Canon

F-788SG

USER INSTRUCTION

E-IE-444

ENGLISH

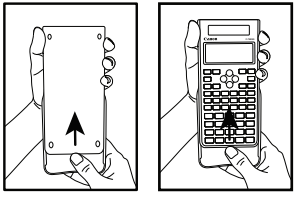
CONTENTS

ADVICE AND PRECAUTIONS

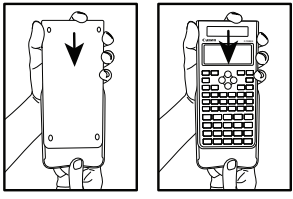
- This calculator contains precision components such as LSI chips and should not be used in place subject to rapid variations in temperature, excessive humidity dirt or dust, or exposed to direct sunlight.
- The liquid crystal display panel is made of glass and should not be subjected to excessive pressure.
- When cleaning the device do not use a damp cloth or a 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 the service representative of a Canon business office.

HOW TO USE THE SLIDE COVER

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

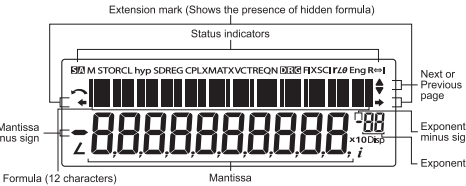


OPEN



CLOSE

DISPLAY (2-LINE DISPLAY)



<Status Indicators>

S	: Shift key
A	: Alpha key
hyp	: Hyperbolic key
M	: Independent memory
STO	: Store Memory
RCL	: Recall Memory
SD	: Statistic Mode
REG	: Regression 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
Eng	: Engineering Notation
r∠θ	: Polar Coordinate
∠	: Angle value
R↔I	: Switch between Real and Imaginary Number
i	: Imaginary number
Disp	: Multi-statements Display
↶	: Undo
▲	: Up Arrow
▼	: Down Arrow

TO GET START

Power ON, OFF

■ **First time operation:**

1. Remove the battery insulation tab to load the battery.
2. Press ON/CA Alpha CLR 3 = ON/CA to initialize the calculator.

ON/CA **(Power ON/Clear):** Turns on the calculator when it is pressed.

Shift OFF **(Power OFF):** Turns off the calculator when it is pressed.

■ **Auto Power Off Function:**

When the calculator is not used for above 7 minutes, the calculator will automatically power off. In such a case, pressing ON/CA key powers the calculator on again.

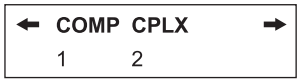
Input Capacity

F-788SG allows you to input a single calculation up to 79 steps. One step is used as each time you press one of the numeric keys, arithmetic keys, scientific calculation keys or Ans key. Shift , Alpha , MODE and the direction keys will not use up any step.

Starting from the 72nd step, the cursor changes from [_] to [■] that notifying the memory is running low. In case you need to input a single calculation with more than 79 steps, you should separate your calculation into two or more segments.

MODE Selection

Press MODE to start the calculation mode selection with the following display:



When pressing ◁ ▷ or MODE, you can access the next (or previous) mode selection page.
The following table shows the mode selection menu:

Operation	Mode		LCD Indicator
MODE 1	COMP	Normal Calculation	
MODE 2	CPLX	Complex Number Calculation	CPLX
MODE MODE 1	SD	Statistical Calculation	SD
MODE MODE 2	REG	Regression Calculation	REG
MODE MODE 3	BASE	Base-n Calculation	d / h / b / o
MODE MODE MODE 1	EQN	Equation Calculation	EQN
MODE MODE MODE 2	MATX	Matrix Calculation	MATX
MODE MODE MODE 3	VCTR	Vector Calculation	VCTR
MODE MODE MODE MODE 1	Deg	Degree	D
MODE MODE MODE MODE 2	Rad	Radian	R
MODE MODE MODE MODE 3	Gra	Gradient	G
MODE ◁ ◁ 1	Fix	Fixed-decimal Setting	FIX
MODE ◁ ◁ 2	Sci	Scientific Notation	SCI
MODE ◁ ◁ 3	Norm	Exponential Notation	
MODE ◁ 1	Disp*1	Display Setup Selection	

*1 Display Setup Selection options

First page : Press 1 [EngON] or 2 [EngOFF] for engineering symbols on or off.

▷ : Press 1 [ab/c] or 2 [d/c] to specify mixed fraction or improper fraction display.

▷ ▷ : Press 1 [Dot] or 2 [Comma] to specify decimal point or 3- digits separator symbols.

1 [Dot] : The decimal point is indicated by dot and the 3-digits separator is indicated by comma.

2 [Comma] : The decimal point is indicated by common and the 3-digits separator is indicated by dot.

• To check or clear the calculation mode, refer page 13.

Display Formats Setting

F-788SG can display a result up to 10 digits. Results exceed the digit limit will be automatically displayed by exponential notation format.

Example : Change the display formats for 1.23 $\times 10^{-03}$

Display Setting	Operation	Display (Lower)
Default setting :	1 2 3 × ·	
Norm 1, EngOFF	0 0 0 0	
Scientific Notation :	1 =	1.23 $\times 10^{-03}$
"5" significant digits	MODE ◁ ◁ 2 5	1.2300 $\times 10^{-03}$
Exponential Notation : Norm 2	MODE ◁ ◁ 3 2	0.00123
Fixed decimal places : "7"	MODE ◁ ◁ 1 7	0.0012300

* For Norm 1 and Norm 2, refer page 25.

Example : 1.23 $\times 10^{-03}$ = 1.23 m (milli)

Display Setting	Operation	Display
Engineering Symbols : On	MODE ◁ 1 1	123x.00001 m 1.23
Display without engineering symbols	Shift •ENG	123x.00001 0.00123

Input Editing

◁ ▷ DEL Insert

New input begins on the left of the upper (entry) line. As the entries are more than 12 digits, the line will scroll to the right consecutively. Press ◁ ▷ to scroll the cursor within the upper (entry) line and you can perform input editing as needed.

Example (under editing): 1234567 + 889900

Replacing an entry (1234567 → 1234560)

Display Setting	Operation	Display (Lower)
Press or keep pressing until "7" blinks	◁	1234567+8899 ➡
Replace with "0"	0	1234560+8899 ➡

Deletion (1234560 → 134560)

Press or keep pressing until "2" blinks	◀	1234560+8899 →
"2" is deleted	DEL	↶ 134560+88990 →

Insertion (889900 → 2889900)

Press or keep pressing until "8" blinks	▶	134560+88990 →
"8" and ⌜⌟ blinks alternately	Shift Insert	134560+88990 →
Insert "2", "8" still blinking	2	134560+28899 →

Undo (889900)

Clear "889900",⌜⌟ still blinking	CE/C	↶ 134560+2⌜⌟
Resume "889900"	Shift (UNDO)	← 560+2889900⌜⌟

- After deleted an input by DEL or cleared the input by CE/C, ↶ icon will be shown on the display.
- Press Shift (UNDO) to resume up to 79 DEL deleted input or to undo the cleared segment and back to the previous display.
- If pressed DEL...CE/C to delete character(s) then clear the display, the calculator will prioritize the undo from resuming the latest CE/C cleared characters, and followed with the deleted characters continuously.
- After inserting a new data or executing a calculation command, the calculator cannot perform the "Undo" function.

Replay, Copy and Multi-statements

Replay

- Replay memory capacity is 128 bytes that can store calculation expressions and results.
- After the calculation is executed, the calculation expression and its result will be stored in the replay memory automatically.
- Pressing ▲ (or ▼) can replay the performed calculation expressions and results.
- Replay memory is cleared when
  - i) Initialize calculator setting by Alpha CLR 2 (or 3 = ON/CA).
  - ii) Change from one calculation mode to another.

Copy

- Press Shift (COPY) after replayed the previous calculation expressions (statements) can make a multi-statement with the current calculation expression.

Multi-statements

- You can put two or more calculation expressions together by using a colon [:].
- The first executed statement will have [Disp] indicator; and the [Disp] icon will disappeared after the last statement is being executed.

Example :

Operation	Display (Upper line)	Display (Lower Line)
[8] [+] [9] [=]	8 + 9	17.
[5] [×] [2] [Alpha] [:] [Ans] [+] [6] [=]	5 x 2	10.$_{Disp}$
[=]	Ans + 6	16.
[↑] [↑] [Shift] [↑]	9 : 5 x 2 : Ans + 6	17.
[=]	8 + 9	17.$_{Disp}$
[=]	5 x 2	10.$_{Disp}$
[=]	Ans + 6	16.

Calculation Stacks

■ This calculator uses memory areas, called "stacks", to temporarily store numeric value (numbers) and commands (+ – x ...) according to their precedence during calculations.

■ The numeric stack has 10 levels and the command stack has 24 levels. A stack error [Stack ERROR] occurs whenever you try to perform a calculation that exceeds the capacity of stacks.

■ Matrix calculations use up to two levels of the matrix stack. Squaring a matrix, cubing a matrix, or inverting a matrix uses one stack level.

■ Calculations are performed in sequence according to "Order of Operations". After the calculation is performed, the stored stack values will be released.

