] [=]	Abs (6+8 *i*) 10
	[▶] [DEL] [Apps] [3] [=]	Arg (6+8 *i*) 53.13010235

Conjugate of a Complex Number

If the complex number is z = a + bi, the conjugate value of this complex number should be z = a – bi.

LINE MODE: [Shift] [SET-UP] [2]

Example	Key in operation	Display
3+4 *i* is 3–4 *i*	[Apps] [4] [3] [+] [4] [*i*] [)] [=]	Conjg (3+4 *i*) 3 - 4 *i*

Determine the Real/Imaginary Values of a Complex Number

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
Real and Imaginary values of a complex number is 23<54	[Apps] [5] [2] [3] [∠] [5] [4] [)] [=]	Real(23∠54) 13.5190608
	[▶] [DEL] [Apps] [6] [=]	Imag(23∠54) 18.60739087

Base-n Calculations and Logical Calculations

- Press [MODE] [4] to enter Base-n mode.
- Decimal (base 10), hexadecimal (base 16), binary (base 2), octal (base 8), or logical calculations.
- To select a specific number system in base mode, simply press [DEC] Decimal [DEC], [HEX] Hexadecimal [HEX], [BIN] Binary [BIN] or [OCT] Octal [OCT].
- Press [Ans] key to perform logical calculations including: Logic connection [and] / [or], exclusive or [Xor], exclusive nor [Xnor], argument complement [Not] and negation [Neg].
- If the binary or octal calculation result is more than 8 digits, ◀BIK will be displayed to indicate the result has a next block. Press [◀BIK] to loop between result blocks.
- In Base-n mode all the scientific functions cannot be used, and you cannot input the value with decimal places or exponents.

MATHEMATICS MODE: [Shift] [SET-UP] [1]

Example	Key in operation	Display
10101011+1100–1001x101÷10 =10100001 (in Binary Mode)	[BIN] 1 0 1 0 1 0 1 1 + 1 1 0 0 − 1 0 0 1 × 1 0 1 ÷ 1 0 =	10101011+1100–1▷ BIN 1010 0001
645+321–23x7÷2 =1064 (in Octal Mode)	[OCT] 6 4 5 + 3 2 1 − 2 3 × 7 ÷ 2 =	645+321-23x7÷2 OCT 00000001064
(77A6C+D9)xB÷F =57C87 (in Hexadecimal Mode)	[HEX] (7 7 [A] 6 [C] + [D] 9) × [B] ÷ [F] =	(77A6C+D9)xB÷F HEX 00057C87

Base-n Transformation [DEC] → [OCT] → [HEX] → [BIN]

Example	Key in operation	Display
12345+101=12446	1 2 3 4 5 + 1 0 1 =	12345+101 DEC 12446
	[HEX]	12345+101 HEX 000309E
	[BIN]	12345+101 ◀BIK 1/2 BIN 1001 1110
	[OCT]	12345+101 OCT 00000030236

Logical Operation

MATHEMATICS MODE: Shift SET-UP 1

Example	Key in operation	Display
789ABC Xnor 147258	7 8 9 A B C Apps 4 1 4 7 2 5 8 =	789ABC⊻nor147258 HEX FF93171B
Ans or 789ABC	Ans Apps 2 7 8 9 A B C =	Ansor789ABC HEX FFFB9FBF
Neg 789ABC	Apps 6 7 8 9 A B C =	Neg(789ABC HEX FF876544

Statistical Calculations

- Press MODE 3 to enter Statistical calculation mode: the "STAT" indicator will light up.
- Press Apps 1 (Type) to select the calculation type.

Statistical Type Selection

There are 8 types of Statistical Calculation, after entering the **Statistical Type Selection** screen, press the number to select the type of Statistic Calculation.

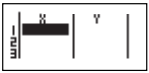
```
1:SD     2:Lin
3:Quad   4:Log
5:e EXP  6:ab EXP
7:Pwr    8:Inv
```

Pressing Key	Statistical Calculation
1 (SD)	One-variable statistics (x)
2 (Lin)	Two-variable, Linear regression (y= A+Bx)
3 (Quad)	Two-variable, Quadratic regression ($y=A+Bx+Cx^2$)
4 (Log)	Two-variable, Logarithmic regression (y=AxBlnx)
5 (e EXP)	Two-variable, E exponential regression ($y=Ae^{Bx}$)
6 (ab EXP)	Two-variable, ab Exponential regression ($y=AB^x$)
7 (Pwr)	Two-variable, Power regression ($y=Ax^B$)
8 (Inv)	Two-variable, Inverse regression (y=A+B/x)

Statistical Data Input

After confirming the calculation type in the **Statistical Type Selection** screen or by pressing Apps 2 (Data) in the STAT mode, the following Statistical Data Input screen will be shown:

1-variable STAT



2-variable STAT

1-variable STAT
"FREQ ON"

- After turning on Data Frequency in the setup menu, the "FREQ" column will be added into the above screen.
- The following are the maximum number of lines for data input.

