EAI EDUCATION

Scientific Series

Scientific Calculator

CalcPAL® EAI-350

401 FUNCTIONS

User's manual

Safety Precautions

Be sure to read the following safety precautions before using this calculator. Keep this manual handy for later reference.

⚠ Caution

This symbol is used to indicate information that can result in personal injury or material damage if ignored.

Batteries

- After removing the battery from the calculator, put it in a safe place where it will not get into the hands of small children and accidentally swallowed.
- Keep batteries out of the reach of small children. If accidentally swallowed, consult with a physician immediately.
- Never charge batteries, try to take batteries apart, or allow batteries to become shorted. Never expose batteries to direct heat or dispose of them by incineration.
- Misuse of batteries can cause them to leak and damage nearby items, and can create the risk of fire and personal injury.
  - Always make sure that the battery's positive ⊕ and negative ⊖ ends are facing correctly when you load it into the calculator.
  - Remove the battery if you do not plan to use the calculator for a long time .
  - Use only the type of battery specified for this calculator in this manual.

Disposing of the Calculator

- Never dispose of the calculator by burning it. Doing so can cause certain components to suddenly burst, creating the risk of fire and personal injury.

- The displays and illustrations (such as key markings) shown in this User's Guide are for illustrative purposes only, and may differ somewhat from the actual items they represent.
- The contents of this manual are subject to change without notice.

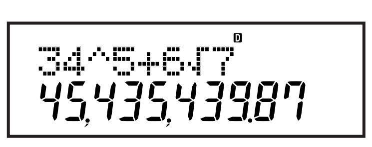
Handling Precautions

- **Be sure to press the ON key before using the calculator for the first time.**
- **Even if the calculator is operating normally, replace the battery at least once every three years.**

A dead battery can leak, causing damage to and malfunction of the calculator. Never leave a dead battery in the calculator.

- **The battery that comes with this unit discharges slightly during shipment and storage. Because of this, it may require replacement sooner than the normal expected battery life.**
- **Low battery power can cause memory contents to become corrupted or lost completely. Always keep written records of all important data.**
- **Avoid use and storage in areas subjected to temperature extremes.**
  Very low temperatures can cause slow display response, total failure of the display, and shortening of battery life. Also avoid leaving the calculator in direct sunlight, near a window, near a heater or anywhere else it might be exposed to very high temperatures. Heat can cause discoloration or deformation of the calculator's case, and damage to internal circuitry.
- **Avoid use and storage in areas subjected to large amounts of humidity and dust.**
  Take care never to leave the calculator where it might be splashed by water or exposed to large amounts of humidity or dust. Such conditions can damage internal circuitry.
- **Never drop the calculator or otherwise subject it to strong impact.**
- **Never twist or bend the calculator.**
  Avoid carrying the calculator in the pocket of your trousers or other tight-fitting clothing where it might be subjected to twisting or bending.
- **Never try to take the calculator apart.**
- **Never press the keys of the calculator with a ballpoint pen or other pointed object.**
- **Use a soft, dry cloth to clean the exterior of the calculator.**
  If the calculator becomes very dirty, wipe it off with a cloth moistened in a weak solution of water and a mild neutral household detergent. Wring out all excess moisture before wiping the calculator. Never use thinner, benzene or other volatile agents to clean the calculator. Doing so can remove printed markings and can damage the case.

Two-line Display



The two-line display makes it possible to view both the calculation formula and its result at the same time.

- The upper line shows the calculation formula.
- The lower line shows the result.

A separator symbol is displayed every three digits when the integer part of the mantissa has more than three digits.

Before getting started...

Modes

- **Users should refer to the "User's Guide 2 (Additional Functions)" for information about modes and their selection.**

- Pressing the MODE key more than twice displays additional setup screens. Setup screens are described in the sections of this manual where they are actually used to change the calculator setup.
- In this manual, the name of the mode you need to enter in order to perform the calculations being described is indicated in the main title of each section.

Example: Equation Calculations EQN

Note!

- To return the calculation mode and setup to the initial defaults shown below, press SHIFT CLR 2(Mode) =.

Calculation Mode:	COMP
Angle Unit:	Deg
Exponential Display Format:	Norm 1
Fraction Display Format:	a^b/c
Decimal Point Character:	Dot

- Mode indicators appear in the upper part of the display.
- Be sure to check the current calculation mode (SD, REG, COMP) and angle unit setting (Deg, Rad, Gra) before beginning a calculation.

Input Capacity

- The memory area used for calculation input can hold 79 "steps." One step is taken up each time you press a number key or arithmetic operator key (+, −, ×, ÷). A SHIFT or ALPHA key operation does not take up a step, so inputting SHIFT ∛, for example, takes up only one step.
- You can input up to 79 steps for a single calculation. Whenever you input the 73rd step of any calculation, the cursor changes from "_" to "■" to let you know memory is running low. If you need to input more than 79 steps, you should divide your input into two or more parts.
- Pressing the Ans key recalls the last result obtained, which you can use in a subsequent calculation. See "Answer Memory" for more information about using the Ans key.

Making Corrections During Input

- Use ◀ and ▶ to move the cursor to the location you want.
- Press DEL to delete the number or function at the current cursor position.
- Press SHIFT INS to change to an insert cursor [ ]. Inputting something while the insert cursor is on the display inserts the input at the insert cursor position.
- Pressing SHIFT INS, or = returns to the normal cursor from the insert cursor.

Replay Function

- Every time you perform a calculation, the replay function stores the calculation formula and its result in replay memory. Pressing the ▲ key displays the formula and result of the calculation you last performed. Pressing ▲ again back steps sequentially (new-to-old) through past calculations.
- Pressing the ◀ or ▶ key while a replay memory calculation is on the display changes to the editing screen.
- Pressing the ◀ or ▶ key immediately after you finish a calculation displays the editing screen for that calculation.
- Pressing AC does not clear replay memory, so you can recall the last calculation even after you press AC.
- Replay memory capacity is 128 bytes for storage of both expressions and results.
- Replay memory is cleared by any of the following actions.
  When you press the ON key
  When you initialize modes and settings by pressing SHIFT CLR 2 (or 3) =.
  When you change from one calculation mode to another
  When you turn off the calculator.

Error Locator

- Pressing ▶ or ◀ after an error occurs displays the calculation with the cursor positioned at the location where the error occurred.

Multi-statements

A multi-statement is an expression that is made up of two or more smaller expressions, which are joined using a colon (:).

- **Example:** To add 2 + 3 and then multiply the result by 4

2 + 3 ALPHA : Ans × 4 = → 2+3 / 5.Disp

= → Ans×4 / 20.

Exponential Display Formats

This calculator can display up to 10 digits. Larger values are automatically displayed using exponential notation. In the case of decimal values, you can select between two formats that determine at what point exponential notation is used.

- To change the exponential display format, press the MODE key a number of times until you reach the exponential display setup screen shown below.

```
Fix Sci Norm
 1   2   3
```

- Press 3. On the format selection screen that appears, press 1 to select Norm 1 or 2 for Norm 2.

• Norm 1

With Norm 1, exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than two decimal places.

• Norm 2

With Norm 2, exponential notation is automatically used for integer values with more than 10 digits and decimal values with more than nine decimal places.

- All of the examples in this manual show calculation results using the Norm 1 format.

Decimal Point and Separator Symbols

You can use the display setup (Disp) screen to specify the symbols you want for the decimal point and 3-digit separator.

- To change the decimal point and separator symbol setting, press the MODE key a number of times until you reach the setup screen shown below.

```
Disp
1
```

- Display the selection screen.

fx-95MS: 1 ▶

Other Models: 1 ▶ ▶

- Press the number key (1 or 2) that corresponds to the setting you want to use.

1(Dot): Period decimal point, comma separator

2(Comma): Comma decimal point, period separator

Initializing the Calculator

- Perform the following key operation when you want to initialize the calculation mode and setup, and clear replay memory and variables.

SHIFT CLR 3(All) =

Basic Calculations COMP

Arithmetic Calculations

Use the MODE key to enter the COMP Mode when you want to perform basic calculations.

COMP .... MODE 1

- Negative values inside of calculations must be enclosed within parentheses.

sin −1.23 → sin ((−) 1.23)

- It is not necessary to enclose a negative exponent within parentheses.

sin 2.34 × 10^{-5} → sin 2.34 EXP (−) 5

- **Example 1:** 3×(5×10^{-9}) = ***1.5×10^{-8}***

3 × (5 EXP (−) 9) =

- **Example 2:** 5×(9+7) = ***80*** 5 × (9 + 7) =
- You can skip all) operations before =.

Fraction Operations

• Fraction Calculations

- Values are displayed in decimal format automatically whenever the total number of digits of a fractional value (integer + numerator + denominator + separator marks) exceeds 10.

- **Example 1:** $\frac{2}{3}+\frac{1}{5}=\frac{13}{15}$

2 a^b/c 3 + 1 a^b/c 5 = → 13⌟15.

- **Example 2:** $3\frac{1}{4}+1\frac{2}{3}=4\frac{11}{12}$

3 a^b/c 1 a^b/c 4 + 1 a^b/c 2 a^b/c 3 = → 4⌟11⌟12.

- **Example 3:** $\frac{2}{4}=\frac{1}{2}$ 2 a^b/c 4 =

- **Example 4:** $\frac{1}{2}+1.6=$ ***2.1*** 1 a^b/c 2 + 1.6 =

- Results of calculations that mix fraction and decimal values are always decimal.

• Decimal ↔ Fraction Conversion

- Use the operation shown below to convert calculation results between decimal values and fraction values.
- Note that conversion can take as long as two seconds to perform.

- **Example 1:** $2.75 = 2\frac{3}{4}$ (Decimal → Fraction)

2.75 =	2.75
a^b/c	2⌟3⌟4.
$=\frac{11}{4}$ SHIFT d/c	11⌟4.

- **Example 2:** $\frac{1}{2}$ ↔ 0.5 (Fraction ↔ Decimal)

1 a^b/c 2 =	1⌟2.
a^b/c	0.5
a^b/c	1⌟2.

• Mixed Fraction ↔ Improper Fraction Conversion

- **Example:** $1\frac{2}{3}\leftrightarrow\frac{5}{3}$

1 a^b/c 2 a^b/c 3 =	1⌟2⌟3.
SHIFT d/c	5⌟3.
SHIFT d/c	1⌟2⌟3.

- You can use the display setup (Disp) screen to specify the display format when a fraction calculation result is greater than one.
- To change the fraction display format, press the MODE key a number of times until you reach the setup screen shown below.

```
Disp
1
```

- Display the selection screen.

1 ▶

- Press the number key (1 or 2) that corresponds to the setting you want to use.

1(a^b/c): Mixed fraction

2(d/c): Improper fraction

- An error occurs if you try to input a mixed fraction while the d/c display format is selected.

Percentage Calculations

- **Example 1:** To calculate 12% of 1500 ***(180)***

1500 × 12 SHIFT %

- **Example 2:** To calculate what percentage of 880 is 660 ***(75%)***

660 ÷ 880 SHIFT %

- **Example 3:** To add 15% onto 2500 ***(2875)***

2500 × 15 SHIFT % +

- **Example 4:** To discount 3500 by 25% ***(2625)***

3500 × 25 SHIFT % −

- **Example 5:** To discount the sum of 168, 98, and 734 by 20% ***(800)***

168 + 98 + 734 = Ans SHIFT STO A

ALPHA A × 20 SHIFT % −
*

* As shown here, if you want to use the current Answer Memory value in a mark up or discount calculation, you need to assign the Answer Memory value into a variable and then use the variable in the mark up/discount calculation. This is because the calculation performed when % is pressed stores a result to Answer Memory before the − key is pressed.

- **Example 6:** If 300 grams are added to a test sample originally weighing 500 grams, what is the percentage increase in weight? ***(160%)***

300 + 500 SHIFT %

- **Example 7:** What is the percentage change when a value is increased from 40 to 46? How about to 48? ***(15%, 20%)***

46 − 40 SHIFT %

◀ ◀ ◀ ◀ ◀ ◀ ◀ 8 =

Degrees, Minutes, Seconds Calculations

- You can perform sexagesimal calculations using degrees (hours), minutes, and seconds, and convert between sexagesimal and decimal values.

- **Example 1:** To convert the decimal value 2.258 to a sexagesimal value and then back to a decimal value

2.258 =	2.258
SHIFT ←°′″	2°15°28.8
°′″	2.258

- **Example 2:** To perform the following calculation:
12°34′56″ × 3.45

12 °′″ 34 °′″ 56 °′″ × 3.45 = → 43°24°31.2

FIX, SCI, RND

- To change the settings for the number of decimal places, the number of significant digits, or the exponential display format, press the MODE key a number of times until you reach the setup screen shown below.

```
Fix Sci Norm
 1   2   3
```

- Press the number key (1, 2, or 3) that corresponds to the setup item you want to change.

1 (Fix): Number of decimal places
2 (Sci): Number of significant digits
3 (Norm): Exponential display format

- **Example 1:** 200 ÷ 7 × 14 =

	200 ÷ 7 × 14 =	400.
(Specifies three decimal places.)	MODE ····· 1(Fix) 3	FIX 400.000
(Internal calculation continues using 12 digits.)	200 ÷ 7 =	28.571
	× 14 =	400.000

The following performs the same calculation using the specified number of decimal places.

	200 ÷ 7 =	28.571
(Internal rounding)	SHIFT Rnd	28.571
	× 14 =	399.994

- Press MODE ····· 3(Norm) 1 to clear the Fix specification.