Calculation Accuracy, Input Ranges

Internal digits: Up to 16
Accuracy*: As a rule, accuracy is ±1 at the 10^{th} digit.
Output ranges: ±1 x 10^{-99} to ±9.999999999 x 10^{99}

Function	Input Range	
sin x	Deg	$0 \leq \lvert x \rvert < 9 \times 10^{9}$
	Rad	$0 \leq \lvert x \rvert < 157079632.7$
	Grad	$0 \leq \lvert x \rvert < 1 \times 10^{10}$
cos x	Deg	$0 \leq \lvert x \rvert < 9 \times 10^{9}$
	Rad	$0 \leq \lvert x \rvert < 157079632.7$
	Grad	$0 \leq \lvert x \rvert < 1 \times 10^{10}$
tan x	Deg	Same as sinx, except when $\lvert x \rvert = 90(2n-1)$
	Rad	Same as sinx, except when $\lvert x \rvert = \pi/2(2n-1)$
	Grad	Same as sinx, except when $\lvert x \rvert = 100(2n-1)$
$\sin^{-1}x$ $\cos^{-1}x$	$0 \leq \lvert x \rvert \leq 1$	
$\tan^{-1}x$ tanhx	$0 \leq \lvert x \rvert \leq 9.999999999 \times 10^{99}$	
sinhx coshx	$0 \leq \lvert x \rvert \leq 230.2585092$	
$\sinh^{-1}x$	$0 \leq \lvert x \rvert \leq 4.999999999 \times 10^{99}$	
$\cosh^{-1}x$	$1 \leq x \leq 4.999999999 \times 10^{99}$	
$\tanh^{-1}x$	$0 \leq \lvert x \rvert \leq 9.999999999 \times 10^{-1}$	
logx lnx	$0 < x \leq 9.999999999 \times 10^{99}$	
10^{x}	$-9.999999999 \times 10^{99} \leq x \leq 99.99999999$	
e^{x}	$-9.999999999 \times 10^{99} \leq x \leq 230.2585092$	
$\sqrt{x}$	$0 \leq x < 1 \times 10^{100}$	
X^2	$\lvert x \rvert < 1 \times 10^{50}$	
X^3	$\lvert x \rvert \leq 2.15443469 \times 10^{33}$	
1/x	$\lvert x \rvert < 1 \times 10^{100}; x \neq 0$	
$\sqrt[3]{x}$	$\lvert x \rvert < 1 \times 10^{100}$	
X!	$0 \leq x \leq 69$ (x is an integer)	

Function	Input Range
nPr	$0 \leq n < 1x10^{10}$, $0 \leq r \leq n$ (n, r are integers) $1 \leq \{n!/(n-r)!\} < 1 x10^{100}$
nCr	$0 \leq n < 1x10^{10}$, $0 \leq r \leq n$ (n, r are integers) $1 \leq [n!/\{r!(n-r)!\}] < 1 x10^{100}$
Pol(x,y)	$\lvert x \rvert$, $\lvert y \rvert \leq 9.999999999x10^{99}$ $(x^2+y^2) \leq 9.999999999x10^{99}$
Rec(r, θ)	$0 \leq r \leq 9.999999999x10^{99}$ θ : Same as sinx, cosx
◦ ’’’	$\lvert a \rvert$, b, c $< 1x10^{100}$ $0 \leq b, c$
< ◦ ’’’	$\lvert x \rvert < 1x10^{100}$ Decimal ↔ Sexagesimal Conversions $0°0'0'' \leq \lvert x \rvert \leq 999999°59'59''$
^(x^y)	x>0: $-1x10^{100} < y \log x < 100$ x=0: y > 0 x<0: y=n, m/(2n+1), (m, n is an integer) However: $-1x10^{100} < y \log \lvert x \rvert < 100$
$x\sqrt{y}$	y>0: x ≠ 0 $-1x10^{100} < (1/x) \log y < 100$ y=0: x > 0 y<0: x=2n+1, (2n+1)/m (m≠ 0; m,n is an integer)
$a\,b/c$	Total of integer, numerator, and denominator must be 10 digits or less (including division marks).
i~Rand(a,b)	$0 \leq a<1x10^{10}$, $0 \leq b<1x10^{10}$ (a,b should be positive integers or 0)
Rand	Result generates a 3 digits pseudo random number (0.000~0.999)
Single-variable	$\lvert x \rvert < 1x10^{100}$ $\lvert FREQ \rvert < 1x10^{100}$
Paired-variable	$\lvert x \rvert < 1x10^{100}$ $\lvert y \rvert < 1x10^{100}$ $\lvert FREQ \rvert < 1x10^{100}$
Abs	$\lvert x \rvert < 1x10^{100}$
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 : -2147483647 ~ -1
OCT	Positive : 0 ~ 177 7777 7777 Negative : 200 0000 0000 ~ 377 7777 7777
HEX	Positive : 0 ~ 7FFF FFFF Negative : 8000 0000 ~ FFFF FFFF

*For a single calculation, the calculation error is ±1 at the 10^{th} digit. For exponential display, calculation error is ±1 at the last significant digit. Errors are cumulative in the case of consecutive calculations, which can cause them to become larger. (This is also true as internal consecutive calculations are performed in the case of $\wedge(x^y)$, $\sqrt[x]{y}$, x!, nPr, nCr, etc.) In the vicinity of a function's singular point and point of inflection, errors are cumulative and may become large.

Order of Operations

The calculator will automatically determine the operation priority. This means that algebraic expressions can be entered just as they are written and the calculation priority is as follows:

1st Priority	Recall memory (A, B, C, D, E, F, 0-9), Rand
2nd	Calculation within parentheses ( ).
3rd	Function with parenthesis that requests the input argument to the right Pol(, Rec(, d/dx, ∫dx, sin(, cos(, tan(, log(, ln(, e^(, 10^(, $\sqrt{}$(, $\sqrt[3]{}$(, Abs(, i~Rand(, etc.
4th	x^2, x^3, x^{-1}, x!, ° ' ", °, r, g, ^(, $\sqrt[x]{}$(, Percent %, $\log_a b$, EXP, ▸t
5th	a b/c, d/c
6th	Prefix symbol: (–) (negative sign), base-n symbols (d, h, b, o, Neg, Not) etc.
7th	Statistical estimated value calculation: x̂, ŷ, x̂1, x̂2 Metric conversion commands
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), FMLA, ▸r< θ, ▸a+bi

Operations of the same precedence are performed from right to left. For example: $e^{\ln\sqrt{120}} \rightarrow e^{x}\{\ln(\sqrt{120})\}$. Other operations are performed from left to right

Operations enclosed with parentheses are performed first. When a calculation contains an argument that is a negative number, the negative number must be enclosed within parentheses.
Example: $(-2)^4 = 16$; and $-2^4 = -16$

Error Messages and Error Locator

The calculator is locked up while an error message is shown on the display to indicate the cause of the error.

- Press ON/CA to clear the error, or
- Press ◁ or ▷ to display the calculation with the cursor positioned under the error and you can correct it accordingly.

Error Message	Cause	Action
Math ERROR	• Calculation 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 your input values and make sure they are all within the allowable ranges. Pay special attention to values in any memory areas you are using.
Stack ERROR	The capacity of the numeric stack or operator stack is exceeded.	Simplify the calculation. The numeric stack has 10 levels and the operator stack has 24 levels. Divide your calculation into two or more separate parts.
Syntax ERROR	An attempt to perform an illegal mathematical operation.	Press ◁ or ▷ to display the calculation with the cursor located at the location of the error and make required corrections.

Error Message	Cause	Action
Arg ERROR	Improper use of an argument.	Press ◁ or ▷ to display the location of the cause of an error and make required corrections.
Dim ERROR	• Under Matrix and Vector mode, the dimension (row, column) over three. • 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.
Solve ERROR	Can't get the result by solve function.	Press ◁ or ▷ to display the location of the cause of an error and make required corrections.

Before Using the Calculator

■ Check the current Calculation Mode

Be sure to check the status indicators that indicate the current calculation mode (CPLX, SD... etc) and angle unit setting (Deg, Rad Gra) before starting a calculation.

■ Return Calculation Mode to the initial setup

You can return the calculation mode to the initial default by pressing Alpha CLR 2 (Mode) = ON/CA

Calculation Mode	: COMP
Angle Unit	: Deg
Exponential Display Format	: Norm 1, Eng Off
Complex Number Display Format	: a+b*i*
Fraction Display Format	: a b/c
Decimal Point Character	: Dot

, and this action will not clear the variable memories.

■ Initialize the Calculator

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

Alpha CLR 3 (All) = ON/CA

BASIC CALCULATIONS

- Press [MODE] [1] to enter COMP mode as you want to perform basic calculations.
- During the busy calculation, the calculator will display the message [PROCESSING].

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

- To calculate the negative values (excludes the negative exponent), you have to enclose them with parentheses.
- To input the negative vaues, use [(−)].

Calculation Expression	Operation	Display (Result)
$(-2.5)^2$	[(] [(−)] [2] [·] [5] [)] [x^2] [=]	6.25
$(4 \times 10^{75})(-2 \times 10^{-79})$	[4] [EXP] [7] [5] [×] [(−)] [2] [EXP] [(−)] [7] [9] [=]	-8×10^{-04}

- This Calculator supports 24-level of parenthetical expression.
- You can omit the close parentheses [)] as the calculation ends with [=] or [M+] .

Calculation Expression	Operation	Display (Result)
(tan - 45) ÷ (-2)	[tan] [(−)] [4] [5] [÷] [(−)] [2] [=]	0.5
tan (- 45 ÷ -2)	[tan] [(] [(−)] [4] [5] [÷] [(−)] [2] [=]	0.414213562

! When the number of [)] is more than [(], [Syntax ERROR] will be shown.

Memory Calculations

Ans M- M+ M STO RCL

Memory Variables

- There are 20 memory variables (0 through 9, A through F, M, X, Y and Z) which store data, results, or dedicated values.
- To store values into memory by pressing STO + Memory variable.
- To recall memory values, press RCL + Memory variable.
- Memory content can be cleared by simply pressing 0 STO + Memory variable.

Example: 23 + 7 (Store to A), calculate sin (memory A), and clear memory A

Calculation Operation	Display (Upper)	Display (Lower)
2 3 + 7 STO A	23+7 ➡ A	30.
sin RCL A =	sin A	0.5
0 STO A	0 ➡ A	0.

Independent Memory

- Independent memory M uses the same memory area as variable M. It is convenient for calculating cumulative total by just pressing M+ (add to memory) or M- (subtract from memory); and the memory contents are retained even when the calculator is turned off.
- To clear independent memory (M), input 0 STO M

! When you want to clear all memory values, pres Alpha CLR 1 (Mcl) = ON/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 or STO followed by a memory variables.
- If you continue with pressing an operator key (+, –, x, ÷, x^2, x^3, x^{-1}, x!, DRG▶, ^(x^y), $\sqrt[x]{}$, nPr and nCr), the displayed value will be changed into [Ans] plus the operator key. Then, you can perform a new calculation with the latest Answer Memory.