Statistic type	FREQ ON	FREQ OFF
Single Variable (only x input)	40	80
2 Variable (x & y input)	26	40

- Input expression and display result values in the **Statistical Data Input** screen are in Line mode (same as Comp mode with Line mode status).
- After inputting the data, press = to store the value into statistical registers and display the value (max. 6 digits) in the cell. You can press the cursor key to move the cursor between each cell.

Editing Statistical Sample Data

■ **Replacing the Data in a Cell**

(1) In the Statistical Data Input screen, move the cursor to the cell you want to edit.
(2) Input the new data value or expression, and press =.

■ **Deleting a Line**

(1) In the Statistical Data Input screen, move the cursor to the line you want to delete.
(2) Press DEL

■ **Inserting a Line**

(1) In the Statistical Data Input screen, move the cursor to the line that will be under the line being inserted.
(2) Press Apps 3 (Edit)
(3) Press 1 (Ins)

■ **Deleting All STAT Data Input**

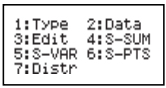
(1) Press Apps 3 (Edit)
(2) Press 2 (Del-A)

Statistical Calculation Screen

- After inputting the STAT Data, press [CA] to enter the **Statistical Calculation** screen.
- **Statistical Calculation** screen is in Line mode for input & output display
- Use the **Statistical Menu** to calculate the Statistical result. (S-SUM, S-VAR, S-PTS, Reg).

Statistical Menu

In the **Statistical Data Input** screen or **Statistical Calculation** screen, press [Apps] to display the **Statistical Menu** screen.



1-variable STAT

2-variable STAT

STAT items	Description
[1] Type	To enter the statistical calculation type screen
[2] Data	To enter the statistical data input screen
[3] Edit	To enter Edit sub-menu for editing STAT editor screen contents
[4] S-SUM	To enter S-Sum sub-menu (calculating sum)
[5] S-VAR	To enter S-Var sub-menu (calculating variable)
[6] S-PTS	To enter S-PTS sub-menu (calculating points)
[7] Distr	To enter Distr sub-menu (calculating distribution)
[8] Reg	To enter Reg sub-menu (Regression calculation)

Statistical calculation result in [4] S-SUM, [5] S-VAR, [6] S-PTS, [8] Reg

STAT sub-menu	STAT Type	Value	Symbol	Operation
S-SUM	1 & 2 variable STAT	Summation of all x2 value	$\sum x^2$	Apps 4 1
		Summation of all x value	$\sum x$	Apps 4 2
	2-variable STAT only	Summation of all y2 value	$\sum y^2$	Apps 4 3
		Summation of all y value	$\sum y$	Apps 4 4
		Summation of xy pairs	$\sum xy$	Apps 4 5
		Summation of all x3 value	$\sum x^3$	Apps 4 6
		Summation of all x2y pairs	$\sum x^2y$	Apps 4 7
		Summation of all x4 pairs	$\sum x^4$	Apps 4 8
S-VAR	1 & 2 variable STAT	Number of data sample	n	Apps 5 1
		Mean of the x values	$\bar{x}$	Apps 5 2
		Population standard deviation of x	$x\sigma_n$	Apps 5 3
		Sample standard deviation of x	$x\sigma_{n-1}$	Apps 5 4
	2-variable STAT only	Mean of the y values	$\bar{y}$	Apps 5 5
		Population standard deviation of y	$y\sigma_n$	Apps 5 6
		Sample standard deviation of y	$y\sigma_{n-1}$	Apps 5 7
S-PTS	1 & 2 variable STAT	Minimum value of X	minX	Apps 6 1
		Maximum value of X	maxX	Apps 6 2
	1-variable STAT only	Median	med	Apps 6 3
		Mode	mode	Apps 6 4
		1st Quartile Value	Q1	Apps 6 5
		3rd Quartile Value	Q3	Apps 6 6
		Range	R	Apps 6 7
	2-variable STAT only	Minimum value of Y	minY	Apps 6 3
		Maximum value of Y	maxY	Apps 6 4
Reg	For non-Quad Reg	Regression coefficient A	A	Apps 8 1
		Regression coefficient B	B	Apps 8 2
		Correlation coefficient r	r	Apps 8 3
		Estimate value of x	$\hat{x}$	Apps 8 4
		Estimate value of y	$\hat{y}$	Apps 8 5
Reg	For Quad Reg only	Regression coefficient A	A	Apps 8 1
		Regression coefficient B	B	Apps 8 2
		Correlation coefficient C	C	Apps 8 3
		Estimate value of x1	$\hat{x}1$	Apps 8 4
		Estimate value of x2	$\hat{x}2$	Apps 8 5
		Estimate value of y	$\hat{y}$	Apps 8 6

Statistical Calculation Example

SD Type Statistical Calculation Example:
To calculate $\sum x^2$, $\sum x$, n, $\bar{x}$, $x\sigma_n$, $x\sigma_{n-1}$, minX, maxX of data: 75, 85, 90, 77, 79 in SD mode (Freq: OFF)

