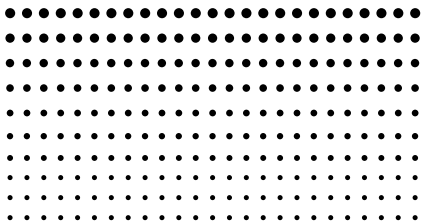


fx-115WA

fx-991WA

User's Guide



Removing and Replacing the Calculator's Cover

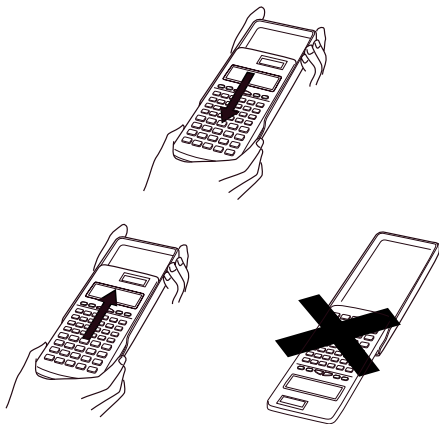
- **To Remove the cover**

Grasp the top of the cover, and slide the unit out from the bottom.

- **To Replace the cover**

Grasp the top of the cover, and slide the unit in from the bottom.

Always slide the unit into the cover with the unit's display end first. Never slide the keyboard end of the unit into the cover.



CASIO ELECTRONICS CO., LTD.
Unit 6, 1000 North Circular Road,
London NW2 7JD, U.K.

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 batteries from the calculator, put them in a safe place where there is no danger of them getting 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 acid that can cause damage to nearby items and creates the possibility of fire and personal injury.
 - Always make sure that a battery's positive \oplus and negative \ominus sides are facing correctly when you load it into the calculator.
 - Remove the batteries if you do not plan to use the calculator for a long time.
 - Use only the type of batteries 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 danger 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.
- In no event shall CASIO Computer Co., Ltd. be liable to anyone for special, collateral, incidental, or consequential damages in connection with or arising out of the purchase or use of these materials. Moreover, CASIO Computer Co., Ltd. shall not be liable for any claim of any kind whatsoever against the use of these materials by any other party.

Handling Precautions

- **Be sure to press the **ON/CLEAR** 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.**
Dead battery can leak, causing damage to and malfunction of the calculator. Never leave the 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 become 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 elements 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 ball-point pen or other pointed object.**

- **Use a soft, dry cloth to clean the exterior of the unit.**

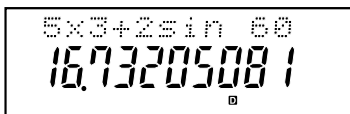
If the calculator becomes very dirty, wipe it off with a cloth moistened in a weak solution of water and a mild neutral household detergent. Wring out all excess moisture before wiping the calculator. Never use thinner, benzine or other volatile agents to clean the calculator. Doing so can remove printed markings and damage the case.

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Two-line Display



You can simultaneously check the calculation formula and its answer.

The first line displays the calculation formula.

The second line displays the answer.

Key Layout

<fx-991WA>

Page	11	8 REPLAY		2		
	SHIFT	ALPHA		MODE	ON/CLEAR	
Page	15 27	24	17	15		
	$x!$ LOGIC	CONV	Rec1	x^y		
Page	15	25	17	14	14	
Page	17 23	11	28	14 27	14 27	
	\leftarrow i	d/c	DEC	10^x BIN	e^x OCT	
Page	16	11	14	14	14	
Page	10	28 10	10	13 10	13 10	
	A	\leftarrow B	C	\sin^{-1} D	\cos^{-1} E	\tan^{-1} F
Page	10	28	13	13	13	
Page	19	23	20 23	23 10	19 10	10 10
	\leftarrow DISTR	\leftarrow Re \rightarrow Im	\leftarrow r \rightarrow arg	\leftarrow Abs \rightarrow X	\leftarrow Y	\leftarrow M \rightarrow M
Page	10	10	10	10	19- \leftarrow DT \rightarrow CL \rightarrow -19	
Page	20 16	20 16	20 16	8	10 18	
	A M	B G	C T	INS	Mcl \leftarrow Scl	
Page	20 16	20 16	20 16	18	18	
	\leftarrow \bar{y} μ	\leftarrow \bar{y} σ m	\leftarrow \bar{y} σ k	nPr	nCr	
Page	18 16	18 16	18 16	20	20	
	\leftarrow \bar{x} f	\leftarrow \bar{x} ρ	\leftarrow \bar{x} ρ	\leftarrow \bar{x}	\leftarrow \bar{y}	
Page	15	15	15	14	12	
	Rnd	Ran#	π	DRG \rightarrow	%	
Page			10	9		

fx-115WA: \leftarrow CONV \rightarrow \leftarrow nCr \rightarrow \leftarrow nPr \rightarrow \leftarrow \rightarrow \leftarrow nCr \rightarrow \leftarrow \rightarrow \leftarrow

Before Starting Calculations...