Calculation Operation	Display (Upper)	Display (Lower)
1 2 3 + 4 5	123+456M+	579.
6 M+		
x^2 =	Ans^2	335,241.

- You can recall and use the latest stored Answer Memory by pressing [Ans].

Calculation Operation	Display (Upper)	Display (Lower)
[7] [8] [9] [9] [0] [0] [−] [Ans] [=]	789900−Ans	454,659.

! Answer Memory is not updated as an error operation had been performed.

Fraction Operations

[a b/c] [d/c]

The Calculator support Fraction Calculation and the conversions between Fraction, Decimal point, Mixed fraction and Improper fraction.

Fraction Calculation, Fraction ↔ Decimal point conversion

Example	Operation	Display (Lower)
$1\frac{2}{3} + \frac{5}{6} = 2\frac{1}{2}$	[1] [a b/c] [2] [a b/c] [3] [+] [5] [a b/c] [6] [=]	2⌟1⌟2.
$2\frac{1}{2}$ ↔ 2.5 (Fraction ↔ Decimal)	[a b/c]	2.5
	[a b/c]	2⌟1⌟2.

- Result will be displayed in decimal format automatically whenever the total digits of a fractional value (integer + numerator + denominator + separator marks) exceeds 10.
- As a fraction calculation is mixed with decimal value, the result will be displayed by decimal format.

Decimal ↔ Mixed fraction ↔ Improper fraction conversion

Example	Operation	Display (Lower)
$5.25 \leftrightarrow 5\frac{1}{4}$ (Decimal ↔ Mixed Fraction) (Mixed Fraction ↔ Improper Fraction)	[5] [·] [2] [5] [=]	5.25
	[a b/c]	5⌟1⌟4.
	[Shift] [d/c]	21⌟4.

- Fraction conversion may take as long as two seconds.

! You can specify the fraction calculation result (when the result greater than one) display format by either mixed fraction or improper fraction. Simply press MODE ◀ [Disp] 1 ▶, then press the corresponding setting you need:

1 a b/c : Mixed fraction

2 b/c : Improper fraction

! [Math ERROR] will occurs if you input a mixed fraction and the improper [d/c] display format is selected.

Percentage Calculations

You can perform the following percentage calculations:

Basic : To calculate a certain percentage of a value
(A × B Shift % =)
: Percentage of a value against another value
(A ÷ B Shift % =)

Example	Operation	Display (Upper)	Display (Lower)
To calculate 25 % of 820	8 2 0 × 2 5 Shift % =	820 x 25 %	205.
The percentage of 750 against 1250	7 5 0 ÷ 1 2 5 0 Shift % =	750 ÷ 1250 %	60.

Mark up and Discount

Example	Operation	Display (Upper)	Display (Lower)
820 mark up 25%	8 2 0 × 2 5 Shift % = 8 2 0 + Ans =	820 + Ans	1,025.
820 have 25% discount	8 2 0 × 2 5 Shift % = 8 2 0 − Ans =	820 - Ans	615.

Percentage Increase : If "A" is added to "B", the percentage increase from "B" is:
(A + B) ÷ B × 1 0 0

Percentage Change : If "A" is changed into "B", the percentage change from "A" to "B" is:
(A − B) ÷ A × 1 0 0

Example	Operation	Display (Upper)	Display (Lower)
300 is added to 750, the percentage increase of 750 is	(3 0 0 + 7 5 0) ÷ 7 5 0 × 1 0 0 =	(300+750)÷75	140.
25 increased into 30, the percentage change of 25 is	(3 0 − 2 5) ÷ 2 5 × 1 0 0 =	(30-25)÷25×1	20.

Percentage Proportion : the ratio/ percentage of each individual portion in a calculation expression.
If A + B + C = D

"A" is a% of "D" where $a = \frac{A}{D} \times 100\%$

Examples: To calculate the ratio of each portion as 25+85+90=200 (100%), the ratio of 25 is 12.5%, 85 is 42.5%, 90 is 45%

Operation	Display (Upper)	Display (Lower)
2 5 + 8 5 + 9 0 STO A	25+85+90 → A	200.
2 5 ÷ RCL * A Shift % =	25÷A %	12.5
8 5 ÷ RCL * A Shift % =	85÷A %	42.5
9 0 ÷ Alpha * A Shift % =	90÷A %	45.

* You can store the sum of value into memory variables, then recall and use the value by pressing RCL or Alpha + Memory variable.

Degree-Minutes-Seconds Calculations

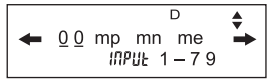
You can use degrees (hours), minutes and seconds key to perform a sexagesimal (base-60 notational system) calculation or convert the sexagesimal value into decimal value.

Degree-Minutes-Seconds ↔ Decimal points

Example	Operation	Display (Lower)
86º37' 34.2"÷0.7 =	8 6 °'" 3 7 °'" 3 4 · 2 °'" ÷	123º45º6º
123º45' 6"	0 · 7 =	
123º45' 6" ➡ 123.7516667	°'"	123.7516667
2.3456 ➡ 2º20' 44"	2 · 3 4 5 6 = Shift °'"	2º20º44.16

Constant Value Calculations

F-788SG has total 79 constant values, you can enter (or exit) the constant value selection menu by pressing [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 [>] button. The selection cursor will shift left or right to underline a constant symbol and at the same time the display lower line 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 underling 0 0.

Operation	Display
[C-VALUE] (menu selection page)	00 m_p m_n m_e INPUT 1–79
[v][>]	04 m_μ a_0 h 1.883531475 $\times 10^{-28}$
[=] (confirm selection)	m_μ 0.
[+] [C-VALUE] [3] [5]	35 m_p m_n m_e INPUT 1–79
[=] [=]	m_μ + g 9.80665

Scientific Constant Table

NO.	Constant	Symbol	Value	Unit
1.	Proton mass	m_p	1.672621777x10^{-27}	kg
2.	Neutron mass	m_n	1.674927351 x10^{-27}	kg
3.	Electron mass	m_e	9.10938291x10^{-31}	kg
4.	Muon mass	m_μ	1.883531475x10^{-28}	kg
5.	Bohr radius $\alpha / 4\pi R\infty$	a_0	0.52917721092x10^{-10}	m
6.	Planck constant	h	6.62606957 x10^{-34}	J s
7.	Nuclear magneton e $\hbar / 2m_p$	μ_N	5.05078353 x10^{-27}	J T^{-1}
8.	Bohr magneton e $\hbar / 2m_e$	μ_B	927.400968 x10^{-26}	J T^{-1}
9.	$h / 2\pi$	$\hbar$	1.054571726 x10^{-34}	J s
10.	Fine-structure constant $e^2 / 4\pi\varepsilon_0 \hbar c$	α	7.2973525698x10^{-3}	
11.	Classical electron radius $\alpha^2 a_0$	r_e	2.8179403267x10^{-15}	m
12.	Compton wavelength h / m_ec	λ_c	2.4263102389 x10^{-12}	m
13.	Proton gyromagnetic ratio $2\mu_p / \hbar$	γ_p	2.675222005 x10^{8}	s^{-1} T^{-1}
14.	Proton Compton wavelength h / m_p c	$\lambda_{c,p}$	1.32140985623 x10^{-15}	m
15.	Neutron Compton wavelength h / m_nc	$\lambda_{c,n}$	1.3195909068x10^{-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 x10^{-27}	kg
18.	Proton magnetic moment	μ_p	1.410606743x10^{-26}	J T^{-1}
19.	Electron magnetic moment	μ_e	-928.476430x10^{-26}	J T^{-1}
20.	Neutron magnetic moment	μ_n	-0.96623647 x10^{-26}	J T^{-1}
21.	Muon magnetic moment	μ_μ	-4.49044807 x10^{-26}	J T^{-1}
22.	Faraday constant N_Ae	F	96485.3365	C mol^{-1}
23.	Elementary charge	e	1.602176565x10^{-19}	C
24.	Avogadro constant	NA	6.02214129x10^{23}	mol^{-1}
25.	Boltzmann constant R / N_A	k	1.3806488 x10^{-23}	J K^{-1}
26.	Molar volume of ideal gas RT / p T=273.15 K, p=101.325 kPa	Vm	22.413968 x10^{-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	3.74177153x10^{-16}	W m^2
30.	Second radiation constant hc/k	c_2	1.4387770 x10^{-2}	m K

