Contents ENGLISH

■ About Using the Manual

- This basic manual briefly introduce F-789SGA functions, specification and usage precautions.
- To familiar with F-789SGA , you can read the **Calculation Examples** for a series of examples, operation procedure's; and the calculation range of major functions.

■ How to use the slide cover

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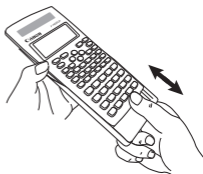
Display

$$\sin\left(\frac{\pi}{4}\right) + \sqrt{2}$$

$$\frac{3\sqrt{2}}{2}$$

<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 $\boxed{\text{ON}}$ $\overset{\text{Shift}}{\boxed{}}$ $\overset{\text{CLR}}{\boxed{}}$ $\boxed{3}$ $\boxed{=}$ $\boxed{\text{CA}}$ to initialize the calculator.

Power ON: When $\boxed{\text{ON}}$ is pressed.

Power OFF: $\overset{\text{Shift}}{\boxed{}}$ $\overset{\text{OFF}}{\boxed{}}$ 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 $\overset{\text{Shift}}{\boxed{}}$ $\overset{\text{SET-UP}}{\boxed{}}$ $\odot$ $\boxed{6}$ (6: ◀ CONT ▶), to enter the Display Contrast Adjustment screen.

```
CONTRAST

LIGHT              DARK
 [◀]               [▶]
```
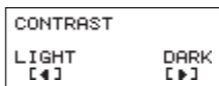
Press $\odot$ to make the display contrast darken.
Press $\odot$ to make the display contrast lighten.
Press $\boxed{\text{CA}}$ or $\boxed{\text{ON}}$ to confirm and clear the screen.

■ To initialize the LCD contrast, press $\overset{\text{Shift}}{\boxed{}}$ $\overset{\text{CLR}}{\boxed{}}$ $\boxed{3}$ $\boxed{=}$ $\boxed{\text{CA}}$ outside the **Display Contrast Adjustment** screen.

Mode Selection

■ Press $\boxed{\text{MODE}}$ to enter the Calculation Mode Selection screen.

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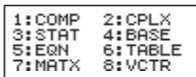
Operation	Mode		LCD Indicator
`MODE` `1`	COMP	Normal calculations	
`MODE` `2`	CPLX	Complex number calculation	CPLX
`MODE` `3`	STAT	Statistical and regression calculations	STAT
`MODE` `4`	BASE	Calculations involving specific number systems	
`MODE` `5`	EQN	Equation solution	EQN
`MODE` `6`	TABLE	Function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

■ Initial mode is COMP mode.

Application Function Menu (Apps Key)

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 $\odot$ / $\otimes$ for next / previons pages.

i) COMP Mode

```
1:π       2:Σ
3:Max     4:Min
5:Q...r   6:Mod
7:LCM     8:GCD
```

ii) CPLX Mode

```
1:▶r∠θ    2:▶a+bi
3:Arg     4:Conj
5:Real    6:Imag
```

iii) STAT Mode

```
1:Type  2:Data
3:Edit  4:S-SUM
5:S-VAR 6:S-PTS
7:Distr
```
In SD mode

```
1:Type  2:Data
3:Edit  4:S-SUM
5:S-VAR 6:S-PTS
7:Distr 8:Reg
```
In REG mode

iv) BASE Mode

```
1:and   2:or
3:xor   4:xnor
5:Not   6:Neg
```
Press [$\odot$] or [$\otimes$] key
```
1:d   2:h
3:b   4:o
```

v) EQN Mode

| 1:2 unknown EQN |
| 2:3 unknown EQN |
| 3:4 unknown EQN |

Press [⌄] or [⌃] key

| 1:Quad EQN |
| 2:Cubic EQN |
| 3:Quart EQN |

vi) MATX Mode

1:Dim	2:Data
3:MatA	4:MatB
5:MatC	6:MatD
7:MatAns	

Press [⌄] or [⌃] key

1:Det	2:Trn
3:Ide	4:Adj
5:Inv	

vii) VCTR Mode

1:Dim	2:Data
3:VctA	4:VctB
5:VctC	6:VctD
7:VctAns	8:Dot
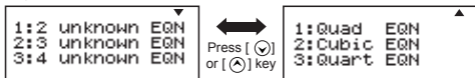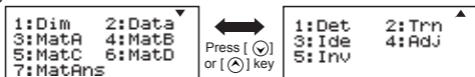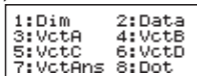
■ Press $\overset{\text{Apps}}{\square}$ $\overset{\text{Apps}}{\square}$ to exit the Apps menu.