■ Modes

Application	Mode Name	Mode Indicator
Calculation Modes		
Normal calculations	COMP	—
Complex number calculations	CMPLX	CMPLX
Standard deviation calculations	SD	SD
Regression calculations	REG	REG
Base- <i>n</i> calculations	BASE-N	b (binary) o (octal) d (decimal) H (hexadecimal)
Angle Unit Modes		
Degrees	DEG	D
Radians	RAD	R
Grads	GRA	G
Display Modes		
Exponential notation (Canceling FIX and SCI specification)	NORM1 NORM2	— —
Number of decimal place specification	FIX	Fix
Number of significant digit specification	SCI	Sci
Exponential display range specifications	ENG	ENG

Note!












- Mode indicators appear in the lower part of the display, except for the Base-*n* indicators which appear in the exponent part of the display.
- The ENG mode cannot be selected while the calculator is in the CMPLX or BASE-N mode.

- You cannot set the angle unit or the display mode while the calculator is in the BASE-N mode.
- The COMP, CMPLX, SD, and REG modes can be used in combination with the angle unit modes.
- Be sure to check the current calculation mode (SD, REG, COMP, CMPLX) and angle unit mode (DEG, RAD, GRA) before beginning a calculation.





■ Input Capacity

- The memory area used for calculation input can hold 79 “steps.” Whenever you input the 73rd step of any calculation, the cursor changes from “_” to “■” to let you know memory is running low. If you still need to input more, you should divide your calculation into two or more parts.

■ Making Corrections During Input

- Use  and  to move the cursor to the location you want.
- Press  to delete the number or function at the current cursor position.
- Press   to change to an insert cursor . Inputting something while the insert cursor is on the display inserts the input at the insert cursor position.
- Press , ,  , or  returns to the normal cursor from the insert cursor.

■ Replay Function

- Pressing  or  recalls the last calculation you performed. You can then make any changes you want in the calculation and re-execute it.
- Pressing  does not clear Replay memory, so you can recall the last calculation even after you press .
- Replay memory is cleared whenever you start a new calculation, change to another mode, or turn off power.

■ Error Locator

- Pressing \blacktriangleright or \blacktriangleleft after an error occurs displays the calculation with the cursor positioned at the location where the error occurred.

■ 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. Press MODE MODE MODE MODE $\boxed{3}$ $\boxed{1}$ (or $\boxed{2}$) to select NORM 1 or 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.

■ Answer Memory

- Whenever you press = after inputting values or an expression, the calculated result is automatically stored in Answer Memory. 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 changed if the operation performed by any of the above key operations results in an error.

Basic Calculations

- Use the COMP mode for basic calculations.

- **Example 1:** $3 \times (5 \times 10^{-9})$

$$3 \times (5 \text{ EXP } (-) 9) = 1.5^{-08}$$

- **Example 2:** $5 \times (9 + 7)$

$$5 \times (9 + 7) = 80.$$

- You can skip all $()$ operations before $=$.

Memory Calculations

■ 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 $0 \text{ STO } M$.

- **Example:**

$23 + 9 = 32$	$23 + 9 \text{ STO } M$	$32.$
$53 - 6 = 47$	$53 - 6 \text{ M}+$	$47.$
$-) 45 \times 2 = 90$	$45 \times 2 \text{ SHIFT M-}$	$90.$
<hr/> $(\text{Total}) -11$	$\text{RCL } M$	$-11.$

■ 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 all nine variables: $\text{SHIFT MCl } =$.
- Use the following operation to delete data assigned to a particular variable: $0 \text{ STO } A$. This operation deletes the data assigned to variable A.

- **Example:** $193.2 \div 23 = 8.4$

$$193.2 \div 28 = 6.9$$

$$193.2 \text{ (STO) (A) } \div 23 \text{ (M) } = \boxed{8.4}$$

$$\text{(ALPHA) (A) } \div 28 \text{ (M) } = \boxed{6.9}$$

Fraction Calculations

■ Fraction Calculations

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

- **Example 1:** $\frac{2}{3} + 1\frac{4}{5}$

$$2 \text{ (a/b)} 3 \text{ (+)} 1 \text{ (a/b)} 4 \text{ (a/b)} 5 \text{ (M) } = \boxed{2\text{ }7\text{ }15.}$$

- **Example 2:** $\frac{1}{2} + 1.6$

$$1 \text{ (a/b)} 2 \text{ (+)} 1.6 \text{ (M) } = \boxed{2.1}$$

- Fraction/decimal calculation results are always decimal.