- **Example 2:** 1 ÷ 3, displaying result with two significant digits (Sci 2)

MODE ····· 2(Sci) 2 1 ÷ 3 = → SCI 3.3^{-01}

- Press MODE ····· 3(Norm) 1 to clear the Sci specification.

Memory Calculations COMP

Use the MODE key to enter the COMP Mode when you want to perform a calculation using memory.

COMP .... MODE 1

Answer Memory

- Whenever you press = after inputting values or an expression, the calculated result automatically updates Answer Memory contents by storing the result.
- In addition to =, Answer Memory contents are also updated with result whenever you press SHIFT %, M+, SHIFT M−, or SHIFT STO followed by a letter (A through F, or M, X, or Y).
- You can recall Answer Memory contents by pressing Ans.
- Answer Memory can store up to 12 digits for the mantissa and two digits for the exponent.
- Answer Memory contents are not updated if the operation performed by any of the above key operations results in an error.

Consecutive Calculations

- You can use the calculation result that is currently on the display (and also stored in Answer Memory) as the first value of your next calculation. Note that pressing an operator key while a result is displayed causes the displayed value to change to Ans, indicating it is the value that is currently stored in Answer Memory.
- The result of a calculation can also be used with a subsequent Type A function (x^2, x^3, x^{-1}, $x!$, DRG▶), +, −, ^(x^y), $^x\sqrt{\ }$, ×, ÷, nPr and nCr.

Independent Memory

- Values can be input directly into memory, added to memory, or subtracted from memory. Independent memory is convenient for calculating cumulative totals.
- Independent memory uses the same memory area as variable M.
- To clear independent memory (M), input 0 SHIFT STO M (M+).

- **Example:**

23 + 9 = ***32***	23 + 9 SHIFT STO M (M+)
53 − 6 = ***47***	53 − 6 M+
−) 45 × 2 = ***90***	45 × 2 SHIFT M−
(Total) ***−11***	RCL M (M+)

Variables

- There are nine variables (A through F, M, X and Y), which can be used to store data, constants, results, and other values.
- Use the following operation to delete data assigned to a particular variable: 0 SHIFT STO A. This operation deletes the data assigned to variable A.
- Perform the following key operation when you want to clear the values assigned to all of the variables.

SHIFT CLR 1(Mcl) =

- **Example:** 193.2 ÷ 23 = ***8.4***
  193.2 ÷ 28 = ***6.9***

193.2 SHIFT STO A ÷ 23 =

ALPHA A ÷ 28 =

Scientific Function Calculations COMP

Use the MODE key to enter the COMP Mode when you want to perform basic arithmetic calculations.

COMP .... MODE 1

- Certain types of calculations may take a long time to complete.
- Wait for the result to appear on the display before starting the next calculation.
- π = 3.14159265359

Trigonometric/Inverse Trigonometric Functions

- To change the default angle unit (degrees, radians, grads), press the MODE key a number of times until you reach the angle unit setup screen shown below.

```
Deg Rad Gra
 1   2   3
```

- Press the number key (1, 2, or 3) that corresponds to the angle unit you want to use.
(90° = $\frac{\pi}{2}$ radians = 100 grads)

- **Example 1:** sin 63°52′41″ = ***0.897859012***

MODE ····· 1(Deg)

sin 63 °′″ 52 °′″ 41 °′″ =

- **Example 2:** $\cos\left(\frac{\pi}{3}\text{ rad}\right)$ = ***0.5***

MODE ····· 2(Rad)

cos (SHIFT π ÷ 3) =

- **Example 3:** $\cos^{-1}\frac{\sqrt{2}}{2}$ = ***0.25*** π (rad) $\left(=\frac{\pi}{4}\text{ (rad)}\right)$

MODE ····· 2 (Rad)

SHIFT cos⁻¹ (√ 2 ÷ 2) = Ans ÷ SHIFT π =

- **Example 4:** tan^{-1} 0.741 = ***36.53844577°***

MODE ····· 1(Deg)

SHIFT tan⁻¹ 0.741 =

Hyperbolic/Inverse Hyperbolic Functions

- **Example 1:** sinh 3.6 = ***18.28545536*** hyp sin 3.6 =
- **Example 2:** sinh^{-1} 30 = ***4.094622224***

hyp SHIFT sin⁻¹ 30 =

Common and Natural Logarithms/ Antilogarithms

- **Example 1:** log 1.23 = ***0.089905111*** log 1.23 =
- **Example 2:** In 90 (= log$_e$ 90) = ***4.49980967*** In 90 =
  In e = ***1*** In ALPHA e =
- **Example 3:** e^{10} = ***22026.46579*** SHIFT e^x 10 =
- **Example 4:** 10$^{1.5}$ = ***31.6227766*** SHIFT 10^x 1.5 =
- **Example 5:** 2^4 = ***16*** 2 ^ 4 =

Square Roots, Cube Roots, Roots, Squares, Cubes, Reciprocals, Factorials, Random Numbers, π, and Permutation/Combination

- **Example 1:** $\sqrt{2}+\sqrt{3}\times\sqrt{5}$ = ***5.287196909***

√ 2 + √ 3 × √ 5 =

- **Example 2:** $\sqrt[3]{5}+\sqrt[3]{-27}$ = ***−1.290024053***

SHIFT ∛ 5 + SHIFT ∛ ((−) 27) =

- **Example 3:** $\sqrt[7]{123}$ (= $123^{\frac{1}{7}}$) = ***1.988647795***

7 SHIFT $^x\sqrt{\ }$ 123 =

- **Example 4:** 123 + 30^2 = ***1023*** 123 + 30 x^2 =
- **Example 5:** 12^3 = ***1728*** 12 SHIFT x^3 =
- **Example 6:** $\dfrac{1}{\frac{1}{3}-\frac{1}{4}}$ = ***12***

(3 x^{-1} − 4 x^{-1}) x^{-1} =

- **Example 7:** 8! = ***40320*** 8 SHIFT $x!$ =
- **Example 8:** To generate a random number between 0.000 and 0.999

SHIFT Ran# = → 0.664

(The above value is a sample only. Results differ each time.)

- **Example 9:** 3π = ***9.424777961*** 3 SHIFT π =
- **Example 10:** To determine how many different 4-digit values can be produced using the numbers 1 through 7
  - Numbers cannot be duplicated within the same 4-digit value (1234 is allowed, but 1123 is not). ***(840)***

7 SHIFT nPr 4 =

- **Example 11:** To determine how many different 4-member groups can be organized in a group of 10 individuals ***(210)***

10 SHIFT nCr 4 =

Angle Unit Conversion

- Press SHIFT DRG▶ to display the following menu.

```
 D   R   G
 1   2   3
```

- Pressing 1, 2, or 3 converts the displayed value to the corresponding angle unit.
- **Example:** To convert 4.25 radians to degrees

MODE ····· 1(Deg)

4.25 SHIFT DRG▶ 2(R) = → 4.25r / 243.5070629

Coordinate Conversion (Pol (x, y), Rec (r, θ))

- Calculation results are automatically assigned to variables E and F.
- **Example 1:** To convert polar coordinates (r=2, θ=60°) to rectangular coordinates (x, y) (Deg)

x = ***1*** SHIFT Rec(2 , 60) =

y = ***1.732050808*** RCL F

- Press RCL E to display the value of x, or RCL F to display the value of y.
- **Example 2:** To convert rectangular coordinates (1, $\sqrt{3}$) to polar coordinates (r,θ) (Rad)

r = ***2*** SHIFT Pol(1 , √ 3) =

θ = ***1.047197551*** RCL F

- Press RCL E to display the value of r, or RCL F to display the value of θ.

Engineering Notation Calculations

- **Example 1:** To convert 56,088 meters to kilometers

→ ***56.088*** ×10^3 (km) 56088 = ENG

- **Example 2:** To convert 0.08125 grams to milligrams

→ ***81.25*** ×10^{-3} (mg) 0.08125 = ENG

Equation Calculations EQN

The EQN Mode lets you solve equations up to three degrees and simultaneous linear equations with up to three unknowns.

Use the MODE key to enter the EQN Mode when you want to solve an equation.

EQN .... MODE MODE MODE 1

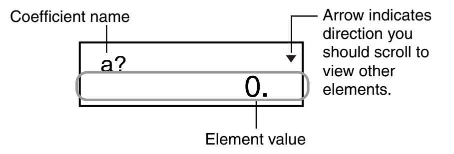
Quadratic and Cubic Equations

Quadratic Equation: $ax^2 + bx + c = 0$
Cubic Equation: $ax^3 + bx^2 + cx + d = 0$

Entering the EQN Mode and pressing ▶ displays the initial quadratic/cubic equation screen.

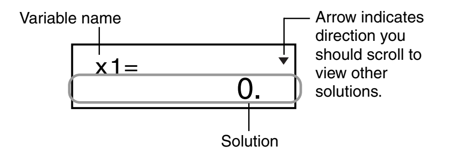
```
◂Degree?
  2   3
```

Use this screen to specify 2 (quadratic) or 3 (cubic) as the degree of the equation, and input values for each of the coefficients.



- Any time until you input a value for the final coefficient (c for a quadratic equation, d for a cubic equation), you can use the ▲ and ▼ keys to move between coefficients on the screen and make changes, if you want.
- Note that you cannot input complex numbers for coefficients.

Calculation starts and one of the solutions appears as soon as you input a value for the final coefficient.



Press the ▼ key to view other solutions. Use ▲ and ▼ to scroll between all of the solutions for the equation.
Pressing the AC key at this point returns to the coefficient input screen.

- Certain coefficients can cause calculation to take more time.

- **Example 1:** To solve the equation
  $x^3 - 2x^2 - x + 2 = 0$ ***(x = 2, −1, 1)***

(Degree?)	3
(a?)	1 =
(b?)	(−) 2 =
(c?)	(−) 1 =
(d?)	2 =
(x1 = 2)	▼
(x2 = −1)	▼
(x3 = 1)	

- If a result is a complex number, the real part of the first solution appears first. This is indicated by the "R↔I" symbol on the display. Press SHIFT Re↔Im to toggle the display between the real part and imaginary part of a solution.

```
x1=        R↔I
       0.25
```

⬇⬆ SHIFT Re↔Im

```
x1=        R↔I
       0.75i
```

- **Example 2:** To solve the equation
  $8x^2 - 4x + 5 = 0$ ***(x = 0.25 ± 0.75i)***

(Degree?)	2
(a?)	8 =
(b?)	(−) 4 =
(c?)	5 =
(x1 = 0.25 + 0.75i)	▼
(x2 = 0.25 − 0.75i)	

Simultaneous Equations

Simultaneous Linear Equations with Two Unknowns:

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

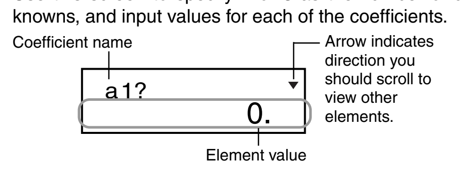
Simultaneous Linear Equations with Three Unknowns:

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

Entering the EQN Mode displays the initial simultaneous equation screen.

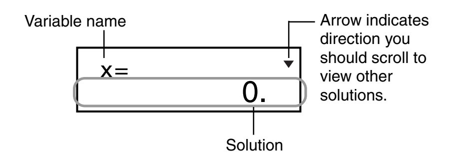
```
Unknowns?   ▸
2    3
```

Use this screen to specify 2 or 3 as the number of unknowns, and input values for each of the coefficients.



- Any time until you input a value for the final coefficient (c_2 for two unknowns, d_3 for three unknowns), you can use the ▲ and ▼ keys to move between coefficients on the screen and make changes, if you want.
- Note that you cannot input complex numbers for coefficients.

Calculation starts and one of the solutions appears as soon as you input a value for the final coefficient.



Press the ▼ key to view other solutions. Use ▲ and ▼ to scroll between all of the solutions for the equation.
Pressing the AC key at this point returns to the coefficient input screen.

- **Example:** To solve the following simultaneous equations
  $2x + 3y - z = 15$
  $3x - 2y + 2z = 4$
  $5x + 3y - 4z = 9$ ***(x = 2, y = 5, z = 4)***

(Unknowns?)	3
(a_1?) .... (d_1?)	2 = 3 = (−) 1 = 15 =
(a_2?) .... (d_2?)	3 = (−) 2 = 2 = 4 =
(a_3?) .... (d_3?)	5 = 3 = (−) 4 = 9 =
(x = 2)	▼
(y = 5)	▼
(z = 4)	

Statistical Calculations SD REG

Standard Deviation SD

Use the MODE key to enter the SD Mode when you want to perform statistical calculations using standard deviation.

SD .... MODE MODE 1

- Always start data input with SHIFT CLR 1(Scl) = to clear statistical memory.
- Input data using the key sequence shown below.
  <x-data> DT
- Input data is used to calculate values for n, Σx, Σx^2, $\bar{x}$, σ_n and σ_{n-1}, which you can recall using the key operations noted nearby.

To recall this type of value:	Perform this key operation:
Σx^2	SHIFT S-SUM 1
Σx	SHIFT S-SUM 2
n	SHIFT S-SUM 3
$\bar{x}$	SHIFT S-VAR 1
σ_n	SHIFT S-VAR 2
σ_{n-1}	SHIFT S-VAR 3

- **Example:** To calculate σ_{n-1}, σ_n, $\bar{x}$, n, Σx, and Σx^2 for the following data : 55, 54, 51, 55, 53, 53, 54, 52

In the SD Mode:

SHIFT CLR 1(Scl) = (Stat clear)

55 DT → n= SD 1.

Each time you press DT to register your input, the number of data input up to that point is indicated on the display (n value).