NO.	Constant	Symbol	Value	Unit
31.	Stefan-Boltzmann constant	σ	5.670373x10^{-8}	W m^{-2} K^{-4}
32.	Electric constant $1 / \mu_0 c^2$	ε_0	8.854187817 x10^{-12}	F m^{-1}
33.	Magnetic constant	μ_0	12.566370614x10^{-7}	N A^{-2}
34.	Magnetic flux quantum h / 2e	Φ_0	2.067833758x10^{-15}	Wb
35.	Standard acceleration of gravity	g	9.80665	m s^{-2}
36.	Conductance quantum $2e^2 / h$	G_0	7.7480917346 x10^{-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	6.67384x10^{-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 x10^{-15}	m
43.	Planck length $\hbar / m_P c = (\hbar G / c^3)^{1/2}$	l_P	1.616199 x10^{-35}	m
44.	Planck time $l_P / c = (\hbar G / c^5)^{1/2}$	t_P	5.39106 x10^{-44}	s
45.	Planck mass $(\hbar c / G)^{1/2}$	m_P	2.17651 x10^{-8}	kg
46.	Atomic mass constant	m_u	1.660538921 x10^{-27}	kg
47.	Electron volt: (e / C)J	eV	1.602176565 x10^{-19}	J
48.	Molar planck constant	$N_A h$	3.9903127176 x10^{-10}	J s mol^{-1}
49.	Wien displacement law constant	b	2.8977721 x10^{-3}	m K
50.	Lattice parameter of Si(in vacuum, 22.5°C)	a	543.1020504 x10^{-12}	m
51.	Hartree energy $e^2 / 4\pi\varepsilon_0 a_0$	Eh	4.35974434 x10^{-18}	J
52.	Loschmidt constant N_A / Vm	n_0	2.6867805 x10^{25}	m^{-3}
53.	Inverse of conductance quantum	G_0^{-1}	12906.4037217	Ω
54.	Josephson constant 2e / h	K_J	483597.870 x10^9	Hz V^{-1}
55.	Von Klitzing constant h / e^2	R_K	25812.8074434	Ω
56.	$\lambda_c / 2\pi$	$\lambda\!\!\!^{-}_c$	386.15926800 x10^{-15}	m
57.	Thomson cross section $(8\pi / 3) r_e^2$	σ_e	0.6652458734 x10^{-28}	m^2
58.	Electron magnetic moment anomaly $\lvert \mu_e \rvert / \mu_B - 1$	a_e	1.15965218076 x10^{-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 x10^{-11}	s^{-1} T^{-1}
61.	Muon magnetic moment anomaly	a_μ	1.16592091 x10^{-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 x10^{-15}	m
64.	$\lambda_{c,\mu}$ / 2π	$\lambda\!\!\!^{-}_{c,\mu}$	1.867594294 x10^{-15}	m
65.	Tau Compton wavelength h / $m_\tau c$	$\lambda_{c,\tau}$	0.697787 x10^{-15}	m
66.	$\lambda_{c,\tau}$ / 2π	$\lambda\!\!\!^{-}_{c,\tau}$	0.111056 x10^{-15}	m
67.	Tau mass	m_τ	3.16747 x10^{-27}	kg
68.	$\lambda_{c,p}$ / 2π	$\lambda\!\!\!^{-}_{c,p}$	0.21030891047 x10^{-15}	m
69.	Shielded proton magnetic moment(H_2O, sphere, 25°C)	μ'_p	1.410570499 x10^{-26}	J T^{-1}
70.	Neutron g-factor 2 μ_n / μ_N	g_n	-3.82608545	
71.	Neutron gyromagnetic ratio 2|μ_n| / $\hbar$	γ_n	1.83247179 x10^{-8}	s^{-1} T^{-1}
72.	Deuteron mass	m_d	3.34358348 x10^{-27}	kg
73.	Deuteron magnetic moment	μ_d	0.433073489 x10^{-26}	J T^{-1}
74.	Helion mass	m_h	5.00641234 x10^{-27}	kg
75.	Shielded helion magnetic moment(gas, sphere, 25°C)	μ'_h	-1.074553044 x10^{-26}	J T^{-1}
76.	Shielded helion gyromagnetic ratio 2|μ'_h| / $\hbar$ (gas, sphere, 25°C)	γ'_h	2.037894659 x10^{-8}	s^{-1} T^{-1}
77.	Alpha particle mass	m_α	6.64465675 x10^{-27}	kg
78.	Shielded proton gyromagnetic ratio 2 μ'_p / $\hbar$ (H_2O, sphere, 25°C)	γ'_p	2.675153268 x10^{-8}	s^{-1} T^{-1}
79.	Proton magnetic shielding correction 1-μ'_p / μ_p(H_2O, sphere, 25°C)	σ'_p	25.694 x10^{-6}	

! Constant value cannot perform rounding.

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

Metric Unit Conversions

F-788SG has 172 patterns of unit conversions to convert a value to specified metric units. There are 8 categories including distance, area, temperature, capacity, weight, energy, pressure and speed.

- Press CONVT to enter the conversion menu.
- Press ^ or v to select the category .
- Press < or > then = to select the start unit.
- Press < or > then = to select the end unit. You can preview the value before pressing = .

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

- You can go back to the calculation mode instantly as the CONVT key is pressed within the category selection pages. But after selected the base conversion unit, ▲, ▼ or CONVT keys will be invalid.

Example: Convert 10 + (5 ft² → m²) = 10.4645152

Operation	Display
1 0 + 5 CONVT (enter the conversion menu)	◄ → feet m mil ▲▼ ► 0.
▼ = (select ft²)	◄ ft² yd² m² 5.
▼ ▼ = (convert to m²)	10+5ft² → m²_ ▲ 0.
= (calculate the answer)	10+5ft² → m²_ ▲ 10.4645152

! If the converted result is overflow, [-E-] will be shown in the lower display. User cannot press = to select the over flow value but following scenario are valid:

Scenario A - Keep selecting the other conversion value by pressing ▼ or ▲.

Scenario B - Clear the screen by ON/CA and jump out the selection.

Scenario C - Pressing CONVT to jump back to previous calculation screen.

Engineering Notation Calculations

ENG ◄ENG

Following nine symbols can be used when engineering symbols a turned on by pressing MODE ▲ 1 1 and the LCD will display [Eng].

Operation:	Value	Unit
Alpha k	Kilo	10^3
Alpha M	Mega	10^6
Alpha G	Giga	10^9
Alpha T	Tera	10^{12}
Alpha m	Milli	10^{-3}
Alpha μ	Micro	10^{-6}
Alpha n	Nano	10^{-9}
Alpha p	Pico	10^{-12}
Alpha f	Femto	10^{-15}

Example: Convert 0.0007962 second into nano-second = 79620000 x 10^{-09}

Operation	Display (Upper)	Display (Lower)
0 · 0 0 0 7 9 6 2 =	0.0007962 μ ▲	796.2
ENG	0.0007962 n ▲	796200.

Example: 0.128 gram + 9.3 kilogram = 9300.128 gram

0 · 1 2 8 + 9 · 3 Alpha =	0.128 + 9.3k k ▲	9.300128

Fix, Sci, Norm, ROUND

You can change the number of decimal point, the number of significant digits, or the exponential notation criteria by pressing MODE ◁ ◁ to the following selection screen:

◀ Fix	Sci	Norm ▶
1	2	3

1 (Fixed Decimal Setting) : [Fix 0 ~ 9?] appears on the display. Then you can specify the number of decimal places by pressing 0 ~ 9.

2 (Scientific Notation) : [Sci 0 ~ 9?] appears on the display. Then you can specify the number of significant digits by pressing 0 ~ 9.

3 (Exponential Notation) : [Norm 1 ~ 2?] appears. Then you can 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 point.

Norm 2 : Exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than nine decimal point.

• To clear the setting, refer page 13.

ROUND (internal rounding) : Calculate the value or formula result to decimal, round it off to the significant decimal place according to the current specified indication digit setting (Fix, Sci, Norm).

Examples: 57 ÷ 7 x 20 = ??	**Operation**	**Display (Lower)**
At default setting. To fix 4 digits decimal point. (Internal calculation continues 16 digits)	5 7 ÷ 7 × 2 0 = MODE ◁ ◁ 1 4 5 7 ÷ 7 = × 2 0 =	162.8571429 162.8571 8.1429 162.8571
Perform internal rounding under the specified decimal setting.	5 7 ÷ 7 = Shift ROUND × 2 0 =	8.1429 162.8580
To display by 6 digits scientific notation.	MODE ◁ ◁ 2 6	1.62858×10^{02}
Notation format by pressing 1 to clear the FIX and Sci specifications.	MODE ◁ ◁ 3 1	162.858

FUNCTIONAL SCIENTIFIC CALCULATIONS

- Press MODE 1 to enter COMP mode for performing functional scientific calculations.
- During the busy calculation, the calculator will display the message [PROCESSING].
- π = 3.14159265359

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

x^2 Square	√ Root	x^3 Cube	$\sqrt[3]{}$ Cube Root
^ Power	$\sqrt[x]{}$ Power Root	x^{-1} Reciprocal	π Pi

Example: ($\sqrt{-2^2 + 5^3}$) x π = 35.68163348

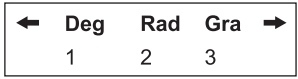
Operation	Display (Upper)	Display (Lower)
(√ (((−) 2) x^2 + 5 Shift x^3)) Shift π =	$(\sqrt{(-2)^2 + 5^3})$	35.68163348

Example: ($\sqrt[3]{2^6} + \sqrt[5]{243}$)$^{-1}$ = 0.142857142

Operation	Display (Upper)	Display (Lower)
(Shift $\sqrt[x]{}$ 2 ^ 6 + 5 Shift $\sqrt[x]{}$ 2 4 3) Shift x^{-1} =	$(\sqrt[3]{2^6 + 5\sqrt[x]{24}}$	0.142857142

Angle Unit Conversion

The calculator default angle unit setting is "Degree". If you need to change into "Radian" or "Gradient", you can press MODE a number of times until you reach the setup screen:



Then press the corresponding number key 1 , 2 , or 3 for the angle unit you need. Then the display will show the D , R , or G indicator accordingly.

To convert an angle unit between "Degree", "Radian" and "Gradient", you can press Shift DRG▸ and the following display menu will be shown:

Then, press 1 , 2 , or 3 will convert the displayed value into the selected angle unit. If you want to indicate the value with other degree unit after conversion, change the unit using MODE ◁◁◁ .

Example: Convert 180 degree into radian and gradient
($180^{o} = \pi^{Rad} = 200^{Gad}$)

Operation	Display (Upper)	Display (Lower)
MODE ▷▷▷ 2 (Radian mode) 1 8 0 Shift DRG▸ 1 =	R 180	3.141592654
MODE ◁◁◁ 3 (Gradient mode) =	G 180	200.

Trigonometry Calculations

sin cos tan $\sin^{-1}$ $\cos^{-1}$ $\tan^{-1}$ hyp

- Before using the trigonometric functions (except hyperbolic calculations), select the appropriate angle unit (Deg/ Rad/ Gad) by MODE .
- $90^{o} = \frac{\pi}{2}$; Radian = 100 Gradient.