Calculator Set-up Menu

■ Press $\overset{\text{Shift}}{\square}$ $\overset{\text{SET-UP}}{\square}$ to enter the **Calculator Set-up Menu**; press ⌄ / ⌃ for next / previous page.

1:Maths	2:Line
3:Deg	4:Rad
5:Gra	6:Fix
7:Sci	8:Norm

Press [⌄] or [⌃] key

1:ab/c	2:d/c
3:CPLX	4:STAT
5:Disp	6:◄CONT►
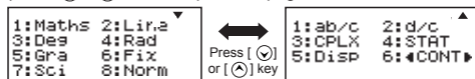
■ **To select the calculator input & output format [1] Maths or [2] Line**

[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

$$\frac{\sqrt{5}+1}{3-1} \qquad \frac{\sqrt{6}}{2}$$
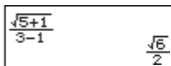
[2] Line – (Line mode): The majority of calculation input and output are shown in the lines format. And "LINE" icon will be shown.

Line mode

$$\text{J}(5+1)\text{J}(3-1)^{\text{LINE}}$$

$$1.224744871$$
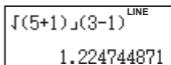
For the STAT, EQN, MATX, VCTR mode, the Input & Display format will switch to Line mode automatically.

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■ **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

$90º = \frac{\pi}{2}$ 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 Polor 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] $\lessdot$ CONT $\gtrdot$**
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 $\overset{\text{Shift}}{\square}$ $\overset{\text{CLR}}{\square}$ $\boxed{1}$ $\boxed{=}$ (YES) $\boxed{\text{CA}}$ 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 "COMP", angle unit "Degree", clears reply and variable memories), and resets LCD contrast) by performing the following key operations:
$\overset{\text{Shift}}{\square}$ $\overset{\text{CLR}}{\square}$ $\boxed{3}$ (All) $\boxed{=}$ (YES) $\boxed{\text{CA}}$.

Inputting Expressions and Values

Input Capacity

F-789SGA allows you to input a single calculation with up to 99 bytes. When 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 (Maths mode), the line will scroll to the right consecutively. You can scroll back to the left by using ⊙ and ⊙ to review the input.

■ Omit the multiplication sign and final close parenthesis.

Example: 2 x log 100 x (1+3) = 16 .... **EX #1**

*1. Omit multiplication sign (x)
  - Input before an open parentheses ⎣ (⎦: 1 <u>x</u> (2+3)
  - Input before scientific functions that includes parenthesis: 2 x cos(30)
  - Input before Random number function $\overset{\text{Rand}}{\square}$
  - 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+ ⎦, $\overset{\text{M-}}{\square}$, $\overset{\text{Shift}}{\square}$ and $\overset{\text{STO}}{\square}$.

■ Insert and Overwrite Input mode
In Line mode, you can use INSERT $\overset{\text{Insert}}{\square}$ 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 $\overset{\text{Shift}}{\square}$ $\overset{\text{Insert}}{\square}$ 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 $\boxed{\text{DEL}}$.

In Overwrite mode: Move the cursor under the character or function being deleted, then press $\boxed{\text{DEL}}$.

Example: 1234567 + 889900

(1) Replace an entry (1234567 ➡ 1234560) ...... **EX #2**

(2) Deletion (1234567 ➡ 134567)....... **EX #3**

(3) Insertion (889900 ➡ 2889900) .... **EX #4**

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.

EX #5

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 $\textcircled{\langle}$ or $\textcircled{\rangle}$ to view the full expression.