54 DT 51 DT 55 DT

53 DT DT 54 DT 52 DT

Sample Standard Deviation (σ_{n-1}) = ***1.407885953***	SHIFT S-VAR 3 =
Population Standard Deviation (σ_n) = ***1.316956719***	SHIFT S-VAR 2 =
Arithmetic Mean ($\bar{x}$) = ***53.375***	SHIFT S-VAR 1 =
Number of Data (n) = ***8***	SHIFT S-SUM 3 =
Sum of Values (Σx) = ***427***	SHIFT S-SUM 2 =
Sum of Squares of Values (Σx^2) = ***22805***	SHIFT S-SUM 1 =

Data Input Precautions

- DT DT inputs the same data twice.
- You can also input multiple entries of the same data using SHIFT ;. To input the data 110 ten times, for example, press 110 SHIFT ; 10 DT.
- You can perform the above key operations in any order, and not necessarily that shown above.
- While inputting data or after inputting data is complete, you can use the ▲ and ▼ keys to scroll through data you have input. If you input multiple entries of the same data using SHIFT ; to specify the data frequency (number of data items) as described above, scrolling through data shows both the data item and a separate screen for the data frequency (Freq).
- You can then edit the displayed data, if you want. Input the new value and then press the = key to replace the old value with the new one. This also means that if you want to perform some other operation (calculation, recall of statistical calculation results, etc.), you should always press the AC key first to exit data display.
- Pressing the DT key instead of = after changing a value on the display registers the value you input as a new data item, and leaves the old value as it is.
- You can delete a data value displayed using ▲ and ▼ by pressing SHIFT CL. Deleting a data value causes all values following it to be shifted up.
- Data values you register are normally stored in calculator memory. The message "Data Full" appears and you will not be able to input any more data if there is no memory left for data storage. If this happens, press the = key to display the screen shown below.

```
EditOFF ESC
1       2
```

Press 2 to exit data input without registering the value you just input.
Press 1 if you want to register the value you just input, without saving it in memory. If you do this, however, you will not be able to display or edit any of the data you have input.

- To delete data you have just input, press SHIFT CL.
- After inputting statistical data in the SD Mode or REG Mode, you will be unable to display or edit individual data items any longer after perform either the following operations.
  Changing to another mode
  Changing the regression type (Lin, Log, Exp, Pwr, Inv, Quad)

Regression Calculations REG

Use the MODE key to enter the REG Mode when you want to perform statistical calculations using regression.

REG .... MODE MODE 2

- Entering the REG Mode displays screens like the ones shown below.

```
Lin Log Exp ▸
1    2   3
```

▶ ⬇⬆ ◀

```
◂Pwr Inv Quad
 1    2   3
```

- Press the number key (1, 2, or 3) that corresponds to the type of regression you want to use.

1 (Lin):	Linear regression
2 (Log):	Logarithmic regression
3 (Exp):	Exponential regression
▶ 1 (Pwr):	Power regression
▶ 2 (Inv):	Inverse regression
▶ 3 (Quad):	Quadratic regression

- Always start data input with SHIFT CLR 1(Scl) = to clear statistical memory.
- Input data using the key sequence shown below.
  <x-data> , <y-data> DT
- The values produced by a regression calculation depend on the values input, and results can be recalled using the key operations shown in the table below.

To recall this type of value:	Perform this key operation:
Σx^2	SHIFT S-SUM 1
Σx	SHIFT S-SUM 2
n	SHIFT S-SUM 3
Σy^2	SHIFT S-SUM ▶ 1
Σy	SHIFT S-SUM ▶ 2
Σxy	SHIFT S-SUM ▶ 3
$\bar{x}$	SHIFT S-VAR 1
$x\sigma_n$	SHIFT S-VAR 2
$x\sigma_{n-1}$	SHIFT S-VAR 3
$\bar{y}$	SHIFT S-VAR ▶ 1
$y\sigma_n$	SHIFT S-VAR ▶ 2
$y\sigma_{n-1}$	SHIFT S-VAR ▶ 3
Regression coefficient A	SHIFT S-VAR ▶ ▶ 1
Regression coefficient B	SHIFT S-VAR ▶ ▶ 2
Regression calculation other than quadratic regression	
Correlation coefficient r	SHIFT S-VAR ▶ ▶ 3
$\hat{x}$	SHIFT S-VAR ▶ ▶ ▶ 1
$\hat{y}$	SHIFT S-VAR ▶ ▶ ▶ 2

- The following table shows the key operations you should use to recall results in the case of quadratic regression.

To recall this type of value:	Perform this key operation:
Σx^3	SHIFT S-SUM ▶ ▶ 1
Σx^2y	SHIFT S-SUM ▶ ▶ 2
Σx^4	SHIFT S-SUM ▶ ▶ 3
Regression coefficient C	SHIFT S-VAR ▶ ▶ 3
$\hat{x}_1$	SHIFT S-VAR ▶ ▶ ▶ 1
$\hat{x}_2$	SHIFT S-VAR ▶ ▶ ▶ 2
$\hat{y}$	SHIFT S-VAR ▶ ▶ ▶ 3

- The values in the above tables can be used inside of expressions the same way you use variables.

• Linear Regression

- The regression formula for linear regression is:
  y = A + Bx.

- **Example:** Atmospheric Pressure vs. Temperature

Temperature	Atmospheric Pressure
10°C	1003 hPa
15°C	1005 hPa
20°C	1010 hPa
25°C	1011 hPa
30°C	1014 hPa

Perform linear regression to determine the regression formula terms and correlation coefficient for the data nearby. Next, use the regression formula to estimate atmospheric pressure at 18°C and temperature at 1000 hPa. Finally, calculate the coefficient of determination (r^2) and sample covariance $\left(\dfrac{\Sigma xy - n\cdot\bar{x}\cdot\bar{y}}{n-1}\right)$.

In the REG Mode:

1(Lin)

SHIFT CLR 1(Scl) = (Stat clear)

10 , 1003 DT → n= REG 1.

Each time you press DT to register your input, the number of data input up to that point is indicated on the display (n value).

15 , 1005 DT

20 , 1010 DT 25 , 1011 DT

30 , 1014 DT

Regression Coefficient A = ***997.4*** SHIFT S-VAR ▶ ▶ 1 =

Regression Coefficient B = ***0.56*** SHIFT S-VAR ▶ ▶ 2 =

Correlation Coefficient r = ***0.982607368*** SHIFT S-VAR ▶ ▶ 3 =

Atmospheric Pressure at 18°C = ***1007.48*** 18 SHIFT S-VAR ▶ ▶ ▶ 2 =

Temperature at 1000 hPa = ***4.642857143*** 1000 SHIFT S-VAR ▶ ▶ ▶ 1 =

Coefficient of Determination = ***0.965517241*** SHIFT S-VAR ▶ ▶ 3 x^2 =

Sample Covariance = ***35*** (SHIFT S-SUM ▶ 3 − SHIFT S-SUM 3 × SHIFT S-VAR 1 × SHIFT S-VAR ▶ 1) ÷ (SHIFT S-SUM 3 − 1) =

• Logarithmic, Exponential, Power, and Inverse Regression

- Use the same key operations as linear regression to recall results for these types of regression.
- The following shows the regression formulas for each type of regression.

Logarithmic Regression	y = A + B・ln x
Exponential Regression	y = A・$e^{B \cdot x}$ (ln y = ln A + Bx)
Power Regression	y = A・x^B (ln y = ln A + Bln x)
Inverse Regression	y = A + B・$^1/_x$

• Quadratic Regression

- The regression formula for quadratic regression is: $y = A + Bx + Cx^2$.
- **Example:**

x_i	y_i
29	1.6
50	23.5
74	38.0
103	46.4
118	48.0

Perform quadratic regression to determine the regression formula terms for the data nearby. Next, use the regression formula to estimate the values for $\hat{y}$ (estimated value of y) for x_i = 16 and $\hat{x}$ (estimated value of x) for y_i = 20.

In the REG Mode:

▶ 3(Quad)

SHIFT CLR 1(Scl) = (Stat clear)

29 , 1.6 DT 50 , 23.5 DT
74 , 38.0 DT 103 , 46.4 DT
118 , 48.0 DT

Regression Coefficient A = ***–35.59856934*** SHIFT S-VAR ▶ ▶ 1 =

Regression Coefficient B = ***1.495939413*** SHIFT S-VAR ▶ ▶ 2 =

Regression Coefficient C = ***–6.71629667 × 10⁻³*** SHIFT S-VAR ▶ ▶ 3 =

$\hat{y}$ when x_i is 16 = ***–13.38291067*** 16 SHIFT S-VAR ▶ ▶ ▶ 3 =

$\hat{x}_1$ when y_i is 20 = ***47.14556728*** 20 SHIFT S-VAR ▶ ▶ ▶ 1 =

$\hat{x}_2$ when y_i is 20 = ***175.5872105*** 20 SHIFT S-VAR ▶ ▶ ▶ 2 =

Data Input Precautions

- DT DT inputs the same data twice.
- You can also input multiple entries of the same data using SHIFT ;. To input the data "20 and 30" five times, for example, press 20 , 30 SHIFT ; 5 DT.
- The above results can be obtained in any order, and not necessarily that shown above.
- Precautions when editing data input for standard deviation also apply for regression calculations.

Technical Information

■ When you have a problem......

If calculation results are not what you expect or if an error occurs, perform the following steps.

1. Press SHIFT CLR 2(Mode) = to initialize all modes and settings.
2. Check the formula you are working with to confirm it is correct.
3. Enter the correct mode and try performing the calculation again.

If the above steps do not correct the problem, press the ON key. The calculator performs a self-check operation and deletes all data stored in memory if any abnormality is detected. Make sure you always keep written copies of all important data.

■ Error Messages

The calculator is locked up while an error message is on the display. Press AC to clear the error, or press ◀ or ▶ to display the calculation and correct the problem. See "Error Locator" for details.

Math ERROR

- **Causes**
  - Calculation result is outside the allowable calculation range.
  - An attempt to perform a function calculation using a value that exceeds the allowable input range.
  - An attempt to perform an illogical operation (division by zero, etc.)
- **Action**
  - 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

- **Cause**
  - The capacity of the numeric stack or operator stack is exceeded.
- **Action**
  - 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

- **Cause**
  - An attempt to perform an illegal mathematical operation.
- **Action**
  - Press ◀ or ▶ to display the calculation with the cursor located at the location of the error and make required corrections.

Arg ERROR

- **Cause**
  - Improper use of an argument
- **Action**
  - Press ◀ or ▶ to display the location of the cause of the error and make required corrections.

■ Order of Operations

Calculations are performed in the following order of precedence.

① Coordinate transformation: Pol (x, y), Rec (r, θ)
Differentials: d/dx*
Integrations: $\int dx$*
Normal distribution: P(*, Q(*, R(*
② Type A functions:
With these functions, the value is entered and then the function key is pressed.
x^3, x^2, x^{-1}, $x!$, ° ' "
Engineering symbols*
Normal distribution: $\rightarrow t$*
$\hat{x}$, $\hat{x}_1$, $\hat{x}_2$, $\hat{y}$
Angle unit conversions (DRG►)
Metric conversions**
③ Powers and roots: ^(x^y), $\sqrt[x]{\ }$
④ $a^b/_c$
⑤ Abbreviated multiplication format in front of π, e (natural logarithm base), memory name, or variable name: 2π, 3e, 5A, πA, etc.
⑥ Type B functions:
With these functions, the function key is pressed and then the value is entered.
$\sqrt{\ }$, $\sqrt[3]{\ }$, log, ln, e^x, 10^x, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, (–)
d*, h*, b*, o*, Neg*, Not*, Det**, Trn**, arg*, Abs*, Conjg*
⑦ Abbreviated multiplication format in front of Type B functions: 2 $\sqrt{3}$, Alog2, etc.
⑧ Permutation and combination: nPr, nCr
∠*
⑨ Dot (•)**
⑩ ×, ÷
⑪ +, –
⑫ and*
⑬ xnor*, xor*, or*

- Operations of the same precedence are performed from right to left. $e^x\ln\sqrt{\ }120 \rightarrow e^x\{\ln(\sqrt{\ }120)\}$
- Other operations are performed from left to right.
- Operations enclosed in parentheses are performed first.
- When a calculation contains an argument that is a negative number, the negative number must be enclosed within parentheses. The negative sign (–) is treated as a Type B function, so particular care is required when the calculation includes a high-priority Type A function, or power or root operations.

Example: $(-2)^4 = 16$
$-2^4 = -16$

■ Stacks

This calculator uses memory areas, called "stacks," to temporarily store values (numeric stack) and commands (command stack) 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 is so complex that the capacity of a stack is exceeded.

- 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.
- **Example:**

2 × ((3 + 4 × (5 + 4) ÷ 3) ÷ 5) + 8 =

① ② ③ ④ ⑤
1 2 3 4 5 6 7

Numeric Stack	
①	2
②	3
③	4
④	5
⑤	4
⋮	

Command Stack	
1	×
2	(
3	(
4	+
5	×
6	(
7	+
⋮	

Mathematical Expression Calculations and Editing Functions (COMP)

Use the MODE key to enter the COMP Mode when you want to perform mathematical expression calculations or edit expressions.
COMP .... MODE 1

■ Replay Copy

Replay copy lets you recall multiple expressions from replay so they are connected as a multi-statement on the screen.