Trigonometric (sin/ cos/ tan), Inverse Trigonometric (sin^{-1}/ cos^{-1}/ tan^{-1}) Functions

Examples	Operation	Display (Lower)
Degree Mode	MODE ◁ ◁ ◁ 1	0.
sin 53° 22' 12" = 0.802505182	sin 5 3 °'" 2 2 °'" 1 2 °'" =	0.802505182
cosec x = 1/sinx cosec 45° = 1.414213562	(sin 4 5) Shift x^4 =	1.414213562
tan^{-1} (5/6) = 39.80557109°	Shift tan^{-1} (5 ÷ 6 =	39.80557109
Radian Mode	MODE ◁ ◁ ◁ 2 ON/CA	0.
$cos(\pi/6)^{Rad}$ = 0.866025403	cos 6 Shift x^4 Shift π =	0.866025403
$\cos^{-1}\frac{1}{\sqrt{2}}$ = 0.785398163 0.25 π (Rad)	Shift cos^{-1} (1 ÷ √ 2 = Ans ÷ Shift π =	0.785398163 0.25

Hyperbolic (sinh/ cosh/ tanh), Inverse Hyperbolic ($sinh^{-1}$/ $cosh^{-1}$/ $tanh^{-1}$) Functions

Examples	Operation	Display (Lower)
sinh 2.5 – cosh 2.5 = -0.082084998	hyp sin 2 · 5 − hyp cos 2 · 5 =	-0.082084998
$cosh^{-1}$ 45 = 4.499686191	hyp Shift cos^{-1} 4 5 =	4.499686191

Logarithm, Natural Logarithm, Antilogarithm and Logab

log ln 10^x e^x $log_a b$

Examples	Operation	Display (Lower)
log 255 + ln 3 = 3.505152469	log 2 5 5 + ln 3 =	3.505152469
e^{-3} + $10^{1.2}$ = 15.89871899	Shift e^x (−) 3 + Shift 10^x 1 · 2 =	15.89871899
$log_3 81$ – log 1 = 4	Shift $log_a b$ 3 , 8 1) − log 1 =	4.

Coordinate Conversion

Shift Pol(

- With polar coordinates, you can calculate and display θ within $-180^{\circ} < \theta \leqq 180^{\circ}$ range. (Same as Radian and Gradient)
- After conversion, results will be automatically assigned to memory variables E and F.

Shift Pol(: To convert rectangular coordinates (x, y) to polar coordinates (r , θ); Press RCL X to display the value of r, or RCL Y to display the value of θ .

Examples	Operation	Display (Lower)
With rectangular coordinate (x =1,y = $\sqrt{3}$). Find Polar coordinate (r, θ) at degree mode	Shift Pol(1 , √ 3 =	2.
	RCL Y	60.
	RCL X	2.

Shift Rec(: To converts polar coordinates (r , θ) to rectangular coordinates(x, y); Press RCL X to display the value of x, or RCL Y to display the value of y.

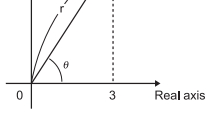
Examples	Operation	Display (Lower)
With Polar coordinate(r=2, θ =60°). Find rectangular coordinate (x,y) at degree mode	Shift Rec(2 , 6 0 =	1.
	RCL Y	1.732050808
	RCL X	1.

! [Syntax ERROR] will be shown if , is missed in the coordinate conversion calculation.

Complex Number Calculations

Re↔Im i Abs Arg Conjg

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

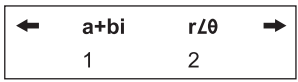


As you need to perform the complex number calculation

- Press MODE 2 to enter CPLX mode.
- Check the current angle unit setting (Deg, Rad, Grad).
- The R⇔I indicator will be shown as the calculation result having complex numbers. Just press Shift Re⇔Im to switch the result display.
- [i] icon indicate the display result is imaginary number part; [∠] indicate the display value is the argument value θ.
- But the imaginary numbers will use up replay memory capacity.

Displaying the complex number calculation result

Pressing MODE ◁ 1 ▷, following display options will be shown:



You can set up the complex number calculation result display format by pressing:

1 : Rectangular form (Default setting).

2 : Polar form (the [r∠θ] display indicator will be turned on).

Example: (12+3i) - (3 + 1i) = 9 + 2i = 9.219544457 (r)∠12.52880771 (θ)

Operation (Angle Unit: Degree)	Display (Upper)	Display (Lower)
(1 2 + 3 i) − (3 + i =	(12+3i)-(3+i	9.
Shift Re⇔Im	(12+3i)-(3+i	2.i
MODE ◁ 1 ▷ 2 (change display value)	(12+3i)-(3+i r∠θ	∠12.52880771
Shift Re⇔Im	(12+3i)-(3+i r∠θ	9.219544457

Rectangular Form ⟷ Polar Form Conversion

Press Shift ▶r∠θ can convert rectangular form complex number into polar form; whereas press Shift ▶a+bi will convert polar form complex number into rectangular form.

Example: 3 + 4i = 5 ∠ 53.13010235

Operation (Angle Unit: Degree)	Display (Upper)	Display (Lower)
3 + 4 i Shift ▶r∠θ =	3 + 4i > r∠θ	5
Shift Re⇔Im	3 + 4i > r∠θ	∠53.13010235

Example: $\sqrt{2}\angle 45 = 1 + i$

Operation (Angle Unit: Degree)	Display (Upper)	Display (Lower)
√ 2 ∠ 4 5 Shift ►a+bi =	√2∠45>a+bi	1.
Shift Re↔Im	√2∠45>a+bi	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 Shift Abs or Shift Arg key respectively.

Example: What's the absolute value (r) and argument (θ) if complex number is $6+8i$

Operation (Angle Unit: Degree)	Display (Upper)	Display (Lower)
Shift Abs (6 + 8 i =	Abs (6+8i	10.
⊙ Shift Arg =	arg (6+8i	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.

Example: The conjugate of $3 + 4i$ is $3 - 4i$

Operation (Angle Unit: Degree)	Display (Upper)	Display (Lower)
Shift Conjg (3 + 4 ∠ =	Conjg (3+4i	3.
Shift Re↔Im	Conjg (3+4i	-4.i

Base-n Calculations and Logical Calculations

- Press MODE MODE 3 to enter Base-n mode for decimal (base 10), hexadecimal (base 16), binary (base 2), octal (base 8), or logical calculations.
- Default base number system is Decimal with [d] display indicator
- To select a specific number system in base mode, simply press DEC Decimal [d], HEX Hexadecimal [H], BIN Binary [b], or OCT Octal [o].
- The Logic key allows you to perform logical calculations includes: 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-digit, [1b] / [1o] will be displayed to indicate the result has next block. Keep pressing ◄Bit can loop between result blocks.
- All the scientific functions cannot be used, and you cannot input the value with decimal place or exponent.

Binary Calculation BIN

Example: 10101011 + 1100 – 1001 x 101 ÷ 10 = 10100001
(at Binary Mode)

Operation	Display (Upper)	Display (Lower)
1 0 1 0 1 0 1 1 + 1 1 0 0 − 1 0 0 1 × 1 0 1 ÷ 1 0 =	10101011+110	10100001. b

Octal Calculation OCT

Example: 645 + 321 – 23 x 7 ÷ 2 = 1064 (at Octal Mode)

6 4 5 + 3 2 1 − 2 3 × 7 ÷ 2 =	645+321-23x7	1064. o

Hexadecimal Calculation HEX

Example: (77A6C + D9) x B ÷ F = 57C87 (at Hexadecimal Mode)

(7 7 A 6 C + D 9) × B ÷ F =	(77A6C + D9) x B	57C87. H

Base-n transformation DEC ➡ OCT ➡ HEX ➡ BIN

OCT 1 2 3 4 5 + logic logic logic 3 1 0 1 =	12345+b101	12352. o
HEX	12345+b101	14EA. H
BIN	12345+b101	11101010.1b
◀BIN (go to next block of the result)	12345+b101	10100.2b
◀BIN	12345+b101	11101010.1b

Logical Operation logic

Examples (Hexadecimal Mode)	Operation	Display (Lower)
789ABC Xnor 147258	HEX 7 8 9 A B C logic 3 1 4 7 2 5 8 =	FF93171b. H
Ans Or 789ABC	Ans logic 2 7 8 9 A B C =	FFFb9FbF. H
Neg 789ABC	logic logic 3 7 8 9 A B C =	FF876544. H

! Beware of the allowable input range of each number system (page 10).

STATISTICAL CALCULATIONS [SD] [REG]

- To enter the standard deviation mode by pressing MODE MODE 1, [SD] indicator lights up. If press MODE MODE 2, you can enter the regression mode selection menu. [REG] indicator will be turned on.
- Before starting, be sure to clear the statistic memory by pressing Alpha CLR 1 = ON/CA.
- Perform the data input.
  - In SD mode, store the displayed data by pressing Data, pressing Data Data will input the same data twice.
  - In REG mode, store the x-data and y-data in the form of: x-data , y-data Data, pressing Data Data will input the same data twice.
  - Use Shift ; for same data multiple entries. For example in SD mode, the data 20 has 8 times will press 20 Shift ; 8 Data.
  - Each time you press Data to register the input, the number of data input up to that point is indicated on the display once (n = the number of input data).
  - Press ↑ or ↓ key during or after data input can display the data value (x) and data frequency (Freq). Follow with the above example, press ↓ will display [x1 = 20], and press ↓ will display [Freq1= 8].
  - To edit the stored data, input the new value during the display of that data value (x) after pressing ↑ or ↓ key, and then press = to confirm the edit. But, if you press Data instead of =, a new data value will be stored.
  - Press Alpha CD can delete the data during the display of that data value (x) after ↑ or ↓ key is pressed; and the sequence of the data which following the deleted data will be shifted up automatically.
  - Press ON/CA key to exit the data value and frequency display, then you can perform other calculation operations.
  - Input data are stored in calculation memory. As the memory full, [Data Full] will be displayed and you cannot input or perform any calculation. Press ON/CA key to perform other calculation operations.
  - After changing into another mode or regression type (Lin, Log, Exp, Pwr, Inv, Quad), input data will be cleared.
- After finishing data entries, you can recall or calculate the statistical values.

Standard Deviation

- Press MODE MODE 1 to ender SD mode.
- Before starting, be sure to clear the statistical memory by pressing Alpha CLR 1 = ON/CA.
- You can recall the following statistical value after input all the data.