■ Decimal-to-Fraction Conversion

- **Example:** $2.75 \rightarrow 2\frac{3}{4}$

$$2.75 \text{ (M) } = \boxed{2.75}$$

$$\text{(a/b)} = \boxed{2\text{ }3\text{ }4.}$$

$$\text{(SHIFT) (d/c)} = \boxed{11\text{ }4.}$$

■ Fraction-to-Decimal Conversion

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

$$1 \text{ (a/b)} 2 \text{ (M) } = \boxed{1\text{ }2.}$$

$$a \frac{b}{c} \quad \boxed{0.5}$$

$$a \frac{b}{c} \quad \boxed{1 \div 2}$$

Percentage Calculations

- Use the COMP mode for percentage calculations.

- **Example 1:** To calculate 12% of 1500

$$1500 \times 12 \text{ [SHIFT] [%]} \quad \boxed{180.}$$

- **Example 2:** To calculate what percentage of 880 is 660

$$660 \div 880 \text{ [SHIFT] [%]} \quad \boxed{75.}$$

- **Example 3:** To add 15% onto 2500

$$2500 \times 15 \text{ [SHIFT] [%] [+]} \quad \boxed{2875.}$$

- **Example 4:** To discount 3500 by 25%

$$3500 \times 25 \text{ [SHIFT] [%] [-]} \quad \boxed{2625.}$$

- **Example 5:** If 300 grams are added to a test sample originally weighing 500 grams, what is the percentage increase in weight?

$$\frac{300 + 500}{500} \times 100 = 160 (\%)$$

$$300 \text{ [+]} 500 \text{ [SHIFT] [%]} \quad \boxed{160.}$$

- **Example 6:** If temperature changes from 40°C to 46°C, what percentage did it rise?

$$\frac{46 - 40}{40} \times 100 = 15 (\%)$$

$$46 \text{ [-]} 40 \text{ [SHIFT] [%]} \quad \boxed{15.}$$

Scientific Function Calculations

- Use the COMP mode for scientific function calculations.
- $\pi = 3.14159265359$

■ Trigonometric/Inverse Trigonometric Functions

- **Example 1:** $\sin 63^\circ 52' 41''$

MODE **MODE** **MODE** **1** → “**D**”

sin **63** **°** **52** **'** **41** **"** **=** 0.897859012
D

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

MODE **MODE** **MODE** **2** → “**R**”

cos **(** **SHIFT** **π** **÷** **3** **)** **=** 0.5
R

- **Example 3:** $\cos^{-1} \frac{\sqrt{2}}{2} = \frac{\pi}{4} \text{ rad}$

MODE **MODE** **MODE** **2** → “**R**”

SHIFT **cos⁻¹** **(** **√** **2** **÷** **2** **)** **=** 0.785398163
R

Ans **÷** **SHIFT** **π** **=** 0.25

- **Example 4:** $\tan^{-1} 0.741$

MODE **MODE** **MODE** **1** → “**D**”

SHIFT **tan⁻¹** **0.741** **=** 36.53844577
D

■ Hyperbolic/Inverse Hyperbolic Functions

- **Example 1:** $\sinh 3.6$

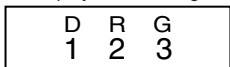
hyp **sin** **3.6** **=** 18.28545536

- **Example 2:** $\sinh^{-1} 30$

hyp **SHIFT** **sin⁻¹** **30** **=** 4.094622224

■ Angle Unit Conversion

- Press **SHIFT** **DRG** to display the following menu.



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

MODE **MODE** **MODE** **1** → “D”

4.25 **SHIFT** **DRG** **2** (R) **=**

4.25 ^r
243.5070629

■ Common and Natural Logarithms/ Antilogarithms

- **Example 1** : $\log 1.23$ **log** 1.23 **=**

0.089905111

- **Example 2** : $\ln 90$ ($=\log_e 90$)

ln 90 **=**

4.49980967

- **Example 3** : e^{10} **SHIFT** **e^x** 10 **=**

22026.46579

- **Example 4** : $10^{1.5}$ **SHIFT** **10^x** 1.5 **=**

31.6227766

- **Example 5** : 2^4 2 **(x^y)** 4 **=**

16.

