

fx-570MS

fx-991MS

User's Guide 2

(Additional Functions)



CASIO®

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Important!

Please keep your manual and all information handy for future reference.



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See the “fx-95MS/fx-100MS/fx-115MS/fx-570MS/fx-991MS 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 fx-570MS and fx-991MS.

fx-570MS and fx-991MS Modes

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

- Pressing the 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**

Note!

- To return the calculation mode and setup to the initial defaults shown below, press (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 $Y = X^2 + 3X - 12$ 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 $D = 9.8 \text{ m/s}^2$.

(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** **CMPLEX**

- 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:** $9 \div 10 = 0.9$ m (milli)

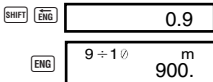
MODE **1**(Disp) **1**

Eng
0.

$9 \div 10 =$

$9 \div 10$ m
900.

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



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) $2 + 3i + 4 + 5i =$

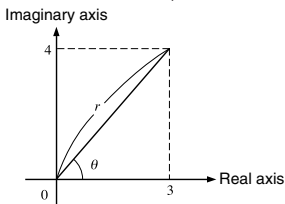
(Imaginary part 8i) **SHIFT** **Re-Im**

■ 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)

$$(r = 5, \theta = 53.13010235^\circ)$$



$$(r = 5)$$

$$\text{SHIFT} \text{Abs} (3 + 4 i) =$$

$$(\theta = 53.13010235^\circ)$$

$$\text{SHIFT} \text{arg} (3 + 4 i) =$$

- 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)

$$\sqrt{} 2 \text{SHIFT} \angle 45 =$$

$$\text{SHIFT} \text{Re--Im}$$

■ Rectangular Form \leftrightarrow 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 $\text{SHIFT} \text{Re--Im}$ to toggle the display between the absolute value (r) and argument (θ).

- **Example:** $1 + i \leftrightarrow 1.414213562 \angle 45$

$$(\text{Angle unit: Deg}) \quad 1 + i \text{SHIFT} \rightarrow r \angle \theta = \text{SHIFT} \text{Re--Im}$$

$$\sqrt{} 2 \text{SHIFT} \angle 45 \text{SHIFT} \rightarrow a+bi = \text{SHIFT} \text{Re--Im}$$

- 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	$1000000000 \leq x \leq 1111111111$
	$0 \leq x \leq 0111111111$
Octal	$4000000000 \leq x \leq 7777777777$
	$0 \leq x \leq 3777777777$
Decimal	$-2147483648 \leq x \leq 2147483647$
Hexadecimal	$80000000 \leq x \leq \text{FFFFFFFF}$
	$0 \leq x \leq 7\text{FFFFFFF}$

- Example 1:** To perform the following calculation and produce a binary result:

$$10111_2 + 11010_2 = 110001_2$$

Binary mode: AC BIN 0. ^b

10111 + 11010 =

- Example 2:** To perform the following calculation and produce an octal result:

$$7654_8 \div 12_{10} = 516_8$$

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:

$$120_{16} \text{ or } 1101_2 = 12d_{16} = 301_{10}$$

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

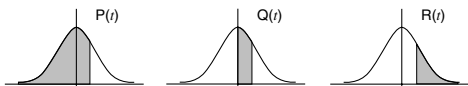
Use the MODE key to enter the SD Mode when you want to perform a calculation involving normal distribution.

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 $\boxed{1}$ to $\boxed{4}$ 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 \boxed{DT} 54 \boxed{DT} 51 \boxed{DT} 55 \boxed{DT}
 53 \boxed{DT} \boxed{DT} 54 \boxed{DT} 52 \boxed{DT}
 53 \boxed{SHIFT} \boxed{DISTR} $\boxed{4}$ ($\rightarrow t$) $\boxed{=}$
 \boxed{SHIFT} \boxed{DISTR} $\boxed{1}$ ($P()$) (\leftarrow) 0.28 $\boxed{}$ $\boxed{=}$

Differential Calculations

COMP

The procedure described below obtains the derivative of a function.

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

COMP \boxed{MODE} $\boxed{1}$

- 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).

\boxed{SHIFT} $\boxed{d/dx}$ expression $\boxed{,}$ a $\boxed{,}$ Δx $\boxed{)}$

- 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)

\boxed{SHIFT} $\boxed{d/dx}$ 3 \boxed{ALPHA} \boxed{X} $\boxed{X^2}$ $\boxed{-}$ 5 \boxed{ALPHA} \boxed{X} $\boxed{+}$ 2 $\boxed{,}$ 2 $\boxed{,}$
 2 \boxed{EXP} $\boxed{(-)}$ 4 $\boxed{)}$ $\boxed{=}$

- 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.

[$\int dx$] expression **[\circ]** a **[\circ]** b **[\circ]** n **[\circ]**

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

[$\int dx$] 2 **[ALPHA]** **[\times]** **[x^2]** **[+]** 3 **[ALPHA]** **[\times]** **[+]**

8 **[\circ]** 1 **[\circ]** 5 **[\circ]** 6 **[\circ]** **[=]**

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.

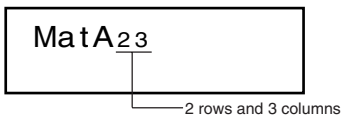
MAT **MODE** **MODE** **MODE** **2**

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.