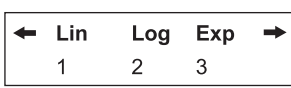
Value	Symbol	Operation
Square of Sum	Σx^2	Shift S-SUM 1
Summation of x	Σx	Shift S-SUM 2
Number of data sample	n	Shift S-SUM 3
Mean of x	$\bar{x}$	Shift S-VAR 1
Population Standard Deviation of x	$x\sigma_n$	Shift S-VAR 2
Sample Standard Deviation of x	$x\sigma_{n-1}$	Shift S-VAR 3

Example: To calculate Σx^2, Σx, n, $\bar{x}$, $x\sigma_n$, and $x\sigma_{n-1}$ of data: 75, 85, 90, 77, 77 in SD mode.

Operation	Display (Upper)	Display (Lower)
Alpha CLR 1 = ON/CA (select Sd, clear Stat. memory)		0.
7 5 Data 8 5 Data 9 0 Data	n =	5.
7 7 Shift ; 2 Data		
Shift S-SUM 1 =	Σx^2	32,808.
Shift S-SUM 2 =	Σx	404.
Shift S-SUM 3 =	n	5.
Shift S-VAR 1 =	$\bar{x}$	80.8
Shift S-VAR 2 =	$x\sigma_n$	5.741080038
Shift S-VAR 3 =	$x\sigma_{n-1}$	6.418722614

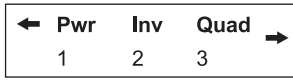
Regression Calculations

- Press MODE MODE 2 to ender REG mode, then the follow screen options will be shown:



Press 1 , 2 or 3 for the corresponding regression.
[Lin] = Linear regression
[Log] = Logarithmic regression
[Exp] = Exponential regression

If follow with MODE or ▶ another regression options will be displayed as follow:



You can press 1 , 2 or 3 for the corresponding regression.
[Pwr] = Power regression
[Inv] = Inverse regression
[Quad] = Quadratic regression

- Before starting, be sure to clear the statistical memory by pressing Alpha CLR 1 = ON/CA.
- Input data in the form of x-data , y-data Data. Use Shift ; for same data multiple entries.
- Press Alpha CD can delete the data during the display of data value after ▲ or ▼ key is pressed.
- You can recall and use the following regression results:

Value	Symbol	Operation
Summation of all x^2 value	Σx^2	Shift S-SUM 1
Summation of all x value	Σx	Shift S-SUM 2
Number of data sample	n	Shift S-SUM 3
Summation of all y^2 values	Σy^2	Shift S-SUM ▶ 1
Summation of all y values	Σy	Shift S-SUM ▶ 2
Summation of all xy pairs	Σxy	Shift S-SUM ▶ 3
Mean of the x values	$\bar{x}$	Shift S-VAR 1
Population Standard Deviation of x	$x\sigma_n$	Shift S-VAR 2
Sample Standard Deviation of x	$x\sigma_{n-1}$	Shift S-VAR 3
Mean of the y values	$\bar{y}$	Shift S-VAR ▶ 1
Population Standard Deviation of y	$y\sigma_n$	Shift S-VAR ▶ 2
Sample Standard Deviation of y	$y\sigma_{n-1}$	Shift S-VAR ▶ 3
Regression coefficient	A	Shift S-VAR ▶▶ 1
Regression coefficient	B	Shift S-VAR ▶▶ 2

For non-quadratic regression		
Correlation coefficient	C	Shift S-VAR ▷ ▷ 3
Regression estimated value	$\hat{x}$	Shift S-VAR ▷ ▷ ▷ 1
Regression estimated value	$\hat{y}$	Shift S-VAR ▷ ▷ ▷ 2
For Quadratic regression only		
Summation of all x^3 values	Σx^3	Shift S-SUM ▷ ▷ 1
Summation of all x^2y pairs	Σx^2y	Shift S-SUM ▷ ▷ 2
Summation of all x^4 values	Σx^4	Shift S-SUM ▷ ▷ 3
Regression coefficient	C	Shift S-VAR ▷ ▷ 3
Regression estimated value x_1	$\hat{x}_1$	Shift S-VAR ▷ ▷ ▷ 1
Regression estimated value x_2	$\hat{x}_2$	Shift S-VAR ▷ ▷ ▷ 2
Regression estimated value y	$\hat{y}$	Shift S-VAR ▷ ▷ ▷ 3

Linear regression

- The Linear regression formula is in relation to two variables: $y = A + Bx$
- **Example:** By the following investment and yield table, calculate the linear regression (regression coefficient A, regression coefficient B) of capital investment verse yield, the correlation coefficient, the yield percentage at 45 thousand unit of investment, and the investment unit at 180% yield.

Investment (thousand unit)	Yield (%)
20	120
30	126
40	130
50	136
60	141

Operation	Display (Upper)	Display (Lower)
MODE MODE 2 1 (Lin Regression)		0.
Alpha CLR 1 = ON/CA (Clear Stat. memory)		0.
2 0 , 1 2 0 Data 3 0 , 1 2 6 Data 4 0 , 1 3 0 Data 5 0 , 1 3 6 Data 6 0 , 1 4 1 Data	n =	5.
Shift S-VAR ▷ ▷ 1 = (Coefficient A)	A	109.8
Shift S-VAR ▷ ▷ 2 = (Coefficient B)	B	0.52
Shift S-VAR ▷ ▷ 3 = (Correlation Coefficient)	r	0.998523984
4 5 Shift S-VAR ▷ ▷ ▷ 2 = (Yield %)	45 $\hat{y}$	133.2
1 8 0 Shift S-VAR ▷ ▷ ▷ 1 = (Investment unit)	180 $\hat{x}$	135

Logarithmic, Exponential, Power, and Inverse Regression Formulas

- Loarithmic Regression : $y = A + B\ln x$
- Exponential Regression : $y = Ae^{Bx}$ ($\ln y = \ln A + Bx$)
- Power Regression : $y = Ax^{B}$ ($\ln y = \ln A + B\ln x$)
- Invere Regression : $y = A+Bx^{-1}$

Quadratic Regression

- The quadratic regression is in relation to the formula:
  $y = A + Bx + Cx^2$
- **Example:** ABC company investigated the effectiveness of the advertisement expenses in coded units, the following data were obtained:

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

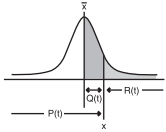
Please calculate the correlation coefficient; use the regression to estimate the effectiveness (estimate the value of y) if the advertisement expenses x = 30, and estimate the advertisement expenses level (estimate the value of x) for the effectiveness y = 50.

Operation	Display (Upper)	Display (Lower)
MODE MODE 2 ▷ 3 (Quad Regression)		
Alpha CLR 1 = ON/CA		0.
1 8 , 3 8 Data 3 5 , 5 4 Data 4 0 , 5 9 Data 2 1 , 4 0 Data 1 9 , 3 8 Data	n =	5.
Shift S-VAR ▷ ▷ 1 = (Coefficient A)	A	23.49058119
Shift S-VAR ▷ ▷ 2 = (Coefficient B)	B	0.688165819
Shift S-VAR ▷ ▷ 3 = (Coefficient C)	C	$5.067334875 \times 10^{-03}$
3 0 Shift S-VAR ▷ ▷ ▷ 3 = ($\hat{y}$ when x = 30)	30 $\hat{y}$	48.69615715
5 0 Shift S-VAR ▷ ▷ ▷ 1 = ($\hat{x}_1$ when y = 50)	50 $\hat{x}_1$	31.30538226
5 0 Shift S-VAR ▷ ▷ ▷ 2 = ($\hat{x}_2$ when y = 50)	50 $\hat{x}_2$	-167.1096731

Distribution Calculations

■ After sample data are 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" is a parameter when the normal distribution is standardized. "t" can be found from the statistical result.



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

x : Random variable

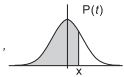
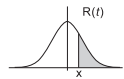
$\bar{x}$: Mean of sample

$x\sigma_n$: Standard deviation

■ Press Shift DISTR. will display the following selection screen.

P(	Q(	R(	→ t
1	2	3	4

You can press 1 , 2 , 3 or 4 for the corresponding calculations.

P(t): Probability below a given point x	$P(t)=\int_{-\infty}^{x}\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2}(\frac{t-\mu}{\sigma})^2}dt$, 
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, 26, 19, 23, 20 when x = 26.

Operation	Display (Upper)	Display (Lower)
MODE MODE 2 1 (Lin Regression)		0.
Alpha CLR 1 = ON/CA		0.
2 0 Data 4 3 Data 2 6 Data 4 6 Data 2 0 Data 4 3 Data 2 6 Data 1 9 Data 2 3 Data 2 0 Data	n =	10.
2 6 Shift DISTR 4 =	26 → t	-0.250603137
Shift DISTR 1 (–) 0 · 2 5) =	P(-0.25)	0.40129

Permutation, Combination, Factorials and Random Number Generation

- Permutation : $nPr = \frac{n!}{(n-r)}$
- Combination : $nCr = \frac{n!}{r!(n-r)}$
- Factorial : x! = x(x-1)(x-2).....(2)(1)

Examples	Operation	Display (Lower)
${}_{10}P_3$	1 0 Shift nPr 3 =	720.
${}_5C_2$	5 Shift nCr 2 =	10.
5!	5 Shift x! =	120

Random Number Generation

Shift Rand : To generate a random number between 0.000 and 0.999 ; the result differ each time with the same possibility of occurrence.

Alpha i-Rand : To generate a random number between two specified positive integers. Results differ each time with the same possibility occurrence within a boundary. The entry is divided with " , ".