Key in operation	Display
MODE 3	1:SD 2:Lin 3:Quad 4:Log 5:e^ EXP 6:ab EXP 7:Pwr 8:Inv
1 (SD)	
7 5 = 8 5 = 9 0 = 7 7 = 7 9 =	
CA Apps 4 1 =	$\sum x^2$ 33120
CA Apps 4 2 =	$\sum x$ 406
CA Apps 5 1 =	n 5
CA Apps 5 2 =	$\bar{x}$ 81.2
CA Apps 5 3 =	$x\sigma n$ 5.528109984
CA Apps 5 4 =	$x\sigma n-1$ 6.180614856

Quadratic Regression Type Statistical Calculation Example:
ABC Company investigated the effectiveness of the advertisement expenses in coded units, the following data was obtained:

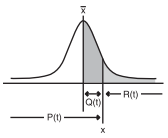
Advertisement expenses: X	18	35	40	21	19
Effectiveness: y (%)	38	54	59	40	38

Please use regression to estimate the effectiveness (estimate the value of y) if the advertisement expenses X=30, also estimate the advertisement expenses level (estimate the value of X_1, X_2) if the effectiveness is y = 50.

Key in operation	Display
MODE 3	1:SD 2:Lin 3:Quad 4:Log 5:e EXP 6:ab EXP 7:Pwr 8:Inv
3 (Quad)	
1 8 = 3 5 = 4 0 = 2 1 = 1 9 = ▽ ▷ 3 8 = 5 4 = 5 9 = 4 0 = 3 8 =	
CA 3 0 Apps 8 6 =	$30\hat{y}$ 48.69615715
CA 5 0 Apps 8 4 =	$50\hat{x}_1$ 31.30538226
CA 5 0 Apps 8 5 =	$50\hat{x}_2$ -167.1096731

Distribution Calculations

■ After sample data is entered in either Statistic (SD) or Regression (REG) mode, you can perform the normal distribution or probability distribution calculation such as P(t), Q(t) and R(t) in which t is the variate of the probabilistic experiment.



$$t = \frac{x - \bar{x}}{x\sigma_n}$$

x : Random variable

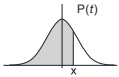
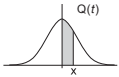
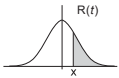
$\bar{x}$: Mean of sample

$x\sigma_n$: Standard deviation

■ Press [Apps] [7] to display the distribution calculations screen.

1: P(	2: Q(
3: R(	4: ▶t

■ Press [1], [2], [3] or [4] for the corresponding calculations.

P(t): Probability below a given point x	$P(t)=\int_{-\infty}^{t}\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2}\left(\frac{t-u}{\sigma}\right)^2}dt$, 
Q(t): Probability below a given point x and above the mean	Q (t) = 0.5 – R (t), 
R(t): Probability above a given point x	R (t) = 1 – P (t), 

Example: Calculate the probability distribution P(t) for the sample data: 20, 43, 26, 46, 20, 43, when x = 26.

Key in operation	Display
[MODE] [3] [1]	
[2] [0] [=] [4] [3] [=] [2] [6] [=] [4] [6] [=] [2] [0] [=] [4] [3] [=]	
[CA] [2] [6] [Apps] [7] [4] [=]	26▶t -0.6236095645
[Apps] [7] [1] [=]	P(Ans 0.26644

Equation Calculations

■ Press MODE 5 to enter the equation mode; press ⊙ / ⊙ for next / previous pages.

Equation Item	Description
[1] 2 unknown EQN	Simultaneous Linear Equations with two unknowns
[2] 3 unknown EQN	Simultaneous Linear Equations with three unknowns
[3] 4 unknown EQN	Simultaneous Linear Equations with four unknowns
[4] Quad EQN	Quadratic Equation, degree 2 equation
[5] Cubic EQN	Cubic Equation, degree 3 equation
[6] Quartic EQN	Quartic Equation, degree 4 equation

Simultaneous Linear Equations

Simultaneous Linear Equations with Two Unknowns:

$$a_1x + b_1y = c_1$$
$$a_2x + b_2y = c_2$$

Simultaneous Linear Equations with Three Unknowns:

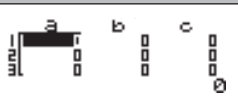
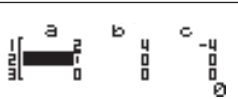
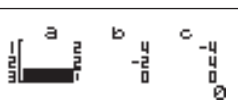
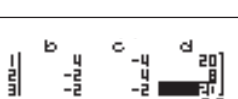
$$a_1x + b_1y + c_1z = d_1$$
$$a_2x + b_2y + c_2z = d_2$$
$$a_3x + b_3y + c_3z = d_3$$

Simultaneous Linear Equations with Four Unknowns:

$$a_1w + b_1x + c_1y + d_1z = e_1$$
$$a_2w + b_2x + c_2y + d_2z = e_2$$
$$a_3w + b_3x + c_3y + d_3z = e_3$$
$$a_4w + b_4x + c_4y + d_4z = e_4$$

Example: Solve the simultaneous equation with three unknowns:

$2x + 4y - 4z = 20$
$2x - 2y + 4z = 8$
$5x - 2y - 2z = 20$

Key in operation	Display
MODE 5 2 (3 unknowns)	
2 = 4 = (−) 4 = 2 0 =	
2 = (−) 2 = 4 = 8 =	
5 = (−) 2 = (−) 2 = 2 0 =	
=	X= $\frac{11}{2}$
=	Y= 3
=	Z= $\frac{3}{4}$

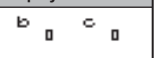
Quadratic, Cubic and Quart Equations

Quadratic equation : $ax^2 + bx + c = 0$ (a second-order polynomial equation with a single variable x)

Cubic equation : $ax^3 + bx^2 + cx + d = 0$ (an equation with cubic polynomial)

Quart equation : $ax^4 + bx^3 + cx^2 + dx + e = 0$

Example: Solve the Cubic equation $5x^3 + 2x^2 - 2x + 1 = 0$

Key in operation	Display
MODE 5 ▽ 2 (Cubic equation)	
5 = 2 = (−) 2 = 1 =	
=	X_1= -1
=	X_2= $\frac{3}{10}+0.331662479i$
=	X_3= $\frac{3}{10}-0.331662479i$

■ For Quadratic, Cubic or Quart equations, the variable name starts with "X_1".

Solve Function

■ Solve functions use Newton's Method to obtain the approximate solution of equations.

Note: SOLVE function can be used in the COMP Mode only.

■ The following describes the types of equations whose solutions can be obtained by using SOLVE function.

- **Equations that include variable X,**
  SOLVE function solves for X, for example, **$X^2 + 2X - 2$, X = Y + 3, X – 5 = A + B, X = tan(C),**
  - Variable X to be solved should be put at the left hand side of the equation.
    For example, an equation is input as $X^2 + 5X = 24$ or $X^2 + 5X - 24 = 0$ or $X^2 + 5X - 24$
  - An expression like $X^2 + 5X - 24$ will be treated as $X^2 + 5X - 24 = 0$, not necessary to input "= 0".

- **Equations input uses the following syntax : {equation},{solution variable}**
  In general, an equation is solved for X, unless specified. For example, to solve for Y when an equation is input as, **Y = X + 5, Y**

Important precaution when using "Solve" function:

- The following functions $\int$, $\frac{d}{dx}$, $\sum$, $\prod$, Pol, Rec, Q…r, Rand, i-Rand or multi-statement are not allowed to input into an equation for SOLVE function.
- Since SOLVE function uses Newton's Method to obtain the solution, even if there are multiple solutions, only one of them will be shown as the solution.
- SOLVE function may not be able to obtain a solution because of preset initial value of the solution variable. In case this happens, try to change the initial value of the solution variable.
- SOLVE function may not be able to find the correct solution, even if the solution(s) exists.
- If an equation contains input functions that include an open parenthesis, do not omit the closing parenthesis.
- It will show "Variable ERROR" when the expression does not contain the variable that you want to solve.
- Newton's Method may have problems for solving the following types of functions, for example $y = e^x$, $y = \frac{1}{x}$, $y = \sin(x)$, $y = \sqrt{x}$, etc.
- In case the equation takes long time for solving, the calculator will display "PROCESSING" screen, you can cancel the processing of SOLVE operation by pressing the [CA] key.

Example: To solve $X=\frac{1}{3}\pi B^2C$ (when B=5; C=20)

Key in Operation	Display
[Alpha] [X] [Alpha] [=] [1] [a b/c] [3] [▶] [Shift] [π] [Alpha] [B] [x^2] [Alpha] [C]	$X=\frac{1}{3}\pi B^2C$
[Shift] [Solve]	B? 0
[5] [=]	C? 0
[2] [0] [=]	Solve for X Initial value → 0
[=]	$X=\frac{1}{3}\pi B^2C$ X= Solution → 523.5987756 L-R = 0
Solution variable Precision of solution	

- The Precision of Solution shows the result when the obtained solution is assigned to the solution variable. The precision of the obtained solution is higher if this value is closer to zero.

Continue Screen

- SOLVE performs convergence a preset number of times. If it cannot find a solution, it displays a confirmation screen that shows "Continue: [=]", asking if you want to continue. Press [=] to continue or [CA] to cancel the SOLVE operation.

CALC Function

- CALC function is a memory zone with a maximum of 79 steps to store a single calculation expression which can be recalled and calculated a number of times with different values.
- After inputting the calculation expression and pressing [CALC], the calculator will request for the current value of your input variables.
- CALC function can only be used in **COMP mode** or **CPLX mode**.

Example: For the equation $Y = 5x^2 - 2x + 1$, calculate the value of Y if x = 5 or x = 7.

LINE MODE: [Shift] [SET-UP] [2]

Key in operation	Display
[MODE] [1] (COMP MODE)	0
[Alpha] [Y] [Alpha] [=] [5] [Alpha] [X] [x^2] [−] [2] [Alpha] [X] [+] [1]	$Y=5X^2-X+1$ 0
[CALC] [5] [=]	$Y=5X^2-X+1$ 116
[CALC] [7] [=]	$Y=5X^2-X+1$ 232

! The [CALC] stored expression will be cleared when you start a new calculation, change into another mode, or turn off the calculator.