- **Example:**
  Replay memory contents:
  1 + 1
  2 + 2
  3 + 3
  4 + 4
  5 + 5
  6 + 6
  Multi-statement: 4 + 4:5 + 5:6 + 6
  Use ▲ and ▼ to display the expression 4 + 4.
  Press SHIFT ▲(COPY).
- You can also edit expressions on the display and perform other multi-statement operations. For more details about using multi-statements, see "Multi-statements" in the separate "User's Guide."
- Only the expressions in replay memory starting from the currently displayed expression and continuing to the last expression are copied. Anything before the displayed expression is not copied.

■ CALC Memory (COMP) (CMPLX)

- CALC memory lets you temporarily store a mathematical expression that you need to perform a number of times using different values. Once you store an expression, you can recall it, input values for its variables, and calculate a result quickly and easily.
- You can store a single mathematical expression, with up to 79 steps. Note that CALC memory can be used in the COMP Mode and CMPLX Mode only.
- The variable input screen shows the values currently assigned to the variables.
- **Example:** Calculate the result for Y = X² + 3X – 12 when X = 7 (Result: ***58***), and when X = 8 (Result: ***76***).

(Input the function.) ALPHA Y ALPHA = ALPHA X x^2 + 3 ALPHA X − 12
(Store the expression.) CALC
(Input 7 for X? prompt.) 7 =
(Input 8 for X? prompt.) CALC 8 =

- Note that the expression you store is cleared whenever you start another operation, change to another mode, or turn off the calculator.

■ SOLVE Function

The SOLVE function lets you solve an expression using variable values you want, without the need to transform or simply the expression.

- **Example:** C is the time it would take for an object thrown straight up with initial velocity A to reach height B.
  Use the formula below to calculate initial velocity A for a height of B = 14 meters and a time of C = 2 seconds. Gravitational acceleration is D = 9.8 m/s².
  (Result: A = ***16.8***)

$$B = AC - \frac{1}{2}DC^2$$

ALPHA B ALPHA = ALPHA A × ALPHA C −
(1 ÷ 2) × ALPHA D × ALPHA C x^2
SHIFT SOLVE
(B?) 14 =
(A?) ▼
(C?) 2 =
(D?) 9 • 8 =
▲ ▲
(A?) SHIFT SOLVE

- Since the SOLVE function uses Newton's Method, certain initial values (assumed values) can make it impossible to obtain solutions. In this case, try inputting another value that you assume to be near the solution and perform the calculation again.
- The SOLVE function may be unable to obtain a solution, even though a solution exists.
- Due to certain idiosyncrasies of Newton's method, solutions for the following types of functions tend to be difficult to calculate.
  Periodic functions (i.e. $y = \sin x$)
  Functions whose graph produce sharp slopes (i.e. $y = e^x$, $y = 1/x$)
  Discontinuous functions (i.e. $y = \sqrt{x}$)
- If an expression does not include an equals sign (=), the SOLVE function produces a solution for expression = 0.

Scientific Function Calculations (COMP)

Use the MODE key to enter the COMP Mode when you want to perform scientific function calculations.
COMP .... MODE 1

■ Inputting Engineering Symbols (COMP) (EQN) (CMPLX)

- Turning on engineering symbols makes it possible for you to use engineering symbols inside your calculations.
- To turn engineering symbols on and off, press the MODE key a number of times until you reach the setup screen shown below.

```
Disp
1
```

- Press 1. On the engineering symbol setting screen that appears, press the number key (1 or 2) that corresponds to the setting you want to use.
  1(Eng ON): Engineering symbols on (indicated by "Eng" on the display)
  2(Eng OFF): Engineering symbols off (no "Eng" indicator)
- The following are the nine symbols that can be used when engineering symbols are turned on.

To input this symbol:	Perform this key operation:	Unit
k (kilo)	SHIFT k	10^3
M (Mega)	SHIFT M	10^6
G (Giga)	SHIFT G	10^9
T (Tera)	SHIFT T	10^{12}
m (milli)	SHIFT m	10^{-3}
µ (micro)	SHIFT µ	10^{-6}
n (nano)	SHIFT n	10^{-9}
p (pico)	SHIFT p	10^{-12}
f (femto)	SHIFT f	10^{-15}

- For displayed values, the calculator selects the engineering symbol that makes the numeric part of the value fall within the range of 1 to 1000.
- Engineering symbols cannot be used when inputting fractions.
- **Example:** 9 ÷10 = 0.9 m (milli)

MODE ····· 1(Disp) 1 → [Eng 0.]
9 ÷ 10 = → [9÷10 m 900.]

When engineering symbols are turned on, even standard (non-engineering) calculation results are displayed using engineering symbols.

SHIFT ENG → [0.9]
ENG → [9÷10 m 900.]

Complex Number Calculations (CMPLX)

Use the MODE key to enter the CMPLX Mode when you want to perform calculations that include complex numbers.
CMPLX .... MODE 2

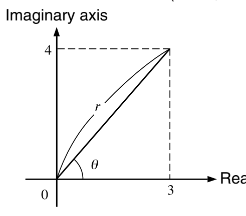
- The current angle unit setting (Deg, Rad, Gra) affects CMPLX Mode calculations. You can store an expression in CALC memory while in the CMPLX Mode.
- Note that you can use variables A, B, C, and M only in the CMPLX Mode. Variables D, E, F, X, and Y are used by the calculator, which frequently changes their values. You should not use these variables in your expressions.
- The indicator "R↔I" in the upper right corner of a calculation result display indicates a complex number result. Press SHIFT Re↔Im to toggle the display between the real part and imaginary part of the result.
- You can use the replay function in the CMPLX Mode. Since complex numbers are stored in replay memory in the CMPLX Mode, however, more memory than normal is used up.
- **Example:** $(2+3i)+(4+5i)$ = ***6+8i***

(Real part 6) 2 + 3 i + 4 + 5 i =
(Imaginary part 8i) SHIFT Re↔Im

■ Absolute Value and Argument Calculation

Supposing the imaginary number expressed by the rectangular form $z = a + bi$ is represented as a point in the Gaussian plane, you can determine the absolute value (r) and argument (θ) of the complex number. The polar form is $r\angle\theta$.

- **Example 1:** To determine the absolute value (r) and argument (θ) of 3+4i (Angle unit: Deg)
  (r = ***5***, θ = ***53.13010235***°)



(r = ***5***) SHIFT Abs (3 + 4 i) =
(θ = ***53.13010235***°) SHIFT arg (3 + 4 i) =

- The complex number can also be input using the polar form $r\angle\theta$.
- **Example 2:** $\sqrt{2}\angle 45$ = ***1 + i***
  (Angle unit: Deg) √ 2 SHIFT ∠ 45 = SHIFT Re↔Im

■ Rectangular Form ↔ Polar Form Display

You can use the operation described below to convert a rectangular form complex number to its polar form, and a polar form complex number to its rectangular form. Press SHIFT Re↔Im to toggle the display between the absolute value (r) and argument (θ).

- **Example:** $1 + i \leftrightarrow 1.414213562\angle 45$
  (Angle unit: Deg) 1 + i SHIFT ►r∠θ = SHIFT Re↔Im
  √ 2 SHIFT ∠ 45 SHIFT ►a+bi = SHIFT Re↔Im
- You select rectangular form ($a+bi$) or polar form ($r\angle\theta$) for display of complex number calculation results.
  MODE ··· 1(Disp) ▶
  1($a+bi$): Rectangular form
  2($r\angle\theta$): Polar form (indicated by "$r\angle\theta$" on the display)

■ Conjugate of a Complex Number

For any complex number z where $z = a+bi$, its conjugate ($\bar{z}$) is $\bar{z} = a-bi$.

- **Example:** To determine the conjugate of the complex number 1.23 + 2.34i (Result: ***1.23 – 2.34i***)

SHIFT Conjg (1 • 23 + 2 • 34 i) =
SHIFT Re↔Im

Base-*n* Calculations (BASE)

Use the MODE key to enter the BASE Mode when you want to perform calculations using Base-n values.
BASE .... MODE MODE 3

- In addition to decimal values, calculations can be performed using binary, octal and hexadecimal values.
- You can specify the default number system to be applied to all input and displayed values, and the number system for individual values as you input them.
- You cannot use scientific functions in binary, octal, decimal, and hexadecimal calculations. You cannot input values that include decimal part and an exponent.
- If you input a value that includes a decimal part, the unit automatically cuts off the decimal part.
- Negative binary, octal, and hexadecimal values are produced by taking the two's complement.
- You can use the following logical operators between values in Base-n calculations: and (logical product), or (logical sum), xor (exclusive or), xnor (exclusive nor), Not (bitwise complement), and Neg (negation).
- The following are the allowable ranges for each of the available number systems.

Binary	1000000000 ≦ x ≦ 1111111111
	0 ≦ x ≦ 0111111111
Octal	4000000000 ≦ x ≦ 7777777777
	0 ≦ x ≦ 3777777777
Decimal	–2147483648 ≦ x ≦ 2147483647
Hexadecimal	80000000 ≦ x ≦ FFFFFFFF
	0 ≦ x ≦ 7FFFFFFF

- **Example 1:** To perform the following calculation and produce a binary result:
  $10111_2 + 11010_2$ = ***110001₂***

Binary mode: AC BIN → [0. b]
10111 + 11010 =

- **Example 2:** To perform the following calculation and produce an octal result:
  $7654_8 \div 12_{10}$ = ***516₈***

Octal mode: AC OCT → [0. o]
LOGIC LOGIC LOGIC 4 (o) 7654 ÷
LOGIC LOGIC LOGIC 1 (d) 12 =

- **Example 3:** To perform the following calculation and produce a hexadecimal and a decimal result:
  120_{16} or 1101_2 = ***12d₁₆*** = ***301₁₀***

Hexadecimal mode: AC HEX → [0. H]
120 LOGIC 2 (or)
LOGIC LOGIC LOGIC 3 (b) 1101 =
Decimal mode: DEC

- **Example 4:** To convert the value 22_{10} to its binary, octal, and hexadecimal equivalents.
  (10110_2, 26_8, 16_{16})

Binary mode: AC BIN → [0. b]
LOGIC LOGIC LOGIC 1 (d) 22 = → [10110. b]
Octal mode: OCT → [26. o]
Hexadecimal mode: HEX → [16. H]

- **Example 5:** To convert the value 513_{10} to its binary equivalent.

Binary mode: AC BIN → [0. b]
LOGIC LOGIC LOGIC 1 (d) 513 = → [Math ERROR b]

- You may not be able to convert a value from a number system whose calculation range is greater than the calculation range of the resulting number system.
- The message "Math ERROR" indicates that the result has too many digits (overflow).

Statistical Calculations (SD) (REG)

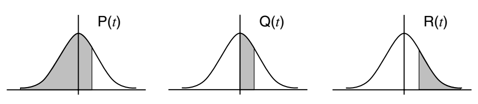
Normal Distribution (SD)

Use the MODE key to enter the SD Mode when you want to perform a calculation involving normal distribution.
SD .... MODE MODE 1

- In the SD Mode and REG Mode, the M+ key operates as the DT key.
- Press SHIFT DISTR, which produces the screen shown below.

```
P(  Q(  R(  →t
1   2   3   4
```

- Input a value from 1 to 4 to select the probability distribution calculation you want to perform.



- **Example:** To determine the normalized variate ($\rightarrow t$) for x = 53 and normal probability distribution P(t) for the following data: 55, 54, 51, 55, 53, 53, 54, 52

($\rightarrow t$ = ***–0.284747398***, P(t) = ***0.38974***)

55 DT 54 DT 51 DT 55 DT
53 DT DT 54 DT 52 DT
53 SHIFT DISTR 4($\rightarrow t$) =
SHIFT DISTR 1(P( ) (–) 0.28) =

Differential Calculations (COMP)

The procedure described below obtains the derivative of a function.

Use the MODE key to enter the COMP Mode when you want to perform a calculation involving differentials.
COMP .... MODE 1

- Three inputs are required for the differential expression: the function of variable x, the point (a) at which the differential coefficient is calculated, and the change in x (Δx).

SHIFT d/dx expression , a , Δx)

- **Example:** To determine the derivative at point x = 2 for the function $y = 3x^2 - 5x + 2$, when the increase or decrease in x is $\Delta x = 2 \times 10^{-4}$ (Result: ***7***)

SHIFT d/dx 3 ALPHA X x^2 − 5 ALPHA X + 2 , 2 ,
2 EXP (–) 4) =

- You can omit input of Δx, if you want. The calculator automatically substitutes an appropriate value for Δx if you do not input one.
- Discontinuous points and extreme changes in the value of x can cause inaccurate results and errors.
- Select Rad (Radian) for the angle unit setting when performing trigonometric function differential calculations.

Integration Calculations (COMP)

The procedure described below obtains the definite integral of a function.

Use the MODE key to enter the COMP Mode when you want to perform integration calculations.
COMP .... MODE 1

- The following four inputs are required for integration calculations: a function with the variable x; a and b, which define the integration range of the definite integral; and n, which is the number of partitions (equivalent to N = 2^n) for integration using Simpson's rule.

∫dx expression , a , b , n)

- **Example:** $\int_1^5 (2x^2 + 3x + 8)\,dx$ = ***150.6666667***
  (Number of partitions n = 6)

∫dx 2 ALPHA X x^2 + 3 ALPHA X +
8 , 1 , 5 , 6) =

Note!