■ Square Roots, Cube Roots, Roots, Squares, Cubes, Reciprocals, Factorials, Random Numbers and π

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

√ 2 **+** **√** 3 **×** **√** 5 **=**

5.287196909

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

∛ 5 **+** **∛** (-) 27 **=**

-1.290024053

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

• **Example 4:** $123 + 30^2$
 123 **[+]** 30 **[x^2]** **[=]** 1023.

• **Example 5:** 12^3 12 **[x^3]** **[=]** 1728.

• **Example 6:** $\frac{1}{\frac{1}{3} - \frac{1}{4}}$
[$($] 3 **[x^{-1}]** **[$-$]** 4 **[x^{-1}]** **[$)$]** **[x^{-1}]** **[=]** 12.

• **Example 7:** $8!$ 8 **[SHIFT]** **[$x!$]** **[=]** 40320.

• **Example 8:** To generate a random number between 0.000 and 0.999

[SHIFT] **[Ran#]** **[=]** 0.664

Example (results differ each time)

• **Example 9:** 3π 3 **[SHIFT]** **[π]** **[=]** 9.424777961

■ FIX, SCI, RND

• **Example 1:** $200 \div 7 \times 14 = 400$
 200 **[\div]** 7 **[\times]** 14 **[=]** 400.

(Specifies three decimal places.) **[MODE]** **[MODE]** **[MODE]** **[MODE]** **[1]** **[3]** 400.000
Fix

(Calculation continues using 10 display digits) 200 **[\div]** 7 **[=]** 28.571

[\times] 14 **[=]** 400.000

Performing the same calculation using the specified number of decimal places

200 **[\div]** 7 **[=]** 28.571

(Internal rounding) **[SHIFT]** **[Rnd]** 28.571

x 14 **=** 399.994

- Press **MODE** **MODE** **MODE** **MODE** **3** **1** to clear FIX specification.
- **Example 2:** $1 \div 3$, displaying result with two significant digits (SCI 2)

MODE **MODE** **MODE** **MODE** **2** **2** 1 **÷** 3 **=** 3.3⁻⁰¹
Sci

- Press **MODE** **MODE** **MODE** **MODE** **3** **1** to clear SCI specification.

■ ENG Calculations

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

56088 **=** **ENG** 56.088⁰³

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

0.08125 **=** **ENG** 81.25⁻⁰³

■ Inputting ENG Calculation Symbols

- **MODE** **MODE** **MODE** **MODE** **MODE** **1** enters the ENG mode in which ENG symbols can be used in calculations.
- To exit the ENG mode, press **MODE** **MODE** **MODE** **MODE** **MODE** **2**.
- The following are the nine ENG symbols that can be used in ENG mode calculations.

Key Operation	Unit	Symbol
SHIFT k	10^3	k (kilo)
SHIFT M	10^6	M (Mega)
SHIFT G	10^9	G (Giga)
SHIFT T	10^{12}	T (Tera)
SHIFT m	10^{-3}	m (milli)
SHIFT μ	10^{-6}	μ (micro)
SHIFT n	10^{-9}	n (nano)
SHIFT p	10^{-12}	p (pico)
SHIFT f	10^{-15}	f (femto)

- * For displayed values, the calculator selects the ENG symbol that makes the numeric part of the value fall within the range of 1 to 1000.
- * ENG symbols cannot be used when inputting fractions.
- * The ENG mode cannot be used in combination with the CMPLX, or BASE-N modes.
- Performing any of the key operations in the above table while you are not in the ENG mode inputs the exponential value in the “Unit” column (without inputting the ENG symbol).
- **Example:** $9 \div 10 = 0.9$ m (milli)

MODE MODE MODE MODE MODE 1

0. ENG

9 \div 10 =

$9 \div 10$ m 900.

In the ENG mode, even standard (non-ENG) calculation results are displayed using ENG symbols.

SHIFT ENG

0.9

ENG

$9 \div 10$ m 900.

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

- Calculation results are automatically assigned to variables E and F.
- **Example 1:** To convert polar coordinates ($r=2, \theta=60^\circ$) to rectangular coordinates (x, y) (DEG mode)

x SHIFT RCL 2 , 60) =

1. D

y RCL F

1.732050808

- RCL E, RCL F swaps displayed value with value in memory.
- **Example 2:** To convert rectangular coordinates ($1, \sqrt{3}$) to polar coordinates (r, θ) (RAD mode)

r Pol 1 , $\sqrt{\quad}$ 3) =

2. R

θ

RCL	F	1.047197551
-----	---	-------------

- **RCL** **E**, **RCL** **F** swaps displayed value with value in memory.

■ Permutation

- **Example:** 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).