Differential Calculations

- Differential Calculations can be used in the COMP mode only.
- To perform a differential calculation, you have to input the expression in the form of:

  [Shift] [$\frac{d}{dx}$□] **f(x) ,** **a ,** **Δx** [)]

  - f(x) : Function of X. (All non-X variables are treated as constants.)
  - a : Differential point.
  - Δx : Tolerance (calculation precision); for Line mode only

- Your calculator performs differential calculations by aprroximating the derivative based on centered difference approximation.

Example: To determine the derivative at point x = 10, $\Delta x = 10^{-8}$, for the function f(x) = sin(3x + 30)

Key in operation	Display
[MODE] [1] (COMP MODE)	0
[Shift] [$\frac{d}{dx}$□] [sin] [3] [Alpha] [X] [+] [3] [0] [)] [Shift] [,] [1] [0] [Shift] [,] [1] [EXP] [(−)] [8] [)] [=]	d/dx(sin(3X+30)▷ 0.02617993878

! You can leave out the Δx in the differential expression and the calculator will automatically substitute a value for Δx.
! The smaller the entered value Δx is, the longer the calculation time will be with more accurate results, the larger the entered value Δx is, the shorter the calculation time will be with comparatively less accurate results.
! Inaccurate results and errors can be caused by the following :
  • Discontinuous points in x values
  • Extreme changes in x value
  • Inclusion of the local maximum point and local minimum point in x values.
  • Inclusion of the inflection point in x values
  • Inclusion of undifferentiable points in x values
  • Differential calculation results approaching zero
! When performing differential calculations with trigonometric functions, select radian (Rad) as the angle unit setting.
! $\log_a b$, i~Rand(, Rec(, Pol(, ∫(, d/dx(, ∑(, ∏(, Max(and Min(functions cannot join in differential calculations.
! You can cancel the processing of differential calculation by pressing the [CA] key.

Integration Calculations

■ Integration Calculations can be used in the COMP mode only.
■ To perform an integration calculation you are required to input the following elements:

[∫dx] **f(x)** [,] **a** [,] **b** [,] **n** [)]

  • f(x) : Function of X. (All non-X variables are treated as constants.)
  • a, b : The integration range of the definite integral.
  • n : Tolerance; for Line Mode only

■ The integration calculation is based on Gauss-kronrod method.
■ The internal integration calculations may take considerable time to complete. For some cases, even after considerable time is spent performing a calculation, the calculation results may be erroneous. Particularly when significant digits are less than 1, an ERROR might occur.

Example: Perform the integration calculation for, with n = 4.

$$\int_2^3 (5x^4 + 3x^2 + 2x + 1)dx$$

Key in operation	Display
[MODE] [1]	0
[∫dx] [5] [Alpha] [X] [x□] [4] [)] [+] [3] [Alpha] [X] [x²] [+] [2] [Alpha] [X] [+] [1] [Shift] [,] [2] [Shift] [,] [3] [Shift] [,] [4] [)] [=]	∫(5X^(4)+3X²+2X▷ 236

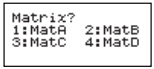
! When performing integration calculations with trigonometric functions, select radian (Rad) as the angle unit setting.
! Log_ab, i~Rand, Rec (and Pol (functions can not join to integration calculations.

Matrix Calculations

■ Press [MODE] [7] to enter Matrix mode.
■ Before starting matrix calculations, you have to create one matrix or a maximum of four matrices named A, B, C and D at one time. The matrix dimension can be up to 4x4.
■ The matrix calculation results are stored into the MatAns memory automatically. You can use the matrix MatAns memory for any subsequent matrix calculations.

Creating a Matrix

■ Press [MODE] [7] to enter Matrix mode.



■ Press [CA] [Apps] to use the MATX application; press ▼ / ▲ for next / previous pages.

MATX ITEM	DESCRIPTION
[1] Dim	Specify the Matrix memory A to D, and specify the dimension (up to 4 x 4)
[2] Data	Specify the matrix A-D for editing and corresponding matrix element
[3] MatA to MatD	Select matrix A to D
[4] MatAns	Calculation Answer of Matrix & Store into MatAns
[5] Det	Determinate function of Matrix A-D
[6] Trn	Transposed data in Matrix A-D
[7] Ide	Identity of matrix
[8] Adj	Adjoint to Matrix
[9] Inv	Inverse of Matrix

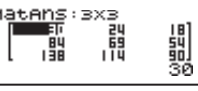
■ Press [CA] to exit the matrix creating screen.

Editing Matrix Data

- Press [CA] [Apps] [2] (Data), then specify the matrix A, B, C or D for editing and the corresponding matrix element indicator will be displayed.
- Input the new value and press [=] to confirm the edit.
- Press [CA] to exit the matrix editing screen.