- You can specify an integer in the range of 1 to 9 as the number of partitions, or you can skip input of the number of partitions entirely, if you want.
- Internal integration calculations may take considerable time to complete.
- Display contents are cleared while an integration calculation is being performed internally.
- Select Rad (Radian) for the angle unit setting when performing trigonometric function integration calculations.

Matrix Calculations (MAT)

The procedures in this section describe how to create matrices with up to three rows and three columns, and how to add, subtract, multiply, transpose and invert matrices, and how to obtain the scalar product, determinant, and absolute value of a matrix.

Use the MODE key to enter the MAT Mode when you want to perform matrix calculations.
MAT .... MODE MODE MODE 2

Note that you must create one or more matrices before you can perform matrix calculations.

- You can have up to three matrices, named A, B, and C, in memory at one time.
- The results of matrix calculations are stored automatically into MatAns memory. You can use the matrix in MatAns memory in subsequent matrix calculations.
- Matrix calculations can use up to two levels of the matrix stack. Squaring a matrix, cubing a matrix, or inverting a matrix uses one stack level. See "Stacks" in the separate "User's Guide" for more information.

■ Creating a Matrix

To create a matrix, press SHIFT MAT 1(Dim), specify a matrix name (A, B, or C), and then specify the dimensions (number of rows and number of columns) of the matrix. Next, follow the prompts that appear to input values that make up the elements of the matrix.

```
MatA23
```

2 rows and 3 columns

You can use the cursor keys to move about the matrix in order to view or edit its elements.

To exit the matrix screen, press AC.

■ Editing the Elements of a Matrix

Press SHIFT MAT 2(Edit) and then specify the name (A, B, or C) of the matrix you want to edit to display a screen for editing the elements of the matrix.

■ Matrix Addition, Subtraction, and Multiplication

Use the procedures described below to add, subtract, and multiply matrices.

- **Example:** To multiply Matrix A = $\begin{bmatrix} 1 & 2 \\ 4 & 0 \\ -2 & 5 \end{bmatrix}$ by Matrix B = $\begin{bmatrix} -1 & 0 & 3 \\ 2 & -4 & 1 \end{bmatrix}$ $\left(\begin{bmatrix} \mathbf{3} & \mathbf{-8} & \mathbf{5} \\ \mathbf{-4} & \mathbf{0} & \mathbf{12} \\ \mathbf{12} & \mathbf{-20} & \mathbf{-1} \end{bmatrix}\right)$

(Matrix A 3×2) SHIFT MAT 1(Dim) 1(A) 3 = 2 =
(Element input) 1 = 2 = 4 = 0 = (–) 2 = 5 = AC
(Matrix B 2×3) SHIFT MAT 1(Dim) 2(B) 2 = 3 =
(Element input) (–) 1 = 0 = 3 = 2 = (–) 4 = 1 = AC
(MatA×MatB) SHIFT MAT 3(Mat) 1(A) × SHIFT MAT 3(Mat) 2(B) =

- An error occurs if you try to add, subtract matrices whose dimensions are different from each other, or multiply a matrix whose number of columns is different from that of the matrix by which you are multiplying it.

■ Calculating the Scalar Product of a Matrix

Use the procedure shown below to obtain the scalar product (fixed multiple) of a matrix.

- **Example:** Multiply Matrix C = $\begin{bmatrix} 2 & -1 \\ -5 & 3 \end{bmatrix}$ by 3. $\left(\begin{bmatrix} \mathbf{6} & \mathbf{-3} \\ \mathbf{-15} & \mathbf{9} \end{bmatrix}\right)$

(Matrix C 2×2) SHIFT MAT 1 (Dim) 3(C) 2 = 2 =
(Element input) 2 = (–) 1 = (–) 5 = 3 = AC
(3×MatC) 3 × SHIFT MAT 3(Mat) 3(C) =

■ Obtaining the Determinant of a Matrix

You can use the procedure below to determine the determinant of a square matrix.

- **Example:** To obtain the determinant of Matrix A = $\begin{bmatrix} 2 & -1 & 6 \\ 5 & 0 & 1 \\ 3 & 2 & 4 \end{bmatrix}$ (Result: ***73***)

(Matrix A 3×3) SHIFT MAT 1(Dim) 1(A) 3 = 3 =
(Element input) 2 = (–) 1 = 6 = 5 = 0 = 1 = 3 = 2 = 4 = AC
(DetMatA) SHIFT MAT ▶ 1(Det) SHIFT MAT 3(Mat) 1(A) =

- The above procedure results in an error if a non-square matrix is specified.

■ Transposing a Matrix

Use the procedure described below when you want to transpose a matrix.

- **Example:** To transpose Matrix B = $\begin{bmatrix} 5 & 7 & 4 \\ 8 & 9 & 3 \end{bmatrix}$ $\left(\begin{bmatrix} \mathbf{5} & \mathbf{8} \\ \mathbf{7} & \mathbf{9} \\ \mathbf{4} & \mathbf{3} \end{bmatrix}\right)$

(Matrix B 2×3) SHIFT MAT 1(Dim) 2(B) 2 = 3 =
(Element input) 5 = 7 = 4 = 8 = 9 = 3 = AC
(TrnMatB) SHIFT MAT ▶ 2(Trn) SHIFT MAT 3(Mat) 2(B) =

■ Inverting a Matrix

You can use the procedure below to invert a square matrix.

- **Example:** To invert Matrix C = $\begin{bmatrix} -3 & 6 & -11 \\ 3 & -4 & 6 \\ 4 & -8 & 13 \end{bmatrix}$ $\left(\begin{bmatrix} \mathbf{-0.4} & \mathbf{1} & \mathbf{-0.8} \\ \mathbf{-1.5} & \mathbf{0.5} & \mathbf{-1.5} \\ \mathbf{-0.8} & \mathbf{0} & \mathbf{-0.6} \end{bmatrix}\right)$

(Matrix C 3×3) SHIFT MAT 1(Dim) 3(C) 3 = 3 =
(Element input) (–) 3 = 6 = (–) 11 = 3 = (–) 4 = 6 = 4 = (–) 8 = 13 = AC
(MatC⁻¹) SHIFT MAT 3(Mat) 3(C) x^{-1} =

- The above procedure results in an error if a non-square matrix or a matrix for which there is no inverse (determinant = 0) is specified.

■ Determining the Absolute Value of a Matrix

You can use the procedure described below to determine the absolute value of a matrix.

- **Example:** To determine the absolute value of the matrix produced by the inversion in the previous example.
  $\left(\begin{bmatrix} \mathbf{0.4} & \mathbf{1} & \mathbf{0.8} \\ \mathbf{1.5} & \mathbf{0.5} & \mathbf{1.5} \\ \mathbf{0.8} & \mathbf{0} & \mathbf{0.6} \end{bmatrix}\right)$

(AbsMatAns) SHIFT Abs SHIFT MAT 3(Mat) 4(Ans) =

Vector Calculations (VCT)

The procedures in this section describe how to create a vector with a dimension up to three, and how to add, subtract, and multiply vectors, and how to obtain the scalar product, inner product, outer product, and absolute value of a vector. You can have up to three vectors in memory at one time.

Use the MODE key to enter the VCT Mode when you want to perform vector calculations.
VCT .... MODE MODE MODE 3

Note that you must create one or more vector before you can perform vector calculations.

- You can have up to three vectors, named A, B, and C, in memory at one time.
- The results of vector calculations are stored automatically into VctAns memory. You can use the matrix in VctAns memory in subsequent vector calculations.

■ Creating a Vector

To create a vector, press SHIFT VCT 1 (Dim), specify a vector name (A, B, or C), and then specify the dimensions of the vector. Next, follow the prompts that appear input values that make up the elements of the vector.

Vector name — Dimensions of vector

```
VctA1        →
           0.
```

Element value

Arrow indicates direction you should scroll to view other elements.

You can use the ◀ and ▶ keys to move about the vector in order to view or edit its elements.

To exit the vector screen, press AC.

■ Editing Vector Elements

Press SHIFT VCT 2(Edit) and then specify the name (A, B, C) of the vector you want to edit to display a screen for editing the elements of the vector.

■ Adding and Subtracting Vectors

Use the procedures described below to add and subtract vectors.

- **Example:** To add Vector A = (1 –2 3) to Vector B = (4 5 –6). (Result: ***(5 3 –3)***)

(3-dimensional Vector A) SHIFT VCT 1(Dim) 1(A) 3 =
(Element input) 1 = (–) 2 = 3 = AC
(3-dimensional Vector B) SHIFT VCT 1(Dim) 2(B) 3 =
(Element input) 4 = 5 = (–) 6 = AC
(VctA + VctB) SHIFT VCT 3(Vct) 1(A) + SHIFT VCT 3(Vct) 2(B) =

- An error occurs in the above procedure if you specify vectors of different dimensions.

■ Calculating the Scalar Product of a Vector

Use the procedure shown below to obtain the scalar product (fixed multiple) of a vector.

- **Example:** To multiply Vector C = (–7.8 9) by 5. (Result: ***(–39 45)***)

(2-dimensional Vector C) SHIFT VCT 1(Dim) 3(C) 2 =
(Element input) (–) 7 • 8 = 9 = AC
(5×VctC) 5 × SHIFT VCT 3(Vct) 3(C) =

■ Calculating the Inner Product of Two Vectors

Use the procedure described below to obtain the inner product (•) for two vectors.

- **Example:** To calculate the inner product of Vector A and Vector B (Result: ***–24***)

(VctA•VctB) SHIFT VCT 3(Vct) 1(A) SHIFT VCT ▶ 1(Dot) SHIFT VCT 3(Vct) 2(B) =

- An error occurs in the above procedure if you specify vectors of different dimensions.

■ Calculating the Outer Product of Two Vectors

Use the procedure described below to obtain the outer product for two vectors.

- **Example:** To calculate the outer product of Vector A and Vector B (Result: ***(–3, 18, 13)***)

(VctA×VctB) SHIFT VCT 3(Vct) 1(A) × SHIFT VCT 3(Vct) 2(B) =

- An error occurs in the above procedure if you specify vectors of different dimensions.

■ Determining the Absolute Value of a Vector

Use the procedure shown below to obtain the absolute value (size) of a vector.

- **Example:** To determine the absolute value of Vector C (Result: ***11.90965994***)

(AbsVctC) SHIFT Abs SHIFT VCT 3(Vct) 3(C) =

- **Example:** To determine the size of the angle (angle unit: Deg) formed by vectors A = (–1 0 1) and B = (1 2 0), and the size 1 vector perpendicular to both A and B. (Result: ***108.4349488***°)

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

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

(3-dimensional Vector A) SHIFT VCT 1(Dim) 1(A) 3 =
(Element input) (–) 1 = 0 = 1 = AC
(3-dimensional Vector B) SHIFT VCT 1(Dim) 2(B) 3 =
(Element input) 1 = 2 = 0 = AC
(VctA•VctB) SHIFT VCT 3(Vct) 1(A) SHIFT VCT ▶ 1(Dot) SHIFT VCT 3(Vct) 2(B) =
(Ans÷(AbsVctA×AbsVctB)) ÷ (SHIFT Abs SHIFT VCT 3(Vct) 1(A) × SHIFT Abs SHIFT VCT 3(Vct) 2(B)) =
(cos⁻¹Ans) (Result: ***108.4349488***°) SHIFT cos⁻¹ Ans =
(VctA×VctB) SHIFT VCT 3(Vct) 1(A) × SHIFT VCT 3(Vct) 2(B) =
(AbsVctAns) SHIFT Abs SHIFT VCT 3(Vct) 4(Ans) =
(VctAns÷Ans)
(Result: ***(– 0.666666666 0.333333333 – 0.666666666)***)
SHIFT VCT 3(Vct) 4(Ans) ÷ Ans =

Metric Conversions (COMP)

Use the MODE key to enter the COMP Mode when you want to perform metric conversions.
COMP .... MODE 1

- A total of 20 different conversion pairs are built-in to provide quick and easy conversion to and from metric units.
- See the Conversion Pair Table for a complete list of available conversion pairs.
- When inputting a negative value, enclose it within parentheses (,).
- **Example:** To convert –31 degrees Celsius to Fahrenheit

((–) 31) SHIFT CONV 38 = → [(–31)°C→°F – 23.8]

38 is the Celsius-to-Fahrenheit conversion pair number.

• Conversion Pair Table

Based on NIST Special Publication 811 (1995).

To perform this conversion:	Input this pair number:	To perform this conversion:	Input this pair number:
in → cm	01	oz → g	21
cm → in	02	g → oz	22
ft → m	03	lb → kg	23
m → ft	04	kg → lb	24
yd → m	05	atm → Pa	25
m → yd	06	Pa → atm	26
mile → km	07	mmHg → Pa	27
km → mile	08	Pa → mmHg	28
n mile → m	09	hp → kW	29
m → n mile	10	kW → hp	30
acre → m²	11	kgf/cm² → Pa	31
m² → acre	12	Pa → kgf/cm²	32
gal (US) → ℓ	13	kgf•m → J	33
ℓ → gal (US)	14	J → kgf•m	34
gal (UK) → ℓ	15	lbf/in² → kPa	35
ℓ → gal (UK)	16	kPa → lbf/in²	36
pc → km	17	°F → °C	37
km → pc	18	C → °F	38
km/h → m/s	19	J → cal	39
m/s → km/h	20	cal → J	40

Scientific Constants (COMP)

Use the MODE key to enter the COMP Mode when you want to perform calculations using scientific constants.
COMP .... MODE 1

- A total of 40 commonly-used scientific constants, such as the speed of light in a vacuum and Planck's constant are built-in for quick and easy lookup whenever you need them.
- Simply input the number that corresponds to the scientific constant you want to look up and it appears instantly on the display.
- See the Scientific Constant Table for a complete list of available constants.
- **Example:** To determine how much total energy a person weighing 65kg has (E = mc² = ***5.841908662 × 10¹⁸***)

65 CONST 28 x^2 = → [65Co² 5.841908662 ¹⁸]

28 is the "speed of light in vacuum" constant number.