7	SHIFT	nPr	4	=	840.
---	-------	-----	---	---	------

■ Combination

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

fx-115WA	10	nCr	4	=	210.
fx-991WA	10	SHIFT	nCr	4	=

Statistical Calculations

■ Standard Deviation (SD Mode)

- Press **MODE** **MODE** **1** to enter the SD Mode for statistical calculations using standard deviation.
- Data input always starts with **SHIFT** **ScI** **=** to clear statistical memory.
- 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.

RCL	A	Σx^2
RCL	B	Σx
RCL	C	n
SHIFT	\bar{x}	\bar{x}
SHIFT	σ_n	σ_n
SHIFT	σ_{n-1}	σ_{n-1}

- 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

Enter SD Mode **MODE** **MODE** **1**

SHIFT **Sci** **=** (Memory Clear)

55 **DT** 54 **DT** 51 **DT** 55 **DT**

53 **DT** **DT** 54 **DT** 52 **DT**

SD 52.

(Sample Standard Deviation σ_{n-1}) **SHIFT** **X σ n-1** **=** 1.407885953

(Population Standard Deviation σ_n) **SHIFT** **X σ n** **=** 1.316956719

(Arithmetic Mean \bar{x}) **SHIFT** **\bar{x}** **=** 53.375

(Number of Data n) **RCL** **C** 8.

(Sum of Values Σx) **RCL** **B** 427.

(Sum of Squares of Values Σx^2) **RCL** **A** 22805.

Data Input Precautions

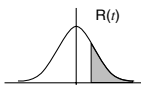
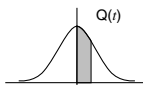
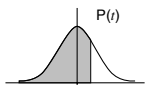
- DT DT** inputs the same data twice.
- You can also input multiple entries of the same data using **SHIFT** **;**. To input the data 110 ten times, for example, press 110 **SHIFT** **;** 10 **DT**.
- The above results can be obtained in any order, and not necessarily that shown above.
- To delete data you have just input, press **SHIFT** **CL**.

Probability Distribution Calculations

- Press **SHIFT** **DISTR** to produce the screen shown below.

P(1 Q(2 R(3 →t 4

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



- **Example** : Using the x -data values input in the example on page 20, determine the normalized variate ($\rightarrow t$) for $x = 53$ and normal probability distribution $P(t)$.

$$53 \text{ [SHIFT] [DISTR] [4] } (\rightarrow t) = \boxed{-0.284747398}$$

$$\text{[SHIFT] [DISTR] [1] } (P()) - 0.28 \text{ [)] } = \boxed{0.38974}$$

■ Regression Calculations (REG Mode)

- Press **[MODE] [MODE] [2]** to enter the REG mode and then select one of the following regression types.
 - [1]** : Linear regression
 - [2]** : Logarithmic regression
 - [3]** : Exponential regression
 - [▶] [1]** : Power regression
 - [▶] [2]** : Inverse regression
 - [▶] [3]** : Quadratic regression
- Data input always starts with **[SHIFT] [Sci] [=]** to clear statistical memory.
- 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.

[RCL] [A]	Σx^2	[SHIFT] [Xσ_{n-1}]	$x\sigma_{n-1}$
[RCL] [B]	Σx	[SHIFT] [\bar{y}]	\bar{y}
[RCL] [C]	n	[SHIFT] [yσ_n]	$y\sigma_n$
[RCL] [D]	Σy^2	[SHIFT] [yσ_{n-1}]	$y\sigma_{n-1}$
[RCL] [E]	Σy	[SHIFT] [A]	Regression coefficient A
[RCL] [F]	Σxy	[SHIFT] [B]	Regression coefficient B
[RCL] [M]	Σx^3	[SHIFT] [C]	Regression coefficient C
[RCL] [X]	$\Sigma x^2 y$	[SHIFT] [r]	Correlation coefficient r
[RCL] [Y]	Σx^4	[SHIFT] [\hat{x}]	\hat{x}
[SHIFT] [\bar{x}]	\bar{x}	[SHIFT] [\hat{y}]	\hat{y}
[SHIFT] [Xσ_n]	$x\sigma_n$		

• 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.

Enter REG Mode (Linear Regression)

MODE MODE 2 1

SHIFT Scl = (Memory Clear)

10 , 1003 DT 15 , 1005 DT

20 , 1010 DT 25 , 1011 DT

30 , 1014 DT

30. REG

(Regression Coefficient A)

SHIFT A =

997.4

(Regression Coefficient B)

SHIFT B =

0.56

(Correlation Coefficient r)

SHIFT r =

0.982607368

(Atmospheric Pressure at 18°C)

18 SHIFT ŷ

1007.48

(Temperature at 1000 hPa)

1000 SHIFT x̂

4.642857143

• **Quadratic Regression**

- The regression formula for quadratic regression is:

$$y = A + Bx + Cx^2.$$

- Input data using the following key sequence.