Matrix Addition, Subtraction and Multiplication

Example: $MatA = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$, $MatB = \begin{bmatrix} 9 & 8 & 7 \\ 6 & 5 & 4 \\ 3 & 2 & 1 \end{bmatrix}$, MatA x MatB=?

Key in operation	Display
[MODE] [7] [1] [▼] [2]	
[1] [=] [2] [=] [3] [=] [4] [=] [5] [=] [6] [=] [7] [=] [8] [=] [9] [=]	
[CA] [Apps] [1] [2] [▼] [2]	
[9] [=] [8] [=] [7] [=] [6] [=] [5] [=] [4] [=] [3] [=] [2] [=] [1] [=]	
[CA] [Apps] [3] [×]	
[Apps] [4] [=]	

! Matrices which will be added, subtracted or multiplied must be the same size. An error occurs if you try to add, subtract or multiply matrices whose dimensions are different from each other. For example, you cannot add or subtract a 2 x 3 to a 2 x 2 matrix.

Obtain the Scalar Product of a Matrix

Each position in the matrix is multiplied by a single value, resulting in a matrix of the same size.

Example: Multiple Matrix C = $\begin{pmatrix} 3 & -2 \\ -1 & 5 \end{pmatrix}$ by 2 <Result: $\begin{pmatrix} 6 & -4 \\ -2 & 10 \end{pmatrix}$>

Key in operation	Display
CA Apps 1 3 ▼ ▼ 3	MatC:2×2 [[ ] [0] [0] [0]] 0
3 = (−) 2 = (−) 1 = 5 =	MatC:2×2 [[3] [−2] [−1] [5]] 5
CA Apps 5 × 2 =	MatAns:2×2 [[6] [−4] [−2] [10]] 6

Obtain the Determinant of a Matrix

Example: Obtain the determinant of Matrix C = $\begin{pmatrix} 10 & -5 & 3 \\ -4 & 9 & 2 \\ 1 & 7 & -3 \end{pmatrix}$
<Result: -471>

Key in operation	Display
CA Apps 1 1 ▼ 2	MatA:3×3 [[ ] [0] [0] [0] [0] [0] [0] [0] [0]] 0
1 0 = (−) 5 = 3 = (−) 4 = 9 = 2 = 1 = 7 = (−) 3 =	MatA:3×3 [[10] [−5] [3] [−4] [9] [2] [1] [7] [−3]] −3
CA Apps ▼ 1	Det(▮ 0
Apps 3) =	Det(MatA) −471

! An error occurs if you obtain the determinant of a non-square matrix.

Transpose a Matrix

Example: Transpose Matrix B = $\begin{pmatrix} 9 & 5 \\ 6 & 2 \\ 8 & 4 \end{pmatrix}$ <Result: $\begin{pmatrix} 9 & 6 & 8 \\ 5 & 2 & 4 \end{pmatrix}$ >

Key in operation	Display
CA Apps 1 2 ⌄ 3	MatB:3X2 0 0 0 0 0 0 0
9 = 5 = 6 = 2 = 8 = 4 =	MatB:3X2 9 5 6 2 8 4 4
CA Apps ⌄ 2	TrnC 0
Apps 4) =	MatAns:2X3 9 6 8 5 2 4 9

Identity of Matrix

Example: Identity Matrix D $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$

Key in operation	Display
CA Apps ⌄ 3	IdeC 0
2) =	MatAns:2X2 1 0 0 1 1

Adjoint of Matrix

Example: Adjoint Matrix A $\begin{pmatrix} 2 & 3 \\ 4 & 5 \end{pmatrix}$ < Result: $\begin{pmatrix} 5 & -3 \\ -4 & 2 \end{pmatrix}$ >

Key in operation	Display
CA Apps 1 1 ⌄ ⌄ 3	MatA:2X2 [[redacted] 0] [0 0] 0
2 = 3 = 4 = 5 =	MatA:2X2 [2 [redacted]3] [4 [redacted]5] 5
CA Apps ⌄ 4	Adj(0
Apps 3) =	MatAns:2X2 [[redacted] -3] [-4 2] 5

Invert a Matrix

Example: Inverting Matrix C = $\begin{pmatrix} 8 & 2 \\ 3 & 6 \end{pmatrix}$

<Result: $\begin{pmatrix} 0.142857142 & -0.047619047 \\ -0.071428571 & 0.19047619 \end{pmatrix}$>

Key in operation	Display
CA Apps 1 3 ⌄ ⌄ 3	MatC:2X2 [[redacted] 0] [0 0] 0
8 = 2 = 3 = 6 =	MatC:2X2 [8 [redacted]2] [3 [redacted]6] 6
CA Apps ⌄ 5	Inv(0
Apps 5) =	MatAns:2X2 [[redacted] -0.047] [-0.071 0.1904] 1.7

Determine the Absolute Value of a Matrix

Example: To determine the absolute value of the inverted Matrix C in the previous example.