• Scientific Constant Table

Based on ISO Standard (1992) data and CODATA recommended values (1998).

To select this constant:	Input this scientific constant number:
proton mass (mp)	01
neutron mass (mn)	02
electron mass (me)	03
muon mass (mµ)	04
Bohr radius (a_0)	05
Planck constant (h)	06
nuclear magneton (µN)	07
Bohr magneton (µB)	08
Planck constant, rationalized (ℏ)	09
fine-structure constant (α)	10
classical electron radius (re)	11
Compton wavelength (λc)	12
proton gyromagnetic ratio (γp)	13
proton Compton wavelength (λcp)	14
neutron Compton wavelength (λcn)	15
Rydberg constant (R∞)	16
atomic mass unit (u)	17
proton magnetic moment (µp)	18
electron magnetic moment (µe)	19
neutron magnetic moment (µn)	20
muon magnetic moment (µµ)	21
Faraday constant (F)	22
elementary charge (e)	23
Avogadro constant (NA)	24
Boltzmann constant (k)	25
molar volume of ideal gas (Vm)	26
molar gas constant (R)	27
speed of light in vacuum (C_0)	28
first radiation constant (C_1)	29
second radiation constant (C_2)	30
Stefan-Boltzmann constant (σ)	31
electric constant (ε_0)	32
magnetic constant (μ_0)	33
magnetic flux quantum (ϕ_0)	34
standard acceleration of gravity (g)	35
conductance quantum (G_0)	36
characteristic impedance of vacuum (Z_0)	37
Celsius temperature (t)	38
Newtonian constant of gravitation (G)	39
standard atmosphere (atm)	40

■ Input Ranges

Internal digits: 12
Accuracy*: As a rule, accuracy is ±1 at the 10th digit.

Functions		Input Range
sin$x$	DEG	0≦ $\lvert x\rvert$ ≦4.499999999×10¹⁰
	RAD	0≦ $\lvert x\rvert$ ≦785398163.3
	GRA	0≦ $\lvert x\rvert$ ≦4.999999999×10¹⁰
cos$x$	DEG	0≦ $\lvert x\rvert$ ≦4.500000008×10¹⁰
	RAD	0≦ $\lvert x\rvert$ ≦785398164.9
	GRA	0≦ $\lvert x\rvert$ ≦5.000000009×10¹⁰
tan$x$	DEG	Same as sin$x$, except when $\lvert x\rvert$= (2n-1)×90.
	RAD	Same as sin$x$, except when $\lvert x\rvert$= (2n-1)×π/2.
	GRA	Same as sin$x$, except when $\lvert x\rvert$= (2n-1)×100.
$\sin^{-1}x$ / $\cos^{-1}x$		0≦ $\lvert x\rvert$ ≦1
$\tan^{-1}x$		0≦ $\lvert x\rvert$ ≦9.999999999×10⁹⁹
sinh$x$ / cosh$x$		0≦ $\lvert x\rvert$ ≦230.2585092
$\sinh^{-1}x$		0≦ $\lvert x\rvert$ ≦4.999999999×10⁹⁹
$\cosh^{-1}x$		1≦ x ≦4.999999999×10⁹⁹
tanh$x$		0≦ $\lvert x\rvert$ ≦9.999999999×10⁹⁹
$\tanh^{-1}x$		0≦ $\lvert x\rvert$ ≦9.999999999×10⁻¹
log$x$/ln$x$		0< x ≦9.999999999×10⁹⁹
10^x		–9.999999999×10⁹⁹≦ x ≦ 99.99999999
e^x		–9.999999999×10⁹⁹≦ x ≦ 230.2585092
$\sqrt{x}$		0≦ x < 1 × 10¹⁰⁰
x^2		$\lvert x\rvert$< 1× 10⁵⁰
1/x		$\lvert x\rvert$< 1× 10¹⁰⁰; x ≠ 0
$\sqrt[3]{x}$		$\lvert x\rvert$< 1× 10¹⁰⁰
$x!$		0≦ x ≦ 69 (x is an integer)
nPr		0≦ n < 1×10¹⁰, 0≦ r ≦ n (n, r are integers) 1≦ {n!/(n–r)!} < 1×10¹⁰⁰
nCr		0≦ n < 1×10¹⁰, 0≦ r ≦ n (n, r are integers) 1≦ [n!/{r!(n–r)!}] < 1×10¹⁰⁰
Pol(x, y)		$\lvert x\rvert$, $\lvert y\rvert$ ≦9.999999999×10⁴⁹ (x^2+y^2) ≦9.999999999×10⁹⁹
Rec(r, θ)		0≦ r ≦9.999999999×10⁹⁹ θ: Same as sin$x$
° ' "		$\lvert a\rvert$, b, c < 1×10¹⁰⁰ 0 ≦ b, c
←° ' "		$\lvert x\rvert$<1×10¹⁰⁰ Decimal ↔ Sexagesimal Conversions 0°0°0°≦ $\lvert x\rvert$ ≦999999°59°
^(x^y)		x>0: –1×10¹⁰⁰<$y$log$x$<100 x=0: y>0 x<0: y=n, $\frac{1}{2n+1}$ (n is an integer) However: –1×10¹⁰⁰ <$y$log$\lvert x\rvert$<100
$\sqrt[x]{y}$		y>0: x ≠ 0 –1×10¹⁰⁰<1/x log$y$<100 y=0: x>0 y<0: x=2n+1, $\frac{1}{n}$ (n ≠ 0; n is an integer) However: –1×10¹⁰⁰ <1/x log$\lvert y\rvert$<100
$a^b/_c$		Total of integer, numerator, and denominator must be 10 digits or less (including division marks).
SD (REG)		$\lvert x\rvert$< 1×10⁵⁰ $\lvert y\rvert$< 1×10⁵⁰ $\lvert n\rvert$< 1×10¹⁰⁰ $x\sigma n$, $y\sigma n$, $\bar{x}$, $\bar{y}$: n ≠ 0 $x\sigma n$–1, $y\sigma n$–1, A, B, r : n ≠ 0, 1

See the "EAI-350 User's Guide" for details about the following items.

Removing and Replacing the Calculator's Cover
Safety Precautions
Handling Precautions
Two-line Display
Before getting started... (except for "Modes")
Basic Calculations
Memory Calculations
Scientific Function Calculations
Equation Calculations
Statistical Calculations
Technical Information

Before getting started...

■ Modes

Before starting a calculation, you must first enter the correct mode as indicated in the table below.

- **The following table shows the modes and required operations for the EAI-350.**

To perform this type of calculation:	Perform this key operation:	To enter this mode:
Basic arithmetic calculations	MODE 1	COMP
Complex number calculations	MODE 2	CMPLX
Standard deviation	MODE MODE 1	SD
Regression calculations	MODE MODE 2	REG
Base-n calculations	MODE MODE 3	BASE
Solution of equations	MODE MODE MODE 1	EQN
Matrix calculations	MODE MODE MODE 2	MAT
Vector calculations	MODE MODE MODE 3	VCT

- Pressing the MODE key more than three times displays additional setup screens. Setup screens are described where they are actually used to change the calculator setup.
- In this manual, the name of the mode you need to enter in order to perform the calculations being described is indicated in the main title of each section.

Example: Complex Number Calculations (CMPLX)

Note!

- To return the calculation mode and setup to the initial defaults shown below, press SHIFT CLR 2 (Mode) =.

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

- Mode indicators appear in the upper part of the display, except for the BASE indicators, which appear in the exponent part of the display.
- Engineering symbols are automatically turned off while the calculator is the BASE Mode.
- You cannot make changes to the angle unit or other display format (Disp) settings while the calculator is in the BASE Mode.
- The COMP, CMPLX, SD, and REG modes can be used in combination with the angle unit settings.
- Be sure to check the current calculation mode (SD, REG, COMP, CMPLX) and angle unit setting (Deg, Rad, Gra) before beginning a calculation.

Mathematical Expression Calculations and Editing Functions (COMP)

Use the MODE key to enter the COMP Mode when you want to perform mathematical expression calculations or edit expressions.

COMP .... MODE 1

■ Replay Copy

Replay copy lets you recall multiple expressions from replay so they are connected as a multi-statement on the screen.

- **Example:**
  Replay memory contents:
  1 + 1
  2 + 2
  3 + 3
  4 + 4
  5 + 5
  6 + 6
  Multi-statement: 4 + 4:5 + 5:6 + 6
  Use ▲ and ▼ to display the expression 4 + 4.
  Press SHIFT ▲ (COPY).
- You can also edit expressions on the display and perform other multi-statement operations. For more details about using multi-statements, see "Multi-statements" in the separate "User's Guide."
- Only the expressions in replay memory starting from the currently displayed expression and continuing to the last expression are copied. Anything before the displayed expression is not copied.

■ CALC Memory (COMP) (CMPLX)

- CALC memory lets you temporarily store a mathematical expression that you need to perform a number of times using different values. Once you store an expression, you can recall it, input values for its variables, and calculate a result quickly and easily.
- You can store a single mathematical expression, with up to 79 steps. Note that CALC memory can be used in the COMP Mode and CMPLX Mode only.
- The variable input screen shows the values currently assigned to the variables.
- **Example:** Calculate the result for Y = X² + 3X – 12 when X = 7 (Result: ***58***), and when X = 8 (Result: ***76***).

(Input the function.)
ALPHA Y ALPHA = ALPHA X x² + 3 ALPHA X − 12
(Store the expression.) CALC
(Input 7 for X? prompt.) 7 =
(Input 8 for X? prompt.) CALC 8 =

- Note that the expression you store is cleared whenever you start another operation, change to another mode, or turn off the calculator.

■ SOLVE Function

The SOLVE function lets you solve an expression using variable values you want, without the need to transform or simply the expression.

- **Example:** C is the time it would take for an object thrown straight up with initial velocity A to reach height B.
  Use the formula below to calculate initial velocity A for a height of B = 14 meters and a time of C = 2 seconds. Gravitational acceleration is D = 9.8 m/s².
  (Result: A = ***16.8***)

$B = AC - \frac{1}{2}DC^2$

ALPHA B ALPHA = ALPHA A × ALPHA C −
(1 ÷ 2) × ALPHA D × ALPHA C x²
SHIFT SOLVE
(B?) 14 =
(A?) ▼
(C?) 2 =
(D?) 9 • 8 =
▲ ▲
(A?) SHIFT SOLVE

- Since the SOLVE function uses Newton's Method, certain initial values (assumed values) can make it impossible to obtain solutions. In this case, try inputting another value that you assume to be near the solution and perform the calculation again.
- The SOLVE function may be unable to obtain a solution, even though a solution exists.
- Due to certain idiosyncrasies of Newton's method, solutions for the following types of functions tend to be difficult to calculate.
  Periodic functions (i.e. $y = \sin x$)
  Functions whose graph produce sharp slopes (i.e. $y = e^x$, $y = 1/x$)
  Discontinuous functions (i.e. $y = \sqrt{x}$)
- If an expression does not include an equals sign (=), the SOLVE function produces a solution for expression = 0.

Scientific Function Calculations (COMP)

Use the MODE key to enter the COMP Mode when you want to perform scientific function calculations.

COMP .... MODE 1

■ Inputting Engineering Symbols

(COMP) (EQN) (CMPLX)

- Turning on engineering symbols makes it possible for you to use engineering symbols inside your calculations.
- To turn engineering symbols on and off, press the MODE key a number of times until you reach the setup screen shown below.

```
Disp
1
```

- Press 1. On the engineering symbol setting screen that appears, press the number key (1 or 2) that corresponds to the setting you want to use.
  1 (Eng ON): Engineering symbols on (indicated by "Eng" on the display)
  2 (Eng OFF): Engineering symbols off (no "Eng" indicator)
- The following are the nine symbols that can be used when engineering symbols are turned on.

To input this symbol:	Perform this key operation:	Unit
k (kilo)	SHIFT k	10^3
M (Mega)	SHIFT M	10^6
G (Giga)	SHIFT G	10^9
T (Tera)	SHIFT T	10^{12}
m (milli)	SHIFT m	10^{-3}
µ (micro)	SHIFT µ	10^{-6}
n (nano)	SHIFT n	10^{-9}
p (pico)	SHIFT p	10^{-12}
f (femto)	SHIFT f	10^{-15}

- For displayed values, the calculator selects the engineering symbol that makes the numeric part of the value fall within the range of 1 to 1000.
- Engineering symbols cannot be used when inputting fractions.
- **Example:** 9 ÷ 10 = 0.9 m (milli)

MODE ····· 1 (Disp) 1 → Eng 0.
9 ÷ 10 = → 9÷10 900. m

When engineering symbols are turned on, even standard (non-engineering) calculation results are displayed using engineering symbols.

SHIFT ENG → 0.9
ENG → 9÷10 900. m

Complex Number Calculations (CMPLX)

Use the MODE key to enter the CMPLX Mode when you want to perform calculations that include complex numbers.