Input Range and Error Messages

■ Calculation Precision, Input Range please refer to ... **EX #6**

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

■ Display of results using $\sqrt{}$

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

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

$$\pm \frac{a\sqrt{b}}{c} \pm \frac{d\sqrt{e}}{f} \qquad \begin{array}{l} 0 \le a < 100, \quad 1 \le d < 100 \\ 0 \le b < 1000, \quad 1 \le e < 1000 \\ 1 \le c < 100, \quad 1 \le f < 100 \end{array}$$

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 **EX #7**

Example 1:

$(−)$ 2 x^2 $=$ $−2^2 = −4$

$($ $(−)$ 2 $)$ x^2 $=$ $(−2)^2 = 4$

Example 2:

1 $÷$ 2 $\overset{Shift}{\frown} \pi$ $=$ $1 ÷ 2\pi = 0.1591549431$

Example 3:

2 $\overset{Shift}{\frown} \overset{STO}{} (−)$ $2 \to A$

1 $÷$ 2 $\overset{Alpha}{\frown} \overset{A}{}$ $=$ $1 ÷ 2A = \dfrac{1}{4}$

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 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 while an error message is shown on the display to indicate the cause of the error.

- Press CA to clear the error message, then return to the initial display of latest mode.
- Press $\langle$ or $\rangle$ to display 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 $\boxed{\text{MODE}}$ $\boxed{1}$ to enter COMP mode.
- During the busy calculation, the calculator shows the message [PROCESSING] (without any calculation result). Press $\boxed{\text{CA}}$ key to interrupt the calculating operation.

Arithmetic Calculations $\boxed{+}$ $\boxed{-}$ $\boxed{\times}$ $\boxed{\div}$

- To calculate the negative values (exclude the negative exponent) enclose then within the parentheses.
- This calculator supports 99 levels of parenthetical expression. ...... **EX #8**

Memory Calculations $\boxed{\text{Ans}}$ $\overset{M-}{\boxed{}}$ $\boxed{M+}$ $\overset{M}{\boxed{}}$ $\overset{STO}{\boxed{}}$ $\boxed{RCL}$

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 $\overset{Shift}{\boxed{}}$ $\overset{STO}{\boxed{}}$ + Memory variable.
- Recall memory values by pressing $\boxed{RCL}$ + Memory variable.
- Memory content can be cleared by pressing $\boxed{0}$ $\overset{Shift}{\boxed{}}$ $\overset{STO}{\boxed{}}$ + Memory variable.

Example: 23 + 7 → A (30 store into A), calculate 2 sinA and clear memory A ...... **EX #9**

Independent Memory

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

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Answer Memory

- The input values or the most recent calculation result will be automatically stored into Answer memory whenever you press $=$, $\overset{Shift}{=}$, $M+$, $\overset{Shift}{}$ M-, $\overset{Shift}{}$ STO. Answer memory can hold up to 18 digits.
- Recall and use the latest stored Answer memory by pressing $\boxed{\text{Ans}}$.
- Answer memory is not updated when an error operation has been performed.
- Answer memory contents can be maintained even after pressing $\boxed{\text{CA}}$, changing the calculation mode, or turning off the calculator. ...... **EX #10**

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 $\boxed{\text{F→D}}$ to switch a calculation result between fraction and decimal format.
- ■ Press $\overset{Shift}{}$ $^{a\,b/c↔d/c}$ to switch a calculation result between improper fraction and mixed fraction format.
- ■ Result will be displayed in decimal format automatically whenever the total digit 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 ...... EX #11

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EX #12

Degree-Minutes-Seconds Calculations ° ' "

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...... **EX #13**

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 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 disappeared after the last statement is executed. ...... **EX #14**

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 $\frac{Shift}{\square}\frac{CVALUE}{\square}$, the following display will be shown:

```
Input    1 — 79        0 0
◄ mp   mn   me   mµ   ao ►
```

- You can go to the next or previous value selection pages by pressing ⓐ or ⓥ.
- 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 ⑤.
- You can instantly get the constant value if you input the constant value item number and press ⑤ when the selection cursor is underlining 0 0. ...... **EX #15**

- **Constant Table** please refer ...... **EX #16**

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 ⓓ. ...... **EX #17**
- 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 ⑤ 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 ft² → m²) = 10.4645152 ...... **EX #18**

Functional Scientific Calculations

- Press $\boxed{\text{MODE}}$ $\boxed{1}$ to enter COMP mode.
- $\pi = 3.141592653589793234$
- $e = 2.7182818284590452324$