<x-data> , <y-data> DT

• **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 and correlation coefficient 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 $y_i = 20$.

Enter REG mode (Quadratic regression)

MODE MODE 2 ▶ 3
SHIFT Scl =

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

118.
REG

(Regression Coefficient A)

SHIFT A = -35.59856934

(Regression Coefficient B)

SHIFT B = 1.495939413

(Regression Coefficient C)

SHIFT C = -6.71629667⁻⁰³

(\hat{y} when $x_i = 16$)

16 SHIFT \hat{y} = -13.38291067

(\hat{x}_1 when $y_i = 20$)

20 SHIFT \hat{x} = 47.14556728

(\hat{x}_2 when $y_i = 20$)

SHIFT \hat{x} = 175.5872105

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.
- To delete data you have just input, press SHIFT CL.

Complex Number Calculations (CMPLX Mode)

- Press MODE 2 to enter the CMPLX Mode for calculations that include complex numbers.
- You can use variables A, B, C and M only. Variables D, E, F, X, and Y are used for storage of the imaginary parts of values and so cannot be used by you.

- **Example:** $(2 + 3i) + (4 + 5i)$

Enter CMPLX Mode **MODE** **2**

(**2** **+** **3** **i** **)** **+**

(**4** **+** **5** **i** **)** **=**

6.

Real number part

SHIFT **Re-Im**

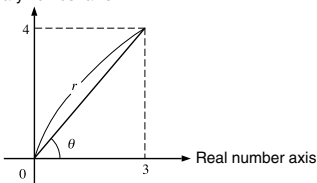
8.i

Imaginary number part

■ Absolute Value/Argument Calculation

- The procedure described below can be used to determine the absolute value (Abs) and argument (arg) for a complex number of the format $Z = a + bi$, which is presumed to exist as coordinates on a Gaussian plane.
- **Example:** To obtain the absolute value (r) and argument (θ) for the complex number $3 + 4i$, when DEG is set for the angle unit mode

Imaginary number axis



Determine the absolute value.

SHIFT **Abs** **(** **3** **+** **4** **i** **)** **=**

5.
CMPLX

Determine the argument.



SHIFT **arg** **(** **3** **+** **4** **i** **)** **=**

53.13010235

Metric Conversions (fx-991WA)

- 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 shown below for a complete list of available conversion pairs.
- **Example:** To convert 31 inches to centimeters

31   CONV ___

01 CONV 01

01 is the inches-to-centimeters conversion pair number.

31 in → cm _ 0.

 31 in → cm
78.74

• Conversion Pair Table

Based on ISO Standard (1992) data and CODATA Bulletin 63 (1986) data.

Number	Conversion Pair	Number	Conversion Pair
01	in → cm	21	oz → g
02	cm → in	22	g → oz
03	ft → m	23	lb → kg
04	m → ft	24	kg → lb
05	yd → m	25	atm → Pa
06	m → yd	26	Pa → atm
07	mile → km	27	mmHg → Pa
08	km → mile	28	Pa → mmHg
09	n mile → m	29	hp → kW
10	m → n mile	30	kW → hp
11	acre → m ²	31	kgf/cm ² → Pa
12	m ² → acre	32	Pa → kgf/cm ²
13	gal (US) → ℓ	33	kgf•m → J
14	ℓ → gal (US)	34	J → kgf•m
15	gal (UK) → ℓ	35	lbf/in ² → kPa
16	ℓ → gal (UK)	36	kPa → lbf/in ²
17	pc → km	37	°F → °C
18	km → pc	38	°C → °F
19	km/h → m/s	39	J → cal
20	m/s → km/h	40	cal → J

Scientific Constants (fx-991WA)

- 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 shown below for a complete list of available constants.
- **Example:** To determine how much total energy a person weighing 65kg has ($E = mc^2$)

65 CONST CONST---

28 CONST28

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

65Co_ 0.

x^2 65Co²_ 0.

= 65Co²
5.841908662¹⁸

• Scientific Constant Table

Based on ISO Standard (1992) data and CODATA Bulletin 63 (1986) data.