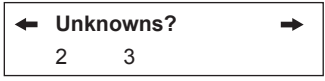
Example: To generate a random number between 0.000 and 0.999; and generate an integer from range of 1 to 100

Operation	Display (Upper)	Display (Lower)
Shift Rand =	Rand	0.833*
Alpha i-Rand 1 , 1 0 0 =	i~Rand(1,100	83.*

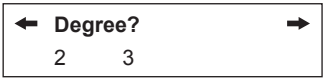
** The value is only a sample, results will differ each time.*

Equation Calculations

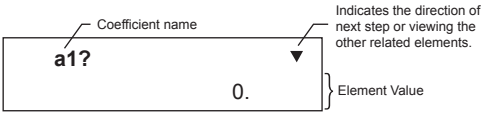
■ Press MODE MODE MODE 1 to enter the equation mode and the following selection options will be displayed:



By this screen, you can choose for the simultaneous linear equation solve with either two (2) or three (3) unknowns. Or, press MODE or ▷ to display another the options for quadratic (2) or cubic (3) equation:

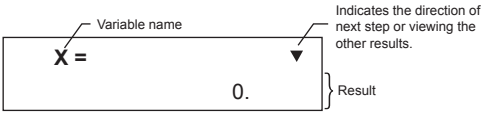


After the equation type is selected, [EQN] indicator lights up. The following equation solve guiding page sample will be shown if you specified the equation solve for two (2) or three (3) unknowns simultaneous linear equation:



(Sample display for simultaneous linear equation solve)

- For quadratic or cubic equation solve, the coefficient name starts with "a"
- You cannot input complex number as an coefficient
- The calculation starts after the last factor ("c2": where the simultaneous linear equations with two unknowns, "d3": where the simultaneous linear equations with three unknowns, "c": quadratic equation and "d": cubic equation) of the specified equation and then the root of an equation appears.



(Sample display for simultaneous linear equation solve)

- The input display appears by pressing the ON/CA key, and you can display or edit the value by pressing the ^ or v key. After that, the last factor is displayed and a calculation is performed again by pressing [=] to display the root.
- For quadratic or cubic equation, the Variable name starts with "X1".
- Press ^ v or [=] key to display the equation solve results.
- If you want to return to the coefficient input screen, simply press ON/CA key.

Simultaneous Linear Equations

Two Unknowns Simultaneous Linear Equation:

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

Three Unknowns Simultaneous Linear Equation:

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

Example: Solve the simultaneous equation with three unknowns:

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

Operation	Display (Upper)	Display (Lower)
MODE MODE MODE 1	← Unknowns? →	2 3
3 (3 unknowns)	a1? ▼	0.
2 = 4 = (−) 4 = 2 0 =	a2? ▲▼	0.
2 = (−) 2 = 4 = 8 =	a3? ▲▼	0.
5 = (−) 2 = (−) 2 = 2 0 =	x = ▼	5.5
⊙	y = ▲▼	3.
=	z = ▲	0.75
CE/C (return to input screen)	a1? ▼	2.

Quadratic or Cubic Equations

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

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

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

Operation	Display (Upper)	Display (Lower)
MODE MODE MODE 1	← Unknowns? →	2 3
⊙	← Degree? →	2 3
3 (Cubic equation)	a? ▼	0.
5 = 2 = (−) 2 = 1 =	x1 = ▼	-1.
⊙	x2 = R↔I ▲▼	0.3
Shift Re↔Im	x2 = R↔I ▲▼	0.331662479 i
=	x3 = ▲	0.3
Shift Re↔Im	x3 = ▲	- 0.331662479 i

SOLVE FUNCTION

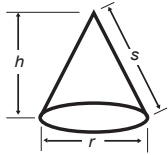
■ You can solve any calculation expression as per your needs in COMP mode. Simply input the expression with different variables and press the Shift Solve key.

Example: A cone of height "h" and base is a circular with radius "r", the volume of the cone will be in the formula:

$$V = \frac{1}{3}\pi r^2 h \quad \left(A = \frac{1}{3}\pi B^2 C \right)$$

So, you can replace the variable "V" by A, variable "r" by "B", and variable "h" by "C".

If the radius is 5cm, cone height is 20cm, calculate the cone volume. And if the cone volume is 200cm^3, with radius 2cm, calculate the cone height.



Operation	Display (Upper)	Display (Lower)
MODE 1		0.
Alpha A Alpha = (1 a b/c 3) Shift π Alpha B x^2 Alpha C	A=(1⌟3) π B^{2}C	0.
Shift Solve	A?	0.
▽	B?	0.
5 = (radius is B = 5cm)	C?	0.
2 0 = (height is C = 20cm)	C?	20.
△△	A?	0.
Shift Solve	A =	523.5987756
= (Calculate with new variables)	A ?	523.5987756
2 0 0 = (volume is A = 200 cm3)	B?	5.
2 = (radius is B = 2 cm)	C?	20.
Shift Solve	C =	47.74648293

! If the expression does not have the equal sign (=) and perform the Solve calculation, the calculator will transform the solution as zero (0).

! When the expression cannot be solved, [Solve ERROR] will be displayed.

CALC FUNCTION

- CALC function is deemed to be a memory zone with maximum 79 steps for you to store a single calculation expression which will be recalled and calculated a number of times by different values.
- After input the calculation expression and pressed [CALC] , the calculator will request for the current value of your input variables.
- Beware that 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 = 2 or x = 7.

Operation	Display (Upper)	Display (Lower)
[Alpha] [Y] [Alpha] [=] [5] [Alpha] [X] [x^2] [−] [2] [Alpha] [X] [+] [1]	$Y = 5x^2 - 2x + 1$	0.
[CALC]	X?	0.
[5] [=]	$Y = 5x^2 - 2x + 1$	116.
[CALC] [7] [=]	$Y = 5x^2 - 2x + 1$	232.

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

DIFFERENTIAL CALCULATIONS

■ Press MODE 1 to enter COMP mode for differential calculation.

To perform a differential calculation, you have to input the expression in the form of:

Shift d/dx **differential expression** , **a** , △**x**)

- The differential expression must contain the variable x.
- "a" is the differential coefficient.
- "△x" is the change interval of x *(calculation precision)*.

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

Operation	Display (Upper)	Display (Lower)
Shift d/dx sin (3 Alpha X + 3 0) , 1 0 , 1 EXP (−) 8) =	d/dx (sin (3x	0.026179938

! You can leave out the △x in the differential expression and the calculator will automatically substitute a value for △x.
! The smaller the entered value △x is, the longer the calculation time will be and the result is more accurate; the bigger the entered value △x is, the shorter the calculation time will be and the result will be comparatively less accurate.
! Discontinuous points and extreme changes in the value of x can cause inaccurate results or errors.
! When performing differential calculation with trigonometric function, select radian (Rad) as the angle unit setting.
! Log_ab, i–Rand, Rec (and Pol (functions can't join to differential calculation.
! During the busy calculation, the calculator will display the message [PROCESSING]

INTEGRATION CALCULATIONS

■ Press [MODE] [1] to enter COMP mode for integration calculation.

To perform an integration calculation you are required to input following elements:

[∫dx] integration expression [,] a [,] b [,] n [)]

- The integration expression has variable x.
- "a" and "b" defining the integration range of the definite integral.
- "n" is the number of partitions (equivalent to N = 2^n).

■ The integration calculation is based on Simpson's rule.

$$\int_a^b f(x)dx,\ n = 2^n\ ,\ \mathbf{1 \leqq n \leqq 9,\ n \neq 0}$$

As the number of significant digits is increased, internal integration calculations may take considerable time to complete. For some cases, even after considerable time is spent for performing a calculation, The calculation precision may be low. Particularly when significant digits are less than 1, an ERROR might be occurred.

Example: Perform the integration calculation for

$$\int_2^3 (5x^4 + 3x^2 + 2x + 1)dx,\ \text{with } n = 4.$$

Operation	Display (Upper)	Display (Lower)
[∫dx] [5] [Alpha] [X] [^] [4] [+] [3] [Alpha] [X] [^] [2] [+] [2] [Alpha] [X] [+] [1] [,] [2] [,] [3] [,] [4] [)] [=]	∫(5 X ^ 4 + 3 X ^ 2 +	236.

- ! The number of partitions (n) have to specify in the range of 1 to 9 integer, any value that out of the setup division range ($N=2^n$, $n \neq 0$, n=1~9 integer), [Arg ERROR] will be displayed.
- ! You can skip the number of partitions and the calculator will automatically assign an appropriate value on behalf of you.
- ! The smaller the value of n is, the shorter the calculation time is, but the result is comparatively less accurate; on the other hand, the bigger the n is, the longer the calculation time is, and the result is more accurate.
- ! When performing integration calculation with trigonometric function, select radian (Rad) as the angle unit setting.
- ! $\text{Log}_a b$, i–Rand, Rec (and Pol (functions can't join to integration calculation.
- ! During the busy calculation, the calculator will display the message [PROCESSING].

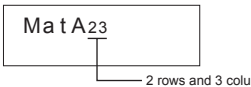
MATRIX CALCULATIONS

- Enter the matrix mode by pressing MODE MODE MODE 2 and [MATX] indicator lights up.
- Before you start matrix calculations, you have to create one matrix or maximum three matrices which named A, B, and C at one time.
- The matrix calculation results are stored into MatAns memory automatically. You can use the matrix MatAns memory for any subsequent matrix calculations.
- Matrix calculation may use up to two levels matrix stack; however, squaring a matrix, cubing a matrix, or inverting a matrix only use one stack.

Create a Matrix

1. Press Shift MATX 1 (Dim) to specify the matrix name (A, B or C), and then specify the dimension (number of rows and number of columns) of the matrix. The dimension of matrix can be up to 3 x 3.

2. Next, input the value (element) of the matrix according to the matrix element indictor display, following is a matrix element indictor example:



3. Use the cursor keys to move, view or edit the matrix elements.

4. When finished the input, press ON/CA to exit the matrix creation screen.

Edit Matrix Elements

1. To edit the element saved in the matrix memory, press Shift MATX 2 (Edit), then specify the matrix A, B or C for editing and the corresponding matrix element indicator will be displayed.

2. Input the new value and press = to confirm the edit.

3. When finished the input, press ON/CA to exit the matrix editing screen.

Matrix Addition, Subtraction and Multiplication

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

Operation	Display (Upper)	Display (Lower)
Shift MATRIX 1 1 (Matrix A 3 x 3)	MatA(mxn) m?	0.
3 = 3 = (Matrix A 3 x 3)	$MatA_{11}$	0.
1 = 2 = 3 = 4 = 5 = 6 = 7 = 8 = 9 = (Input Element)	$MatA_{11}$	1.
Shift MATRIX 1 2 (Matrix B 3 x 3) 3 = 3 =	$MatB_{11}$	0.
9 = 8 = 7 = 6 = 5 = 4 = 3 = 2 = 1 = (Input Element)	$MatB_{11}$	9.
ON/CA Shift MATRIX 3	A B C Ans	1 2 3 4
1 ×	MatA x	0.
Shift MATRIX 3 2	MatA x MatB	0.
=	$MatAns_{11}$	30.
⊙ (press left, right, up or down key to display the result)	$MatAns_{12}$	24.