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

EX #19

Logarithm, Natural logarithm, Antilogarithm and Log$_a$b

EX #20

Angle Unit Conversion

The default calculator angle unit setting is "Degree". Press $\boxed{\text{Shift}}$ $\boxed{\text{SET-UP}}$ to enter the setup menu to change the unit to "Radian" or "Gradient",:

```
1:Maths 2:Line
3:Deg   4:Rad
5:Gra   6:Fix
7:Sci   8:Norm
```

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

Convert an angle unit between "Degree", "Radian" and "Gradient" by pressing $\boxed{\text{Shift}}$ $\boxed{\text{DRG▶}}$

```
1:°     2:ʳ
3:ᵍ
```

Then, pressing $\boxed{1}$, $\boxed{2}$, or $\boxed{3}$ will convert the displayed value into the selected angle unit. .... EX #21

Trigonometry Calculations

- Before using the trigonometric functions (except hyperbolic calculations), select the appropriate angle unit (Deg/Rad/Gra) by pressing $\boxed{\text{Shift}}$ $\boxed{\text{SET-UP}}$.

Angle Unit Setting	Angle Value Input	Input Value Range for √ form result
Deg	Units of 15º	$|\pi| < 9 \times 10^9$
Rad	Multiples of $\frac{1}{12}\pi$ radians	$|\pi| < 20\pi$
Gra	Multiples of $\frac{50}{3}$ grads	$|\pi| < 10000$

- $90º = \frac{\pi}{2}$ Radians = 100 Gradients. ...... EX #22

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■ Hyperbolic (sinh/ cosh/ tanh), Inverse Hyperbolic (sinh⁻¹/cosh⁻¹/tanh⁻¹) functions
■ Pressing $\boxed{\text{hyp}}$ enter sub-hyperbolic menu.

```
1:sinh    2:cosh
3:tanh    4:sinh-1
5:cosh-1  6:tanh-1
```
...... **EX #23**

Permutation, Combination, Factorials and Random Number Generation

■ Permutation: $n\Pr = \dfrac{n!}{(n-r)!}$

■ Combination: $nCr = \dfrac{n!}{r!(n-r)!}$

■ Factorial: $x! = x(x-1)(x-2)\dots(2)(1)$ ...... **EX #24**

■ Random Number Generation

$\boxed{\text{Shift}}$ $\boxed{\text{Rand}}$: Generate a random number between 0.000 and 0.999. And the display result will be fraction format in Maths mode status.

$\boxed{\text{Alpha}}$ $\boxed{\text{i-Rand}}$: Generate a random number between two specified positive integers. The entry is divided by ".".
EX #25

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

Product (π) Calculation

■ Press $\boxed{\text{MODE}}$ $\boxed{1}$ to enter COMP mode.
■ **a** = start , **b** = end, **c** = formula

Math mode: $\displaystyle\prod_{x=\mathbf{a}}^{\mathbf{b}}(\mathbf{C})$ Line mode: $\Pi(\mathbf{c}, \mathbf{a}, \mathbf{b})$

Example: Product of (x+1) from 0 to 5 .... **EX #26**

Summation (∑) Calculation

■ Press $\boxed{\text{MODE}}$ $\boxed{1}$ to enter COMP mode.
■ **a** = start , **b** = end, **c** = formula

Math mode: $\displaystyle\sum_{x=\mathbf{a}}^{\mathbf{b}}(\mathbf{C})$ Line mode: $\sum(\mathbf{c}, \mathbf{a}, \mathbf{b})$

Example: Summation of (x+1) from 1 to 5 .... **EX #27**

Maximum Value and Minimum Value Calculation

■ Press $\boxed{\text{MODE}}$ $\boxed{1}$ to enter COMP mode.
■ At most five values can be calculated. .... **EX #28**

Modulus After Division (Mod) Calculation

■ Press $\boxed{\text{MODE}}$ $\boxed{1}$ to enter COMP mode. ……. **EX #29**

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. ……. **EX #30**

Prime Factorization $\overset{\text{PFact}}{\boxed{}}$

• The factor a positive integer up to 10 digits into prime factors up to the 3 digits.