Key in operation	Display
CA Abs	Abs(0
Apps 7) =	MatAns:2x2 [0.0476 0.1904] [0.0714 0.1904] 1⌟7

Vector Calculations

- Press MODE 8 to enter Vector mode.
- Before starting vector calculations, you have to create one or more vectors named A, B, C and D (maximum four vectors at one time).
- The vector calculation results are stored into VctAns memory automatically. You can use the vector VctAns memory for any subsequent vector calculations.

Creating a Vector

- Press MODE 8 to enter Vector mode.

```
Vector?
1:VctA  2:VctB
3:VctC  4:VctD
```

- Press CA Apps to use the Vector tool;

```
1:Dim    2:Data
3:VctA   4:VctB
5:VctC   6:VctD
7:VctAns 8:Dot
```

ITEM	DESCRIPTION
[1] Dim	Specify the Vector Name A to D, and specify the dimension (2D or 3D)
[2] Data	Specify the Vector A-D for editing and corresponding matrix element
[3] VctA to VctD	Select Vector A to D
[4] VctAns	Calculation Answer of Vector stored into VctAns
[5] Dot	Input the "•" command for obtaining the dot product of a vector Outside VCTR MODE Apps

- Press CA to exit the matrix creating screen.

Editing Vector Elements

- Press CA Apps 2 (data), then specify the matrix A, B, C or D for editing, and the corresponding vector element indicator will be displayed.
- Input the new value and press = to confirm the edit.
- Press CA to exit the vector editing screen.

Vector Addition and Subtraction

Example: Vector A = (9,5), Vector B = (7,3), Vector A – Vector B =?

Key in operation	Display
MODE 8 1 2	VctA:2 [1 0] 0
8 = 5 =	VctA:2 [8 5] 5
CA Apps 1 2 2	VctB:2 [1 0] 0
7 = 3 =	VctB:2 [7 3] 3
CA Apps 3 −	VctA-1 0
Apps 4 =	VctANS:2 [2] 1

! An error occurs if you try to add or subtract vectors whose dimensions are different from each other. For example Vector A (a,b,c) cannot add or subtract to or from Vector B (d,e).

Obtain the Scalar Product of a Vector

Each position in the vector is multiplied by a single value, resulting in a vector of the same size.

s x VctA(*a*,*b*) = VctB(axs, bxs)

Example: To Multiply Vector C = (4,5,-6) by 5

Key in operation	Display
CA Apps 1 3 1	VctC:3 [0 0] 0
4 = 5 = (−) 6 =	VctC:3 [4 5 -6] -6
CA Apps 5 × 5 =	VctAns:3 [25 -30] 20

Calculate the Inner Product of Two Vectors

Example: Calculate the inner product of Vector A and Vector B. As Vector A = (4,5,-6) and Vector B = (-7,8,9).

Key in operation	Display
CA Apps 1 1 1	VctA:3 [0 0] 0
4 = 5 = (−) 6 =	VctA:3 [4 5 -6] -6
CA Apps 1 2 1	VctB:3 [0 0] 0
(−) 7 = 8 = 9 =	VctB:3 [-7 8 9] 9
CA Apps 3	VctA 0
Apps 8	VctA- 0
Apps 4 =	VctA-VctB -42

Calculate the Outer Product of Two Vectors

Example: Calculate the outer product of Vector A and Vector B. As Vector A = (4,5,-6) and Vector B = (-7,8,9).

Key in operation	Display
CA Apps 1 1 1	VctA:3 [0 0] 0
4 = 5 = (−) 6 =	VctA:3 [4 5 -6] -6
CA Apps 1 2 1	VctB:3 [0 0] 0
(−) 7 = 8 = 9 =	VctB:3 [-7 8 9] 9
CA Apps 3 ×	VctA×▮ 0
Apps 4 =	VctAns:3 [6 61] 93

! An error occurs if you try to obtain an inner or outer product of two vectors whose dimensions are different from each other.

Determine the Absolute Value of a Vector

Example: Determine the absolute value of the Vector C. When Vector C = (4,5,-6) and is already created in the calculator.

LINE MODE: Shift SET-UP 2

Key in operation	Display
CA Apps 1 3 1	VctA:3 [0 0] 0
4 = 5 = (−) 6 =	VctA:3 [4 5 -6] -6
CA Abs Apps 5) =	Abs(VctC) 8.774964387

Example : Based on Vector A=(-1, 0, 1) and Vector B=(1, 2, 0), determine the size of the angle θ (angle unit: Deg) and a unit 1 vector perpendicular to both A and B.

$$\cos\theta = \frac{(A \cdot B)}{|A||B|}, \text{ whereas } \theta = \cos^{-1}\frac{(A \cdot B)}{|A||B|}$$

Unit 1 vector perpendicular to both A and B= $\frac{A \times B}{|A \times B|}$

< Result: $\frac{VctA \times VctB}{|VctA \times VctB|}$=(0.666666666, -0.333333333, 0.666666666) >

Key in operation	Display
CA Apps 1 1 1	VctA:3 [■■■■■■■] [0 0] 0
(−) 1 = 0 = 1 =	VctA:3 [-1] [0 ■■■■■■■] 1
CA Apps 1 2 1	VctB:3 [■■■■■■■] [0 0] 0
1 = 2 = 0 =	VctB:3 [1] [2 ■■■■■■■] 0
CA Apps 3 Apps 8 Apps 4 =	VctA·VctB -1
÷ (Abs Apps 3) × Abs Apps 4) =	Ans÷(Abs(VctA)×▷ -0.316227766
Shift cos⁻¹ Ans) = Apps 3 × Apps 4 =	VctAns:3 [■■■■■■■] [1 -2] -2
Abs Apps 7) = Apps 7 ÷ Ans =	VctAns:3 [■■■■■■■] [0.3333 -0.666] -2.3

Function (x, y) Table Calculation

■ Input f(x) function to generate the function table for x & f(x).