CMPLX .... MODE 2

- The current angle unit setting (Deg, Rad, Gra) affects CMPLX Mode calculations. You can store an expression in CALC memory while in the CMPLX Mode.
- Note that you can use variables A, B, C, and M only in the CMPLX Mode. Variables D, E, F, X, and Y are used by the calculator, which frequently changes their values. You should not use these variables in your expressions.
- The indicator "R↔I" in the upper right corner of a calculation result display indicates a complex number result. Press SHIFT Re↔Im to toggle the display between the real part and imaginary part of the result.
- You can use the replay function in the CMPLX Mode. Since complex numbers are stored in replay memory in the CMPLX Mode, however, more memory than normal is used up.

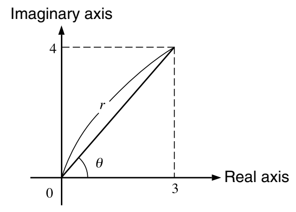
- **Example:** $(2+3i)+(4+5i) = \boldsymbol{6+8i}$

(Real part 6) 2 + 3 i + 4 + 5 i =
(Imaginary part 8i) SHIFT Re↔Im

■ Absolute Value and Argument Calculation

Supposing the imaginary number expressed by the rectangular form $z = a + bi$ is represented as a point in the Gaussian plane, you can determine the absolute value (r) and argument (θ) of the complex number. The polar form is $r\angle\theta$.

- **Example 1:** To determine the absolute value (r) and argument (θ) of 3+4i (Angle unit: Deg)
  (r = ***5***, θ = ***53.13010235***°)



(r = ***5***) SHIFT Abs (3 + 4 i) =
(θ = ***53.13010235***°) SHIFT arg (3 + 4 i) =

- The complex number can also be input using the polar form $r\angle\theta$.
- **Example 2:** $\sqrt{2} \angle 45 = \boldsymbol{1+i}$
  (Angle unit: Deg) √ 2 SHIFT ∠ 45 =
  SHIFT Re↔Im

■ Rectangular Form ↔ Polar Form Display

You can use the operation described below to convert a rectangular form complex number to its polar form, and a polar form complex number to its rectangular form. Press SHIFT Re↔Im to toggle the display between the absolute value (r) and argument (θ).

- **Example:** 1 + i ↔ 1.414213562 ∠ 45
  (Angle unit: Deg) 1 + i SHIFT ►r∠θ = SHIFT Re↔Im
  √ 2 SHIFT ∠ 45 SHIFT ►a+bi = SHIFT Re↔Im
- You select rectangular form (a+bi) or polar form ($r\angle\theta$) for display of complex number calculation results.

MODE ··· 1 (Disp) ►
1 (a+bi): Rectangular form
2 ($r\angle\theta$): Polar form (indicated by "$r\angle\theta$" on the display)

■ Conjugate of a Complex Number

For any complex number z where $z = a+bi$, its conjugate ($\bar{z}$) is $\bar{z} = a-bi$.

- **Example:** To determine the conjugate of the complex number 1.23 + 2.34i (Result: ***1.23 – 2.34i***)

SHIFT Conjg (1 • 23 + 2 • 34 i) =
SHIFT Re↔Im

Base-n Calculations (BASE)

Use the MODE key to enter the BASE Mode when you want to perform calculations using Base-n values.

BASE .... MODE MODE 3

- In addition to decimal values, calculations can be performed using binary, octal and hexadecimal values.
- You can specify the default number system to be applied to all input and displayed values, and the number system for individual values as you input them.
- You cannot use scientific functions in binary, octal, decimal, and hexadecimal calculations. You cannot input values that include decimal part and an exponent.
- If you input a value that includes a decimal part, the unit automatically cuts off the decimal part.
- Negative binary, octal, and hexadecimal values are produced by taking the two's complement.
- You can use the following logical operators between values in Base-n calculations: and (logical product), or (logical sum), xor (exclusive or), xnor (exclusive nor), Not (bitwise complement), and Neg (negation).
- The following are the allowable ranges for each of the available number systems.

Binary	1000000000 ≦ x ≦	1111111111
	0 ≦ x ≦	0111111111
Octal	4000000000 ≦ x ≦	7777777777
	0 ≦ x ≦	3777777777
Decimal	–2147483648 ≦ x ≦	2147483647
Hexadecimal	80000000 ≦ x ≦	FFFFFFFF
	0 ≦ x ≦	7FFFFFFF

- **Example 1:** To perform the following calculation and produce a binary result:
  $10111_2 + 11010_2 = \boldsymbol{110001_2}$

Binary mode: AC BIN → 0. b
10111 + 11010 =

- **Example 2:** To perform the following calculation and produce an octal result:
  $7654_8 \div 12_{10} = \boldsymbol{516_8}$

Octal mode: AC OCT → 0. o
LOGIC LOGIC LOGIC 4 (o) 7654 ÷
LOGIC LOGIC LOGIC 1 (d) 12 =

- **Example 3:** To perform the following calculation and produce a hexadecimal and a decimal result:
  120_{16} or 1101_2 = $\boldsymbol{12d_{16}}$ = $\boldsymbol{301_{10}}$

Hexadecimal mode: AC HEX → 0. H
120 LOGIC 2 (or)
LOGIC LOGIC LOGIC 3 (b) 1101 =
Decimal mode: DEC

- **Example 4:** To convert the value 22_{10} to its binary, octal, and hexadecimal equivalents.
  (***10110_2, 26_8, 16_{16}***)

Binary mode: AC BIN → 0. b
LOGIC LOGIC LOGIC 1 (d) 22 = → 10110. b
Octal mode: OCT → 26. o
Hexadecimal mode: HEX → 16. H

- **Example 5:** To convert the value 513_{10} to its binary equivalent.

Binary mode: AC BIN → 0. b
LOGIC LOGIC LOGIC 1 (d) 513 = → Math ERROR b

- You may not be able to convert a value from a number system whose calculation range is greater than the calculation range of the resulting number system.
- The message "Math ERROR" indicates that the result has too many digits (overflow).

Statistical Calculations (SD) (REG)

Normal Distribution (SD)

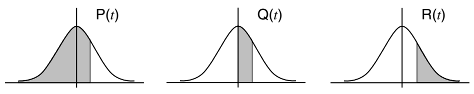
Use the MODE key to enter the SD Mode when you want to perform a calculation involving normal distribution.

SD .... MODE MODE 1

- In the SD Mode and REG Mode, the M+ key operates as the DT key.
- Press SHIFT DISTR, which produces the screen shown below.

```
P(  Q(  R(  →t
1   2   3   4
```

- Input a value from 1 to 4 to select the probability distribution calculation you want to perform.



- **Example:** To determine the normalized variate (→t) for x = 53 and normal probability distribution P(t) for the following data: 55, 54, 51, 55, 53, 53, 54, 52

(→t = ***−0.284747398***, P(t) = ***0.38974***)

55 DT 54 DT 51 DT 55 DT
53 DT 53 DT 54 DT 52 DT
53 SHIFT DISTR 4 (→t) =
SHIFT DISTR 1 (P( ) (–) 0.28) =

Differential Calculations (COMP)

The procedure described below obtains the derivative of a function.

Use the MODE key to enter the COMP Mode when you want to perform a calculation involving differentials.

COMP .... MODE 1

- Three inputs are required for the differential expression: the function of variable x, the point (a) at which the differential coefficient is calculated, and the change in x (Δx).

SHIFT d/dx expression , a , Δx)

- **Example:** To determine the derivative at point x = 2 for the function $y = 3x^2 - 5x + 2$, when the increase or decrease in x is $\Delta x = 2 \times 10^{-4}$ (Result: ***7***)

SHIFT d/dx 3 ALPHA X x² − 5 ALPHA X + 2 , 2 ,
2 EXP (–) 4) =

- You can omit input of Δx, if you want. The calculator automatically substitutes an appropriate value for Δx if you do not input one.
- Discontinuous points and extreme changes in the value of x can cause inaccurate results and errors.
- Select Rad (Radian) for the angle unit setting when performing trigonometric function differential calculations.

Integration Calculations (COMP)

The procedure described below obtains the definite integral of a function.

Use the MODE key to enter the COMP Mode when you want to perform integration calculations.

COMP .... MODE 1

- The following four inputs are required for integration calculations: a function with the variable x; a and b, which define the integration range of the definite integral; and n, which is the number of partitions (equivalent to N = 2^n) for integration using Simpson's rule.

∫dx expression , a , b , n)

- **Example:** $\int_1^5 (2x^2 + 3x + 8)\,dx = \boldsymbol{150.6666667}$
  (Number of partitions n = 6)

∫dx 2 ALPHA X x² + 3 ALPHA X +
8 , 1 , 5 , 6) =

Note!

- You can specify an integer in the range of 1 to 9 as the number of partitions, or you can skip input of the number of partitions entirely, if you want.
- Internal integration calculations may take considerable time to complete.
- Display contents are cleared while an integration calculation is being performed internally.
- Select Rad (Radian) for the angle unit setting when performing trigonometric function integration calculations.

Matrix Calculations (MAT)

The procedures in this section describe how to create matrices with up to three rows and three columns, and how to add, subtract, multiply, transpose and invert matrices, and how to obtain the scalar product, determinant, and absolute value of a matrix.

Use the [MODE] key to enter the MAT Mode when you want to perform matrix calculations.

MAT .... [MODE] [MODE] [MODE] [2]

Note that you must create one or more matrices before you can perform matrix calculations.

- You can have up to three matrices, named A, B, and C, in memory at one time.
- The results of matrix calculations are stored automatically into MatAns memory. You can use the matrix in MatAns memory in subsequent matrix calculations.
- Matrix calculations can use up to two levels of the matrix stack. Squaring a matrix, cubing a matrix, or inverting a matrix uses one stack level. See "Stacks" in the separate "User's Guide" for more information.

■ Creating a Matrix

To create a matrix, press [SHIFT] [MAT] [1](Dim), specify a matrix name (A, B, or C), and then specify the dimensions (number of rows and number of columns) of the matrix. Next, follow the prompts that appear to input values that make up the elements of the matrix.

MatA23

2 rows and 3 columns

You can use the cursor keys to move about the matrix in order to view or edit its elements.

To exit the matrix screen, press [AC].

■ Editing the Elements of a Matrix

Press [SHIFT] [MAT] [2](Edit) and then specify the name (A, B, or C) of the matrix you want to edit to display a screen for editing the elements of the matrix.

■ Matrix Addition, Subtraction, and Multiplication

Use the procedures described below to add, subtract, and multiply matrices.

- **Example:** To multiply Matrix A = $\begin{bmatrix} 1 & 2 \\ 4 & 0 \\ -2 & 5 \end{bmatrix}$ by Matrix B = $\begin{bmatrix} -1 & 0 & 3 \\ 2 & -4 & 1 \end{bmatrix}$ $\left(\begin{bmatrix} \mathbf{3} & \mathbf{-8} & \mathbf{5} \\ \mathbf{-4} & \mathbf{0} & \mathbf{12} \\ \mathbf{12} & \mathbf{-20} & \mathbf{-1} \end{bmatrix}\right)$

(Matrix A 3×2) [SHIFT] [MAT] [1](Dim) [1](A) 3 [=] 2 [=]

(Element input) 1 [=] 2 [=] 4 [=] 0 [=] [(-)] 2 [=] 5 [=] [AC]

(Matrix B 2×3) [SHIFT] [MAT] [1](Dim) [2](B) 2 [=] 3 [=]

(Element input) [(-)] 1 [=] 0 [=] 3 [=] 2 [=] [(-)] 4 [=] 1 [=] [AC]

(MatA×MatB) [SHIFT] [MAT] [3](Mat) [1](A) [×] [SHIFT] [MAT] [3](Mat) [2](B) [=]

- An error occurs if you try to add, subtract matrices whose dimensions are different from each other, or multiply a matrix whose number of columns is different from that of the matrix by which you are multiplying it.

■ Calculating the Scalar Product of a Matrix

Use the procedure shown below to obtain the scalar product (fixed multiple) of a matrix.

- **Example:** Multiply Matrix C = $\begin{bmatrix} 2 & -1 \\ -5 & 3 \end{bmatrix}$ by 3. $\left(\begin{bmatrix} \mathbf{6} & \mathbf{-3} \\ \mathbf{-15} & \mathbf{9} \end{bmatrix}\right)$

(Matrix C 2×2) [SHIFT] [MAT] [1] (Dim) [3](C) 2 [=] 2 [=]

(Element input) 2 [=] [(-)] 1 [=] [(-)] 5 [=] 3 [=] [AC]

(3×MatC) 3 [×] [SHIFT] [MAT] [3](Mat) [3](C) [=]

■ Obtaining the Determinant of a Matrix

You can use the procedure below to determine the determinant of a square matrix.

- **Example:** To obtain the determinant of Matrix A = $\begin{bmatrix} 2 & -1 & 6 \\ 5 & 0 & 1 \\ 3 & 2 & 4 \end{bmatrix}$ (Result: ***73***)

(Matrix A 3×3) [SHIFT] [MAT] [1](Dim) [1](A) 3 [=] 3 [=]

(Element input) 2 [=] [(-)] 1 [=] 6 [=] 5 [=] 0 [=] 1 [=] 3 [=] 2 [=] 4 [=] [AC]

(DetMatA) [SHIFT] [MAT] [▶] [1](Det) [SHIFT] [MAT] [3](Mat) [1](A) [=]

- The above procedure results in an error if a non-square matrix is specified.

■ Transposing a Matrix

Use the procedure described below when you want to transpose a matrix.