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

• The reminder part 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)

   EX #31

NOTE:
• During any calculation operations, pressing $\overset{\text{Shift}}{\boxed{}}$ $\overset{\text{PFact}}{\boxed{}}$ or $\boxed{=}$ or $\boxed{\text{ENG}}$ or $\boxed{\cdot\,\cdot\,\cdot}$ 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 of 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 $\boxed{<}$ or $\boxed{>}$ to scroll a long calculation result.
■ In Line mode, the quotient value (Q) and remainder (r) will be shown over 2 line.
■ Only Quotient Value (Q) can continue to be used for the next calculation or be stored into memory variables. ...... **EX #32**

Coordinate Conversion

- With polar coordinates, you can calculate and Display θ within the range of −180º < θ ≤ 180º. (Same as Radian and Gradient)
- In Maths mode, press $\langle$ or $\rangle$ 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] $\frac{X}{\square}$ or $\frac{Y}{\square}$ to show the results.

Rectangular Coordinates (Rec)   Polar Coordinates (Pol)
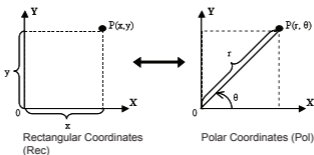
Shift Pol(: Convert rectangular coordinates (x, y) to polar coordinates (r, θ); Press [RCL] $\frac{X}{\square}$ for r, or [RCL] $\frac{Y}{\square}$ for θ. ...... **EX #33**

Shift Rec(: Convert polar coordinates (r, θ) to rectangular coordinates (x, y); Press [RCL] $\frac{X}{\square}$ for x, or [RCL] $\frac{Y}{\square}$ for y. ...... **EX #34**

Absolute Value Calculation

EX #35

Engineering Notation

EX #36

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.

EX #37

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

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Complex Number Calculations

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 (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.
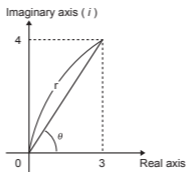
■ Press $\boxed{\text{MODE}}$ $\boxed{2}$ to enter CPLX mode.
■ Press $\overset{\text{Apps}}{\frown}$ to select the calculation type.

Complex Number type selection

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

```
1:▶r∠θ    2:▶a+bi
3:Arg     4:Conjg
5:Real    6:Imag
```

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

Rectangular Form and Polar Form Conversion

Press $\overset{\text{Apps}}{\frown}$ $\boxed{1}$ can convert rectangular form complex numbers into polar form; whereas press $\overset{\text{Apps}}{\frown}$ $\boxed{2}$ will convert polar form complex number into rectangular form. ...... **EX #38**

Absolute Value and Argument Calculation

With the rectangular form complex number, you can calculate the corresponding absolute value (r) or argument (θ) by pressing $\boxed{\text{Abs}}$ or $\overset{\text{Apps}}{\frown}$ $\boxed{3}$ key respectively. ...... **EX #39**

Conjugate of a complex number

If the complex number is $z = a + bi$, the conjugate value of this complex number should be $z = a - bi$. ...... **EX #40**

Determine the Real/Imaginary of complex number
EX #41

Base-n Calculations and Logical Calculations

- Press $\boxed{\text{MODE}}$ $\boxed{4}$ 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 Decimal [DEC], Hexadecimal [HEX], Binary [BIN] or Octal [OCT].
- Press $\overset{\text{Apps}}{\frown}$ 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, ◀BlK will be displayed to indicate the result has a next block. Press $\overset{\text{Blk}}{\frown}$ 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.

EX #42

Base-n Transformation $\overset{\text{DEC}}{\frown} \rightarrow \overset{\text{OCT}}{\frown} \rightarrow \overset{\text{HEX}}{\frown} \rightarrow \overset{\text{BIN}}{\frown}$ ...... **EX #43**

Logical Operation ...... **EX #44**

Statistical Calculations

- Press $\boxed{\text{MODE}}$ $\boxed{3}$ to enter Statistical calculation mode; the "STAT" indicator lights up.
- Press $\overset{\text{Apps}}{\frown}$ $\boxed{1}$ (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:ℓ 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)

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Statistical Data Input

After confirmed the calculation type in the **Statistical Type Selection** screen or by pressing $\stackrel{\text{Apps}}{\square}$ $\boxed{2}$ (Data) in the STAT mode, the following Statistical Data Input screen will be shown.
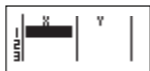
1-variable STAT   2-variable STAT   1-variable STAT "FREQ ON"

- 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 inputted the data, press $\boxed{=}$ to store the value into statistical registers and display the value (max. 6 digits) in the cell. You can press 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 $\boxed{=}$.