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

$$\text{Matrix B} = \begin{bmatrix} -1 & 0 & 3 \\ 2 & -4 & 1 \end{bmatrix} \quad \left(\begin{bmatrix} 3 & -8 & 5 \\ -4 & 0 & 12 \\ 12 & -20 & -1 \end{bmatrix} \right)$$

(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 \times MatB) SHIFT MAT 3 (Mat) 1 (A) X

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. $\left(\begin{bmatrix} 6 & -3 \\ -15 & 9 \end{bmatrix} \right)$

(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

$$\text{Matrix A} = \begin{bmatrix} 2 & -1 & 6 \\ 5 & 0 & 1 \\ 3 & 2 & 4 \end{bmatrix} \text{ (Result: 73)}$$

(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 = $\begin{bmatrix} 5 & 7 & 4 \\ 8 & 9 & 3 \end{bmatrix}$
- $$\left(\begin{bmatrix} 5 & 8 \\ 7 & 9 \\ 4 & 3 \end{bmatrix} \right)$$

(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 = $\begin{bmatrix} -3 & 6 & -11 \\ 3 & -4 & 6 \\ 4 & -8 & 13 \end{bmatrix}$

$$\left(\begin{bmatrix} -0.4 & 1 & -0.8 \\ -1.5 & 0.5 & -1.5 \\ -0.8 & 0 & -0.6 \end{bmatrix} \right)$$

(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.

$$\left(\begin{bmatrix} 0.4 & 1 & 0.8 \\ 1.5 & 0.5 & 1.5 \\ 0.8 & 0 & 0.6 \end{bmatrix} \right)$$

(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.

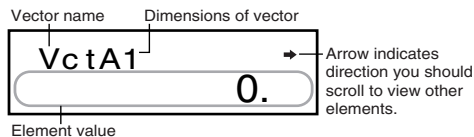
VCT **MODE** **MODE** **MODE** **3**

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.



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) $\boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{3} (\text{Vct}) \boxed{1} (\text{A}) \boxed{\times}$
 $\boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{3} (\text{Vct}) \boxed{2} (\text{B}) \boxed{=}$

- 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) $\boxed{\text{SHIFT}} \boxed{\text{Abs}} \boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{3} (\text{Vct}) \boxed{3} (\text{C}) \boxed{=}$

- **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) $\boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{1} (\text{Dim}) \boxed{1} (\text{A}) \boxed{3} \boxed{=}$

(Element input) $\boxed{(-)} \boxed{1} \boxed{=} \boxed{0} \boxed{=} \boxed{1} \boxed{=} \boxed{\text{AC}}$

(3-dimensional Vector B) $\boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{1} (\text{Dim}) \boxed{2} (\text{B}) \boxed{3} \boxed{=}$

(Element input) $\boxed{1} \boxed{=} \boxed{2} \boxed{=} \boxed{0} \boxed{=} \boxed{\text{AC}}$

(VctA·VctB) $\boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{3} (\text{Vct}) \boxed{1} (\text{A}) \boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{\blacktriangleright} \boxed{1} (\text{Dot})$
 $\boxed{\text{SHIFT}} \boxed{\text{VCT}} \boxed{3} (\text{Vct}) \boxed{2} (\text{B}) \boxed{=}$

(Ans ÷ (AbsVctA × AbsVctB))

\div (SHIFT Abs SHIFT VCT 3 (Vct) 1 (A)
 \times 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) \times

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) \div 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 → m ²	11	kgf/cm ² → Pa	31
m ² → acre	12	Pa → kgf/cm ²	32
gal (US) → ℓ	13	kgf•m → J	33
ℓ → gal (US)	14	J → kgf•m	34
gal (UK) → ℓ	15	lbf/in ² → kPa	35
ℓ → gal (UK)	16	kPa → lbf/in ²	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 ($E = mc^2 = 5.841908662 \times 10^{18}$)

$$65 \text{ [CONST]} 28 \text{ [x}^2\text{]} = \boxed{65\text{Co}^2 \text{ 5.841908662 }^{18}}$$

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 (μ _N)	07
Bohr magneton (μ _B)	08
Planck constant, rationalized (ħ)	09
fine-structure constant (α)	10
classical electron radius (r _e)	11
Compton wavelength (λ _c)	12
proton gyromagnetic ratio (γ _p)	13
proton Compton wavelength (λ _{cp})	14
neutron Compton wavelength (λ _{cn})	15
Rydberg constant (R _∞)	16
atomic mass unit (u)	17
proton magnetic moment (μ _p)	18
electron magnetic moment (μ _e)	19
neutron magnetic moment (μ _n)	20
muon magnetic moment (μ _μ)	21
Faraday constant (F)	22
elementary charge (e)	23
Avogadro constant (N _A)	24
Boltzmann constant (k)	25

To select this constant:	Input this scientific constant number:
molar volume of ideal gas (V_m)	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 type of battery you should use depends on the model number of your calculator.

fx-991MS

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.

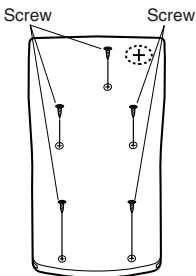
• Replacing the Battery

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.

fx-570MS

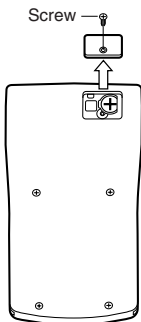
This calculator is powered by single G13 Type (LR44) button battery.

• Replacing the Battery

Dim figures on the display of the calculator indicate that battery power is low. Continued use of the calculator when the battery is low can result in improper operation. Replace the battery as soon as possible when display figures become dim.

• To replace the battery

- ① Press **SHIFT OFF** to turn off power.
- ② Remove the screw that holds the battery cover in place and then remove the battery cover.
- ③ Remove the old battery.
- ④ 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).



- ⑤ Replace the battery cover and secure it in place with the screw.
- ⑥ Press **ON** to turn power on.

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:

fx-570MS: Single G13 Type button battery (LR44)

fx-991MS: Solar cell and a single G13 Type button battery (LR44)

Battery Life:

fx-570MS: Approximately 9,000 hours continuous display of flashing cursor.

Approximately 3 years when left with power turned off.

fx-991MS: 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)

CASIO®

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