Number	Constant Name	Symbol
01	proton mass	mp
02	neutron mass	mn
03	electron mass	me
04	muon mass	$m\mu$
05	Bohr radius	a_0
06	Planck's constant	h
07	nuclear magneton	μN
08	Bohr magneton	μB
09	Planck's constant, rationalized (h-bar)	\hbar

Number	Constant Name	Symbol
10	fine-structure constant	α
11	classical electron radius	r_e
12	electron Compton wavelength	λ_c
13	proton gyromagnetic ratio	γ_p
14	proton Compton wavelength	λ_{cp}
15	neutron Compton wavelength	λ_{cn}
16	Rydberg constant	R_∞
17	atomic mass unit	u
18	proton magnetic moment	μ_p
19	electron magnetic moment	μ_e
20	neutron magnetic moment	μ_n
21	muon magnetic moment	μ_μ
22	Faraday constant	F
23	elementary charge	e
24	Avogadro constant	N_A
25	Boltzmann constant	k
26	molar volume of ideal gas	V_m
27	molar gas constant	R
28	speed of light in vacuum	C_0
29	first radiation constant	C_1
30	second radiation constant	C_2
31	Stefan-Boltzmann constant	σ
32	permittivity of vacuum	ϵ_0
33	permeability of vacuum	μ_0
34	magnetic flux quantum	ϕ_0
35	standard acceleration of gravity	g
36	astronomical unit	AU
37	parsec	pc
38	Celsius temperature	t
39	Newtonian constant of gravitation	G
40	standard atmosphere	atm

Base-*n* Calculations

- 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 you input.

- 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 logical sum), xnor (exclusive logical sum negation), Not (negation), and Neg (minus).
- The following are the allowable ranges for each of the available number systems.

Binary	$100000000 \leq x \leq 111111111$
	$0 \leq x \leq 011111111$
Octal	$400000000 \leq x \leq 777777777$
	$0 \leq x \leq 377777777$
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:

$$10111_2 + 11010_2$$

Binary mode

MODE MODE 3 BIN 0. b

10111₂ + 11010₂ 0. b

= 110001. b

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

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

Octal mode

MODE MODE 3 OCT 0. o

LOGIC LOGIC LOGIC 4 (o) 7654₈ ÷

LOGIC LOGIC LOGIC 1 (d) 12₁₀ 0. o

= 516. o

- **Example 3:** To perform the following calculation and produce a hexadecimal result:

120_{16} or 1101_2

Hexadecimal mode

120_{16} (or)

(b) 1101_2

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

2.258

- **Example 2:** To perform the following calculation:

$12^{\circ}34'56'' \times 3.45$

12 34 56 3.45

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. (COMP mode)
2. (DEG mode)
3. (NORM 1 mode)
4. Check the formula you are working with to confirm it is correct.

5. Enter the correct modes to perform the calculation and try again.

If the above steps do not correct the problem, press the **ON/CLEAR** 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” on page 9 for details.

Ma ERROR

• **Cause**

- Calculation result is outside the allowable calculation range.
- Attempt to perform a function calculation using a value that exceeds the allowable input range.
- 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.

Stk ERROR

• **Cause**

- 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.

Syn ERROR

• **Cause**

- Attempt to perform an illegal mathematical operation.

- **Action**

- Press \blacktriangleleft or \blacktriangleright to display the calculation with the cursor located at the location of the error. Make necessary corrections.

Arg ERROR

- **Cause**

- Improper use of argument

- **Action**

- Press \blacktriangleleft or \blacktriangleright 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)
 - ② Type A functions:
With these functions, the value is entered and then the function key is pressed.
 $x^2, x^{-1}, x!, \circ, \prime, \prime\prime$
 - ③ Powers and roots: $x^y, x\sqrt{\quad}$
 - ④ $a^{b/c}$
 - ⑤ Abbreviated multiplication format in front of π , memory name, or variable name: $2\pi, 5A, \pi A$ etc.
 - ⑥ Type B functions:
With these functions, the function key is pressed and then the value is entered.
 $\sqrt{\quad}, \sqrt[3]{\quad}, \log, \ln, e^x, 10^x, \sin, \cos, \tan, \sin^{-1}, \cos^{-1}, \tan^{-1}, \sinh, \cosh, \tanh, \sinh^{-1}, \cosh^{-1}, \tanh^{-1}, (-)$
 - ⑦ Abbreviated multiplication format in front of Type B functions: $2\sqrt{3}, A\log 2$ etc.
 - ⑧ Permutation and combination: nPr, nCr
 - ⑨ \times, \div
 - ⑩ $+, -$
- * Operations of the same precedence are performed from right to left. $e^x \ln \sqrt{\quad} 120 \rightarrow e^x \{\ln(\sqrt{\quad} 120)\}$
Other operations are performed from left to right.
 - * Operations enclosed in parentheses are performed first.

■ 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 (Stk ERROR) occurs whenever you try to perform a calculation that is so complex that the capacity of a stack is exceeded.

■ 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.