! Matrices which will be added, subtracted or multiplied must be in 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. Following procedures show you how to obtain the scalar product of a matrix with the fixed multiple:

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

Operation	Display (Upper)	Display (Lower)
Shift MATX 1 3	MatC(mxn) m?	0.
2 = 2 = (Matrix C 2x2)	$MatC_{11}$	0.
3 = (−) 2 = (−) 1 = 5 = (Input Element)	$MatC_{11}$	3.
ON/CA 2 × Shift MATX 3 3	2 x MatC	0.
= (2 x MatC)	$MatAns_{11}$	6.
▷	$MatAns_{12}$	-4
▷	$MatAns_{21}$	-2
▷	$MatAns_{22}$	10.

Obtain the Determinant of a Matrix

Following procedures show you how to obtain the determinant of a square matrix:

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

<Result: -471>

Operation	Display (Upper)	Display (Lower)
Shift MATX 1 3 (Dim) 3 = 3 = (Matrix C 3x3)	$MatC_{11}$	0.
1 0 = (−) 5 = 3 = (−) 4 = 9 = 2 = 1 = 7 = (−) 3 = (Input Element)	$MatC_{11}$	10.
ON/CA Shift MATX ▷	Det Trn	1 2
1 Shift MATX 3 3 (DetMatC)	Det MatC	0.
=	Det MatC	-471.

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

Transpose a Matrix

Following procedures show you how to transpose a matrix:

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

Operation	Display (Upper)	Display (Lower)
Shift MATX 1 2 (Dim) 3 = 2 = (Matrix B 3x2)	$MatB_{11}$	0.
9 = 5 = 6 = 2 = 8 = 4 (Input Element)	$MatB_{11}$	9.
ON/CA Shift MATX ▷	Det Trn	1 2
2 Shift MATX 3 2 (Trn MatB)	Trn MatB	0.
= (press left, right, up or down key to display the result)	$MatAns_{11}$	9.

Invert a Matrix

Following procedures show you how to invert a square matrix:

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

<Result: $\begin{pmatrix} \frac{1}{7} & -\frac{1}{21} \\ -\frac{1}{14} & \frac{4}{21} \end{pmatrix}$ >

Operation	Display (Upper)	Display (Lower)
Shift MATX 1 3 (Dim) 2 = 2 = (Matrix C 2x2)	$MatC_{11}$	0.
8 = 2 = 3 = 6 = (Input Element)	$MatC_{11}$	8.
ON/CA Shift MATX 3 3 Shift x^{-1}	$MatC^{-1}$	0.
= ($MatC^{-1}$)	$MatAns_{11}$	1 ⌟ 7
▷	$MatAns_{12}$	-1 ⌟ 21
▷	$MatAns_{21}$	-1 ⌟ 14
▷	$MatAns_{22}$	4 ⌟ 21

Determine the Absolute value of a Matrix

Following procedures show you how to determine the absolute value of a matrix:

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

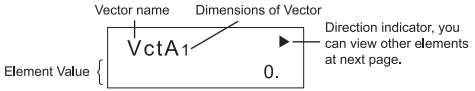
Operation	Display (Upper)	Display (Lower)
Shift Abs Shift MATRIX 3 4	Abs MatAns	0.
=	$MatAns_{11}$	1 ⌋ 7
▷	$MatAns_{12}$	1 ⌋ 21
▷	$MatAns_{21}$	1 ⌋ 14
▷	$MatAns_{22}$	4 ⌋ 21

VECTOR CALCULATIONS

- Enter the vector mode by pressing MODE MODE MODE 3 , and [VCTR] indicator lights up.
- Before you start vector calculations, you have to create one or more vector which named A, B, or C (maximum three 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.

Create a Vector

1. Press Shift VCTR 1 (Dim) to specify the vector name (A, B or C), and then specify the dimension of the vector.
2. Next, input the value (element) of the vector according to the vector element indictor display, following is a vector element indictor example:



3. Use the cursor keys to move, view or edit the vector elements.
4. When finished the input, press ON/CA to exit the vector creation screen.

Edit Vector Elements

1. Press Shift VCTR 2 (Edit), then specify the vector A, B or C for editing and the corresponding vector element indicator will be displayed.
2. Input the new value and press = to confirm the edit.
3. When finished the input, press ON/CA to exit the vector editing screen.

Vector Addition and Subtraction

Following procedures show you how to add or subtract vectors:

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

Operation	Display (Upper)	Display (Lower)
Shift VCTR 1 1 (Create Vector A)	VctA(m) m?	0.
2 = (Vector A dimension is 2)	$VctA_1$	0.
9 = 5 = (Input Element)	$VctA_1$	9.
Shift VCTR 1 2 (Create Vector B) 2 =	$VctB_1$	0.
7 = 3 = (Input Element)	$VctB_1$	7.
ON/CA Shift VCTR 3 1 − Shift VCTR 3 2	VctA - VctB	0.
=	$VctAns_1$	2.
⊙	$VctAns_2$	2.

! 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 with 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.

$$s \times VctA(a,b) = VctB(axs, bxs)$$

Following procedures show you how to obtain the scalar product of a vector with the fixed multiple.

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

Operation	Display (Upper)	Display (Lower)
Shift VCTR 1 3 (Create Vector C)	VctC(m) m?	0.
3 =	$VctC_1$	0.
4 = 5 = (−) 6 = (Input Element)	$VctC_1$	4.
ON/CA 5 × Shift VCTR 3 3	5 x VctC	0.
= (5 x VctC)	$VctAns_1$	20.
⊙	$VctAns_2$	25.
⊙	$VctAns_3$	-30.

Calculate the Inner Product of Two Vectors

Following procedures show you how to 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), and the both vectors are already created in the calculator.

Operation	Display (Upper)	Display (Lower)
ON/CA Shift VCTR 3 1 (Recall Vector A)	VctA	0.
Shift VCTR ▷	Dot	1
1	VctA ▪	0.
Shift VCTR 3 2	VctA ▪ VctB	0.
= (VctA ▪ VctB)	VctA ▪ VctB	-42.

Calculate the Outer Product of Two Vectors

Following procedures show you how to 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), and the both vectors are already created in the calculator.

Operation	Display (Upper)	Display (Lower)
ON/CA Shift VCTR 3 1 (Recall Vector A)	VctA	0.
×	VctA x	0.
Shift VCTR 3 2	VctA x VctB	0.
= (VctA x VctB)	$VctAns_1$	93.
▷	$VctAns_2$	6.
▷	$VctAns_3$	67.

! 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

Following procedures show you how to determine the absolute value (size) of a vector:

Example: To determine the absolute value of the Vector C. As Vector C = (4,5,-6) and already created in the calculator.

Operation	Display (Upper)	Display (Lower)
Shift Abs Shift VCTR 3 3	Abs VctC	0.
=	Abs VctC	8.774964387

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

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

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

Result: $\frac{VctA \times VctB}{|VctA \times VctB|} = (\frac{2}{3}, -\frac{1}{3}, \frac{2}{3})$

Operation	Display (Upper)	Display (Lower)
Shift VCTR 1 1 3 = (Create Vector A)	$VctA_1$	0.
(−) 1 = (−) 2 = 0 = (Input Elements)	$VctA_1$	-1.
Shift VCTR 1 2 3 = (Create Vector B)	$VctB_1$	0.
1 = 0 = (−) 1 = (Input Elements)	$VctB_1$	1.
ON/CA Shift VCTR 3 1 Shift VCTR ▷ 1 Shift VCTR 3 2 = (VctA ▪ VctB)	VctA ▪ VctB	-1.
÷ (Shift Abs Shift VCTR 3 1 × Shift Abs Shift VCTR 3 2) = (calculate $\frac{VctA \cdot VctB}{\lvert VctA \rvert \times \lvert VctB \rvert}$)	Ans ÷ (Abs Vct	-0.316227766
Shift cos⁻¹ Ans = (calculate = $\cos^{-1}\frac{(A \cdot B)}{|A||B|}$)	$\cos^{-1}$ Ans	108.4349488
Shift VCTR 3 1 × Shift VCTR 3 2 = (calculate VctA x VctB = (2, -1, 2))	$VctAns_1$	2.
Shift Abs Shift VCTR 3 4 = (calculate | VctA x VctB |)	Abs VctAns	3.
Shift VCTR 3 4 ÷ Ans = (Calculate $\frac{VctA \times VctB}{\lvert VctA \times VctB \rvert}$ =)	$VctAns_1$	2 ⌟ 3
▷	$VctAns_2$	-1 ⌟ 3
▷	$VctAns_3$	2 ⌟ 3

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 alkaline battery immediately.

Please replace the alkaline 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/CA Alpha CLR 3 = ON/CA to initialize the calculator.

Caution: Do not use the battery other than the specified one. Failure to do so may burst the battery, causing environment contamination or personal injury due to electrolyte leakage.

- Insulate the positive and negative poles of the spent battery with a tape, follow your local environment regulations and waste disposal standards, and then dispose the battery.

Cautions!

- Keep the battery out of reach of children. If the battery is swallowed, contact a doctor immediately.
- Misuse of battery may cause leakage, explosion, damages or personal injury.
- Don't recharge or disassemble the battery, it could cause a short circuit.
- Never expose the battery to high temperatures, direct heat, or dispose by incineration.

SPECIFICATIONS

Power Supply : Solar cell and a single Alkaline battery (LR44 x 1)
Power Consumption : D.C. 1.5V / 0.1mW
Battery Life : Approximately 3 years
(Base on 1 hour of operation per day)
Auto Power Off : Approx. 7 minutes
Usable Temperature : 0 ~ 40°C
Size : 165 (L) x 80 (W) x 14 (H) mm (body)
168 (L) x 86.3 (W) x 17.8 (H) mm (with case)
Weight : 89 g / 124 g (include cover)

* Specifications are subject to change without notice

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