■ Deleting a Line
   (1) In the Statistical Data Input screen, move the cursor to the line you want to delete.
   (2) Press $\boxed{\text{DEL}}$

■ 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 $\stackrel{\text{Apps}}{\square}$ $\boxed{3}$ (Edit)
   (3) Press $\boxed{1}$ (Ins)

■ Deleting All STAT Data Input
   (1) Press $\stackrel{\text{Apps}}{\square}$ $\boxed{3}$ (Edit)
   (2) Press $\boxed{2}$ (Del-A)

Statistical Calculation Screen

- After inputting the STAT Data, press $\boxed{\text{CA}}$ 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 $\overset{\text{Apps}}{\boxed{\quad}}$ to display the **Statistical Menu** screen.

```
1:Type  2:Data          1:Type  2:Data
3:Edit  4:S-SUM         3:Edit  4:S-SUM
5:S-VAR 6:S-PTS         5:S-VAR 6:S-PTS
7:Distr                 7:Distr 8:Reg
```

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 vcalculation)

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	$\sum x^2 y$	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

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) ...... **EX #45**

**Quadratic Regression type Statistical Calculation Example:**
ABC Company investigate the effectiveness of the advertisement expense 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 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_1, X_2) for effectiveness y = 50. ...... **EX #46**

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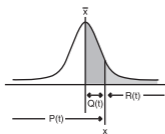
$$t = \frac{x - \bar{x}}{x\sigma_n}$$

x : Random variable

$\bar{x}$: Mean of sample
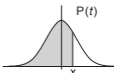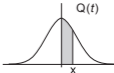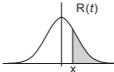
$x\sigma_n$: Standard deviation

■ Press $\overset{Apps}{\square}$ **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	$P(t)= \int_{-\infty}^{x} \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}(\frac{t-\mu}{\sigma})^2} dt$,	P(t) graph with shaded area below x
Q(t): Probability below a given point x and above the mean	$Q(t) = 0.5 - R(t)$,	Q(t) graph
R(t): Probability above a given point x	$R(t) = 1 - P(t)$,	R(t) graph with shaded area above x

Example: Calculate the probability distribution P(t) for the sample data: 20, 43, 26, 46, 20, 43, when x = 26. ...... **EX #47**

Equation Calculations

■ Press $\boxed{\text{MODE}}$ $\boxed{5}$ to enter the equation mode; press $\odot$ / $\odot$ for next / previous pages.

```
1:2 unknown EQN
2:3 unknown EQN
3:4 unknown EQN
```
Press [$\odot$] or [$\odot$] key
```
1:Quad  EQN
2:Cubic EQN
3:Quart EQN
```

Equation Item	Description
[1] 2 unknow EQN	Simultaneous Linear Equations with two unknowns
[2] 3 unknow EQN	Simultaneous Linear Equations with three unknowns
[3] 4 unknow 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: $\quad 2x + 4y - 4z = 20$
$\qquad\qquad\quad 2x - 2y + 4z = 8$
$\qquad\qquad\quad 5x - 2y - 2z = 20$ ...... **EX #48**

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 $5x^3 + 2x^2 - 2x + 1 = 0$.. **EX #49**

■ 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**

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Important precaution when using "Solve" function:

- The following functions $\int$, $\frac{d}{dx}$, Σ, $\prod$, 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 $X = \frac{1}{3} \pi B^2 C$ (when B=5; C=20) …… **EX #50**

- 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. ...... **EX #51**

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

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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:

  $$\overset{Shift}{\Box}\ \overset{d/dx}{\Box}\ f(x)\ \overset{,}{\Box}\ a\ \overset{,}{\Box}\ \Delta x\ \boxed{)}$$

  - 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, Δx = 10⁻⁸, for the function f(x) = sin(3x + 30). ...... **EX #52**

- ! 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 $\boxed{CA}$ 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:

  $$\overset{\int_a^b \blacksquare}{\Box}\ f(x)\ \overset{,}{\Box}\ a\ \overset{,}{\Box}\ b\ \overset{,}{\Box}\ n\ \boxed{)}$$