- **Example:** To transpose Matrix B = $\begin{bmatrix} 5 & 7 & 4 \\ 8 & 9 & 3 \end{bmatrix}$ $\left(\begin{bmatrix} \mathbf{5} & \mathbf{8} \\ \mathbf{7} & \mathbf{9} \\ \mathbf{4} & \mathbf{3} \end{bmatrix}\right)$

(Matrix B 2×3) [SHIFT] [MAT] [1](Dim) [2](B) 2 [=] 3 [=]

(Element input) 5 [=] 7 [=] 4 [=] 8 [=] 9 [=] 3 [=] [AC]

(TrnMatB) [SHIFT] [MAT] [▶] [2](Trn) [SHIFT] [MAT] [3](Mat) [2](B) [=]

■ Inverting a Matrix

You can use the procedure below to invert a square matrix.

- **Example:** To invert Matrix C = $\begin{bmatrix} -3 & 6 & -11 \\ 3 & -4 & 6 \\ 4 & -8 & 13 \end{bmatrix}$ $\left(\begin{bmatrix} \mathbf{-0.4} & \mathbf{1} & \mathbf{-0.8} \\ \mathbf{-1.5} & \mathbf{0.5} & \mathbf{-1.5} \\ \mathbf{-0.8} & \mathbf{0} & \mathbf{-0.6} \end{bmatrix}\right)$

(Matrix C 3×3) [SHIFT] [MAT] [1](Dim) [3](C) 3 [=] 3 [=]

(Element input) [(-)] 3 [=] 6 [=] [(-)] 11 [=] 3 [=] [(-)] 4 [=] 6 [=] 4 [=] [(-)] 8 [=] 13 [=] [AC]

(MatC^{-1}) [SHIFT] [MAT] [3](Mat) [3](C) [x^{-1}] [=]

- The above procedure results in an error if a non-square matrix or a matrix for which there is no inverse (determinant = 0) is specified.

■ Determining the Absolute Value of a Matrix

You can use the procedure described below to determine the absolute value of a matrix.

- **Example:** To determine the absolute value of the matrix produced by the inversion in the previous example. $\left(\begin{bmatrix} \mathbf{0.4} & \mathbf{1} & \mathbf{0.8} \\ \mathbf{1.5} & \mathbf{0.5} & \mathbf{1.5} \\ \mathbf{0.8} & \mathbf{0} & \mathbf{0.6} \end{bmatrix}\right)$

(AbsMatAns) [SHIFT] [Abs] [SHIFT] [MAT] [3](Mat) [4](Ans) [=]

Vector Calculations VCT

The procedures in this section describe how to create a vector with a dimension up to three, and how to add, subtract, and multiply vectors, and how to obtain the scalar product, inner product, outer product, and absolute value of a vector. You can have up to three vectors in memory at one time.

Use the [MODE] key to enter the VCT Mode when you want to perform vector calculations.

VCT .... [MODE] [MODE] [MODE] [3]

Note that you must create one or more vector before you can perform vector calculations.

- You can have up to three vectors, named A, B, and C, in memory at one time.
- The results of vector calculations are stored automatically into VctAns memory. You can use the matrix in VctAns memory in subsequent vector calculations.

■ Creating a Vector

To create a vector, press [SHIFT] [VCT] [1] (Dim), specify a vector name (A, B, or C), and then specify the dimensions of the vector. Next, follow the prompts that appear to input values that make up the elements of the vector.

Vector name   Dimensions of vector

VctA1 ➡

0.

Element value

Arrow indicates direction you should scroll to view other elements.

You can use the [◀] and [▶] keys to move about the vector in order to view or edit its elements.

To exit the vector screen, press [AC].

■ Editing Vector Elements

Press [SHIFT] [VCT] [2](Edit) and then specify the name (A, B, C) of the vector you want to edit to display a screen for editing the elements of the vector.

■ Adding and Subtracting Vectors

Use the procedures described below to add and subtract vectors.

- **Example:** To add Vector A = (1 –2 3) to Vector B = (4 5 –6). (Result: ***(5 3 –3)***)

(3-dimensional Vector A) [SHIFT] [VCT] [1](Dim) [1](A) 3 [=]

(Element input) 1 [=] [(-)] 2 [=] 3 [=] [AC]

(3-dimensional Vector B) [SHIFT] [VCT] [1](Dim) [2](B) 3 [=]

(Element input) 4 [=] 5 [=] [(-)] 6 [=] [AC]

(VctA + VctB) [SHIFT] [VCT] [3](Vct) [1](A) [+] [SHIFT] [VCT] [3](Vct) [2](B) [=]

- An error occurs in the above procedure if you specify vectors of different dimensions.

■ Calculating the Scalar Product of a Vector

Use the procedure shown below to obtain the scalar product (fixed multiple) of a vector.

- **Example:** To multiply Vector C = (–7.8 9) by 5. (Result: ***(–39 45)***)

(2-dimensional Vector C) [SHIFT] [VCT] [1](Dim) [3](C) 2 [=]

(Element input) [(-)] 7 [•] 8 [=] 9 [=] [AC]

(5×VctC) 5 [×] [SHIFT] [VCT] [3](Vct) [3](C) [=]

■ Calculating the Inner Product of Two Vectors

Use the procedure described below to obtain the inner product (•) for two vectors.

- **Example:** To calculate the inner product of Vector A and Vector B (Result: ***–24***)

(VctA•VctB) [SHIFT] [VCT] [3](Vct) [1](A) [SHIFT] [VCT] [▶] [1](Dot) [SHIFT] [VCT] [3](Vct) [2](B) [=]

- An error occurs in the above procedure if you specify vectors of different dimensions.

■ Calculating the Outer Product of Two Vectors

Use the procedure described below to obtain the outer product for two vectors.

- **Example:** To calculate the outer product of Vector A and Vector B (Result: ***(–3, 18, 13)***)

(VctA×VctB) [SHIFT] [VCT] [3](Vct) [1](A) [×] [SHIFT] [VCT] [3](Vct) [2](B) [=]

- An error occurs in the above procedure if you specify vectors of different dimensions.

■ Determining the Absolute Value of a Vector

Use the procedure shown below to obtain the absolute value (size) of a vector.

- **Example:** To determine the absolute value of Vector C (Result: ***11.90965994***)

(AbsVctC) [SHIFT] [Abs] [SHIFT] [VCT] [3](Vct) [3](C) [=]

- **Example:** To determine the size of the angle (angle unit: Deg) formed by vectors A = (–1 0 1) and B = (1 2 0), and the size 1 vector perpendicular to both A and B. (Result: ***108.4349488***°)

$\cos\theta = \dfrac{(A \cdot B)}{|A||B|}$, which becomes $\theta = \cos^{-1}\dfrac{(A \cdot B)}{|A||B|}$

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

(3-dimensional Vector A) [SHIFT] [VCT] [1](Dim) [1](A) 3 [=]

(Element input) [(-)] 1 [=] 0 [=] 1 [=] [AC]

(3-dimensional Vector B) [SHIFT] [VCT] [1](Dim) [2](B) 3 [=]

(Element input) 1 [=] 2 [=] 0 [=] [AC]

(VctA•VctB) [SHIFT] [VCT] [3](Vct) [1](A) [SHIFT] [VCT] [▶] [1](Dot) [SHIFT] [VCT] [3](Vct) [2](B) [=]

(Ans÷(AbsVctA×AbsVctB)) [÷] [(] [SHIFT] [Abs] [SHIFT] [VCT] [3](Vct) [1](A) [×] [SHIFT] [Abs] [SHIFT] [VCT] [3](Vct) [2](B) [)] [=]

(cos^{-1}Ans) (Result: ***108.4349488***°) [SHIFT] [cos^{-1}] [Ans] [=]

(VctA×VctB) [SHIFT] [VCT] [3](Vct) [1](A) [×] [SHIFT] [VCT] [3](Vct) [2](B) [=]

(AbsVctAns) [SHIFT] [Abs] [SHIFT] [VCT] [3](Vct) [4](Ans) [=]

(VctAns÷Ans)

(Result: ***(– 0.666666666 0.333333333 – 0.666666666)***) [SHIFT] [VCT] [3](Vct) [4](Ans) [÷] [Ans] [=]

Metric Conversions COMP

Use the [MODE] key to enter the COMP Mode when you want to perform metric conversions.

COMP .... [MODE] [1]

- A total of 20 different conversion pairs are built-in to provide quick and easy conversion to and from metric units.
- See the Conversion Pair Table for a complete list of available conversion pairs.
- When inputting a negative value, enclose it within parentheses [(], [)].

- **Example:** To convert –31 degrees Celsius to Fahrenheit

[(] [(-)] 31 [)] [SHIFT] [CONV] 38 [=]   (–31)°C→°F – 23.8

38 is the Celsius-to-Fahrenheit conversion pair number.

• Conversion Pair Table

Based on NIST Special Publication 811 (1995).

To perform this conversion:	Input this pair number:	To perform this conversion:	Input this pair number:
in → cm	01	oz → g	21
cm → in	02	g → oz	22
ft → m	03	lb → kg	23
m → ft	04	kg → lb	24
yd → m	05	atm → Pa	25
m → yd	06	Pa → atm	26
mile → km	07	mmHg → Pa	27
km → mile	08	Pa → mmHg	28
n mile → m	09	hp → kW	29
m → n mile	10	kW → hp	30
acre → m²	11	kgf/cm² → Pa	31
m² → acre	12	Pa → kgf/cm²	32
gal (US) → ℓ	13	kgf•m → J	33
ℓ → gal (US)	14	J → kgf•m	34
gal (UK) → ℓ	15	lbf/in² → kPa	35
ℓ → gal (UK)	16	kPa → lbf/in²	36
pc → km	17	°F → °C	37
km → pc	18	C → °F	38
km/h → m/s	19	J → cal	39
m/s → km/h	20	cal → J	40

Scientific Constants COMP

Use the [MODE] key to enter the COMP Mode when you want to perform calculations using scientific constants.

COMP .... [MODE] [1]

- A total of 40 commonly-used scientific constants, such as the speed of light in a vacuum and Planck's constant are built-in for quick and easy lookup whenever you need them.
- Simply input the number that corresponds to the scientific constant you want to look up and it appears instantly on the display.
- See the Scientific Constant Table for a complete list of available constants.

- **Example:** To determine how much total energy a person weighing 65kg has (E = mc² = ***5.841908662 × 10¹⁸***)

65 [CONST] 28 [x^2] [=]   65Co² 5.841908662 18

28 is the "speed of light in vacuum" constant number.

• Scientific Constant Table

Based on ISO Standard (1992) data and CODATA recommended values (1998).

To select this constant:	Input this scientific constant number:
proton mass (mp)	01
neutron mass (mn)	02
electron mass (me)	03
muon mass (mμ)	04
Bohr radius (a_0)	05
Planck constant (h)	06
nuclear magneton (μN)	07
Bohr magneton (μB)	08
Planck constant, rationalized (ℏ)	09
fine-structure constant (α)	10
classical electron radius (re)	11
Compton wavelength (λc)	12
proton gyromagnetic ratio (γp)	13
proton Compton wavelength (λcp)	14
neutron Compton wavelength (λcn)	15
Rydberg constant (R∞)	16
atomic mass unit (u)	17
proton magnetic moment (μp)	18
electron magnetic moment (μe)	19
neutron magnetic moment (μn)	20
muon magnetic moment (μμ)	21
Faraday constant (F)	22
elementary charge (e)	23
Avogadro constant (NA)	24
Boltzmann constant (k)	25
molar volume of ideal gas (Vm)	26
molar gas constant (R)	27
speed of light in vacuum (C_0)	28
first radiation constant (C_1)	29
second radiation constant (C_2)	30
Stefan-Boltzmann constant (σ)	31
electric constant (ε_0)	32
magnetic constant (μ_0)	33
magnetic flux quantum (ϕ_0)	34
standard acceleration of gravity (g)	35
conductance quantum (G_0)	36
characteristic impedance of vacuum (Z_0)	37
Celsius temperature (t)	38
Newtonian constant of gravitation (G)	39
standard atmosphere (atm)	40

Power Supply

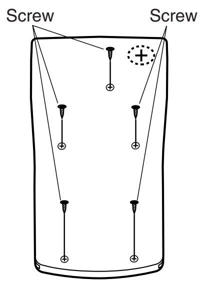
The TWO WAY POWER system actually has two power supplies: a solar cell and a G13 Type (LR44) button battery. Normally, calculators equipped with a solar cell alone can operate only when relatively bright light is present. The TWO WAY POWER system, however, lets you continue to use the calculator as long as there is enough light to read the display.

• Replacing the Battery

Either of the following symptoms indicates battery power is low, and that the battery should be replaced.

- Display figures are dim and difficult to read in areas where there is little light available.
- Nothing appears on the display when you press the [ON] key.

• To replace the battery



① Remove the five screws that hold the back cover in place and then remove the back cover.

② Remove the old battery.

③ Wipe off the sides of new battery with a dry, soft cloth. Load it into the unit with the positive ⊕ side facing up (so you can see it).

④ Replace the back cover and secure it in place with the five screws.

⑤ Press [ON] to turn power on. Be sure not to skip this step.

Auto Power Off

Calculator power automatically turns off if you do not perform any operation for about six minutes. When this happens, press [ON] to turn power back on.

Specifications

Power Supply: Solar cell and a single G13 Type button battery (LR44)

Battery Life: Approximately 3 years (1 hour use per day).

Dimensions: 12.7 (H) × 78 (W) × 154.5 (D) mm
1/2″ (H) × 3 1/16″ (W) × 6 1/16″ (D)

Weight: 105 g (3.7 oz) including battery

Power Consumption: 0.0002 W

Operating Temperature: 0°C to 40°C (32°F to 104°F)