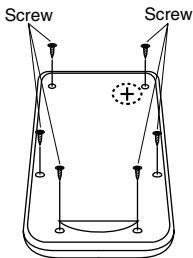
• Replacing the Battery

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/CLEAR** key.

• To replace the battery

- ① Remove the six 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 six screws.



- ⑤ Press **ON/CLEAR** 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/CLEAR** to turn power back on.

■ Input Ranges

Internal digits: 12

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

Functions	Input Range	
$\sin x$	DEG	$0 \leq x \leq 4.499999999 \times 10^{10}$
	RAD	$0 \leq x \leq 785398163.3$
	GRA	$0 \leq x \leq 4.499999999 \times 10^{10}$
$\cos x$	DEG	$0 \leq x \leq 4.500000008 \times 10^{10}$
	RAD	$0 \leq x \leq 785398164.9$
	GRA	$0 \leq x \leq 5.000000009 \times 10^{10}$
$\tan x$	DEG	Same as $\sin x$, except when $ x = (2n-1) \times 90$.
	RAD	Same as $\sin x$, except when $ x = (2n-1) \times \pi/2$.
	GRA	Same as $\sin x$, except when $ x = (2n-1) \times 100$.
$\sin^{-1}x$	$0 \leq x \leq 1$	
$\cos^{-1}x$		
$\tan^{-1}x$	$0 \leq x \leq 9.999999999 \times 10^{99}$	
$\sinh x$	$0 \leq x \leq 230.2585092$	
$\cosh x$		
$\sinh^{-1}x$	$0 \leq x \leq 4.999999999 \times 10^{99}$	
$\cosh^{-1}x$		
$\tanh x$	$0 \leq x \leq 9.999999999 \times 10^{-1}$	
$\tanh^{-1}x$		
$\log x / \ln x$	$0 < x$	
10^x	$-9.999999999 \times 10^{99} \leq x \leq 99.99999999$	
e^x	$-9.999999999 \times 10^{99} \leq x \leq 230.2585092$	
\sqrt{x}	$0 \leq x < 1 \times 10^{100}$	
x^2	$ x < 1 \times 10^{50}$	
$1/x$	$ x < 1 \times 10^{100}; x \neq 0$	
$\sqrt[3]{x}$	$ x < 1 \times 10^{100}$	
$x!$	$0 \leq x \leq 69$ (x is an integer)	

Functions	Input Range
nPr	$0 \leq n \leq 99, r \leq n$ (n, r is an integer) $1 \leq \{n!/(n-r)!\} \leq 9.999999999 \times 10^{99}$
nCr	$0 \leq n \leq 99, r \leq n$ (n, r is an integer)
$\text{Pol}(x, y)$	$ x , y \leq 9.999999999 \times 10^{49}$ $(x^2+y^2) \leq 9.999999999 \times 10^{99}$
$\text{Rec}(r, \theta)$	$0 \leq r \leq 9.999999999 \times 10^{99}$ θ : Same as $\sin x, \cos x$
° ' " ← ° ' "	$ a , b, c < 1 \times 10^{100}$ $0 \leq b, c$
	$ x < 1 \times 10^{100}$ Decimal \leftrightarrow Sexagesimal Conversions $0^{\circ}0'0'' \leq x \leq 999999^{\circ}59'$
x^y	$x > 0$: $-1 \times 10^{100} < y \log x < 100$ $x = 0$: $y > 0$ $x < 0$: $y = n, \frac{1}{2n+1}$ (n is an integer) However: $-1 \times 10^{100} < y \log x < 100$
${}^x\sqrt{y}$	$y > 0$: $x \neq 0$ $-1 \times 10^{100} < 1/x \log y < 100$ $y = 0$: $x > 0$ $y < 0$: $x = 2n+1, \frac{1}{n}$ ($n \neq 0$; n is an integer) However: $-1 \times 10^{100} < 1/x \log y < 100$
a^b/c	Total of integer, numerator, and denominator must be 10 digits or less (including division marks).
SD (REG)	$ x < 1 \times 10^{50}$ $ y < 1 \times 10^{50}$ $ n < 1 \times 10^{100}$ $x\sigma n, y\sigma n, \bar{x}, \bar{y}$ $A, B, r : n \neq 0$ $x\sigma n-1, y\sigma n-1 : n \neq 0, 1$

* Errors are cumulative with such internal continuous calculations as x^y , ${}^x\sqrt{\quad}$, $x!$, and $\sqrt[3]{x}$, so accuracy may be adversely affected.

Specifications

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

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

Dimensions: 10(H)×76(W)×150(D) mm
3/8"(H)×3"(W)×57/8"(D)

Weight: 85 g (3oz) including battery

Power Consumption: 0.0001W

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

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