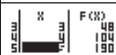
■ Steps to generate a Number Table

1. Press [MODE] [6] to enter the Table function calculation.
2. Function Input screen
   - Input function with X variable ([Alpha] [X]) to generate the Function Table Result.
   - All other variables (A, B, C, D, Y) and independent memory (M) act as the value.
   - Pol, Rec, Q…r, S, $\frac{d}{dx}$ functions can not be used in the Function Input screen.
   - The Function Table Calculation will change X-variable.
3. The input the start, end, & step information
   - Input the value, press [=] to confirm on the following screens
   - Input expression and display result value in following screens are in Line mode status
   - There is a maximum of 30 x-values in the function table generation. "Insufficient Error" will be shown if the start, end, step value combination is more than 30 x-values.

Display screen	You should input:-
Start?	Input the lower limit of X (Default =1).
End?	Input the upper limit of X (Default = 5). *End value must be greater than the start value.
Step?	Input the increment step (Default =1).

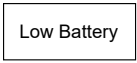
■ In the Function Table Result screen, you cannot edit the content, press [CA] to return to the Function Input screen.

Example : $f(x) = x^3 + 3x^2 - 2x$ to generate the function table for the range $1 \le x \le 5$, incremented in steps of 1.

Key in operation	Display
[MODE] [6]	f(x)=
[Alpha] [X] [Shift] [x^{-1}] [+] [3] [Alpha] [X] [x^2] [−] [2] [Alpha] [X]	f(x)= X³+3X²-2X
[=] [=] [=] [=]	
[▼] [▼] [▼] [▼]	

Battery Replacement

Replace the battery immediately when the display characters are dim even with a darker LCD display contrast **OR** when the following message appears on the screen. Turn the calculator off and replace the lithium battery immediately.



Please replace the lithium battery with the following procedures,

1. Press Shift OFF to power off the calculator.
2. Remove the screw that securely fixes the battery cover in place.
3. Remove battery cover.
4. Remove the old battery with the tip of a ball pen or similar sharp object.
5. Load the new battery with positive “+” side facing up.
6. Replace the battery cover, screw, and press ON, Shift CLR 3 = CA to initialize the calculator.

Caution: Risk of explosion if battery is replaced with an incorrect type. Dispose of used battery according to the instructions.

■ Electromagnetic interference or electrostatic discharge may cause the display to malfunction or the contents of the memory to be lost or altered. Should this occur, press ON, Shift CLR 3 = CA to restart the calculator.

Advice and Precautions

- This calculator contains precision components such as LSI chips and should not be used in places subject to rapid variations in temperature, excessive humidity, dirt or dust, or exposed to direct sunlight.
- The liquid crystal display panel is made of glass and should not be subjected to excessive pressure.
- When cleaning the device, do not use a damp cloth or volatile liquid such as paint thinner. Instead, use only a soft, dry cloth.
- Do not under any circumstances dismantle this device. If you believe that the calculator is not functioning properly, either bring or mail the device together with the guarantee to a service representative of the Canon Business office.
- Never dispose the calculator improperly such as burning; it can create risks of personal injury or harm. You are suggested to dispose this product according to your national law.
- Do replace the battery once every two years even if it is not used frequently.

Battery Caution!

- Keep the battery out of the reach of children. If the battery is swallowed, contact a doctor immediately.
- Misuse of the battery may cause leakage, explosion, damages, or personal injury.
- Do not recharge or disassemble the battery, it could cause a short circuit.
- Never expose the battery to high temperatures, direct heat, or dispose by incineration.
- Never leave a dead battery in the calculator as the dead battery may leak and cause damage to the calculator.
- Continued use of the calculator in the low battery condition may result in improper operation or the stored memory may be corrupted or lost completely. Keep the written records of important data all the time; and replace the battery as soon as possible.

Specifications

Power Supply : Solar Cell and Lithium battery (CR2032 x 1)
Power Consumption : DC 3.0V / 0.3mW
Battery Life : Approximately 4 years
(Based on 1 hour of operation per day)
Auto power off : Approx. 7 minutes
Usable Temperature : 0° ~ 40°C
Size: 171 (L) × 86 (W) × 17.3 (H) mm (with cover) /
168 (L) × 80 (W) × 13.15 (H) mm (without cover)
Weight: 123g (with cover) / 88 g (without cover)
* Specifications are subject to change without notice.

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