  - 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.

$$\int_2^3 (5x^4 + 3x^2 + 2x + 1)dx \ ...... \ \boxed{\text{EX \#53}}$$

! You can leave out the n in the Integration expression and the calculator will automatically substitute a value for n.
! The smaller the entered value n is, the longer the calculation time will be with more accurate results, the larger the entered value n is, the shorter the calculation time will be with comparatively less accurate results.
! When performing integration calculations with trigonometric functions, select radian (Rad) as the angle unit setting.
! $\log_a b$, i~Rand(, Rec(, Pol(, $\int($, d/dx(, $\sum($, $\prod($, Max(and Min(functions cannot join in integration calculations.
! A "Time Out" error occurs when an integration calculation ends without the ending condition being fulfilled.
! You can cancel the processing of integration calculation by pressing the $\boxed{\text{CA}}$ key.

Matrix Calculations

■ Press $\boxed{\text{MODE}}$ $\boxed{7}$ 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 $\boxed{\text{MODE}}$ $\boxed{7}$ to enter Matrix mode.

```
Matrix?
1:MatA    2:MatB
3:MatC    4:MatD
```

■ Press $\boxed{\text{CA}}$ $\overset{\text{Apps}}{\boxed{}}$ to use the MATX application; press $\odot$ / $\otimes$ for next / previous pages.

```
1:Dim     2:Data
3:MatA    4:MatB
5:MatC    6:MatD
7:MatAns
```
Press [$\odot$] or [$\otimes$] key
```
1:Det     2:Trn
3:Ide     4:Adj
5:Inv
```

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 $\boxed{\text{CA}}$ to exit the matrix creating screen.

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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=?

EX #54

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

EX #55

■ Obtain the Determinant of a Matrix

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

EX #56

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

■ Transpose a Matrix

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

EX #57

■ Identity of Matrix

Example: Identity Matrix D $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ ...... **EX #58**

■ Adjoint of Matrix

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

EX #59

■ Invert a Matrix

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

<Result: $\begin{pmatrix} 0.142857142 & -0.047619047 \\ -0.071428571 & 0.19047619 \end{pmatrix}$> ...... **EX #60**

■ Determine the Absolute value of a Matrix

Example: To determine the absolute value of the inverted Matrix C in the previous example. ...... **EX #61**

Vector Calculations

- Press $\boxed{\text{MODE}}$ $\boxed{8}$ 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 $\boxed{\text{MODE}}$ $\boxed{8}$ to enter Vector mode.

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

- Press $\boxed{\text{CA}}$ $\overset{\text{Apps}}{\boxed{\quad}}$ 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 $\boxed{\text{CA}}$ to exit the matrix creating screen.

Editing Vector Elements

- Press $\boxed{\text{CA}}$ $\overset{\text{Apps}}{\boxed{\quad}}$ $\boxed{2}$ (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 $\boxed{=}$ to confirm the edit.
- Press $\boxed{\text{CA}}$ to exit the vector editing screen.

■ Vector Addition and Subtraction
Example: Vector A = (9,5), Vector B = (7,3), Vector A – Vector B =?

EX #62

! 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.

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

Example: To Multiply Vector C = (4,5,-6) by 5 ...... **EX #63**

■ 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). ...... **EX #64**

■ 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). ...... **EX #65**

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

EX #66

Example 2: 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) > ... **EX #67**

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.

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- 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 $\boxed{=}$ 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 $\boxed{CA}$ 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.

EX #68

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.

Low Battery

Please replace the lithium battery using the following procedures,
1. Press $\overset{Shift}{\square}$ $\overset{OFF}{\square}$ 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 ball pen or similar sharp object.
5. Load the new battery with positive "+" side facing up.
6. Replace the battery cover, screw, and press $\boxed{ON}$, $\overset{Shift}{\square}$ $\overset{CLR}{\square}$ $\boxed{3}$ $\boxed{=}$ $\boxed{CA}$ to initialize the calculator.

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

■ 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 $\boxed{ON}$, $\overset{Shift}{\square}$ $\overset{CLR}{\square}$ $\boxed{3}$ $\boxed{=}$ $\boxed{CA}$ 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
(Base on 1 hour 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: 120 g (with cover) / 88 g (without cover)

Specifications are subject to change without notice.