SHARP

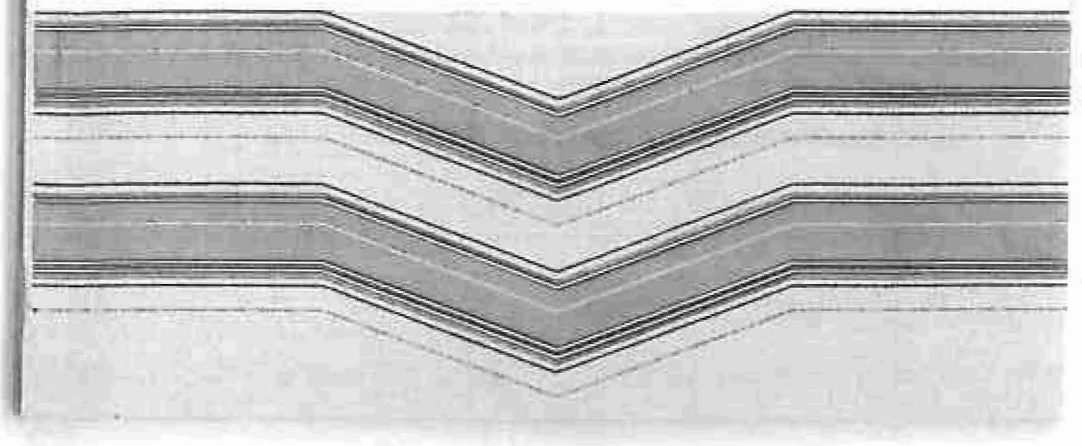
SHARP COMPET

ELSI MATE

ELECTRONIC CALCULATOR

MODEL EL-5001

INSTRUCTION MANUAL



SHARP

SHARP ELECTRONICS CORPORATION

CORPORATE HEADQUARTERS AND EXECUTIVE OFFICES
10 Keystone Place Paramus, New Jersey 07652. Phone: (201) 265-5600

REGIONAL SALES OFFICES AND DISTRIBUTION CENTERS:
Eastern: 10 Keystone Place Paramus, New Jersey 07652. Phone: (201) 265-5600
Midwest: 430 East Plainfield Road, Country Side, La Grange, Illinois 60525. Phone: (312) 242-0670
Western: 21560 Wilmington Avenue, Long Beach, California 90810. Phone: (213) 830-4470, 71, 78

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FOR YOUR RECORDS . . . .

For your assistance in reporting this electronic calculator in case of loss or theft, please record below the model number and serial number which are located on the bottom of the unit.
Please retain this information.

Model Number _____ Serial Number _____

Date of Purchase _____ Place of Purchase _____

LIMITED WARRANTY

SHARP ELECTRONICS CORPORATION warrants its Calculator products to the original purchaser to be free from defective materials and workmanship, and agrees to repair any such defect or to furnish a new or equal part in exchange, except batteries, through an authorized Sharp Factory Service Center.

This warranty does not apply to any appearance items nor to any product whose exterior has been damaged or defaced, nor to any product subjected to misuse, abnormal service or handling, nor to any product altered or repaired by other than an authorized Sharp Factory Service Center. This warranty does not apply to any product purchased outside the United States, its territories or possessions.

The period of this warranty covers one (1) year on parts and one (1) year on labor from date of purchase, except the solar cell contained on the solar calculator, which cell is warranted for three (3) years from date of original purchase.

This warranty entitles the original purchaser to have the warranteed parts and labor rendered at no cost for the period of the warranty described above when the calculator is carried or shipped into an authorized Sharp Factory Service Center together with proof of purchase.

This shall be the exclusive written warranty of the original purchaser and neither this warranty nor any other warranty expressed or implied shall extend beyond the period of time listed above. In no event shall Sharp be liable for consequential economic damage or consequential damage to property. Some states do not allow a limitation on how long an implied warranty lasts or an exclusion of consequential damage, so the above limitation and exclusion may not apply to you. In addition, this warranty gives specific legal rights, and you may have other rights which vary from state to state.

INTRODUCTION

Thank you for your purchase of the SHARP scientific calculator model EL-5001.
Thought small in size, this unit is capable of performing complex calculations with amazing speed and simplicity. Careful reading of this manual will enable you to use your new SHARP calculator to its full capability.

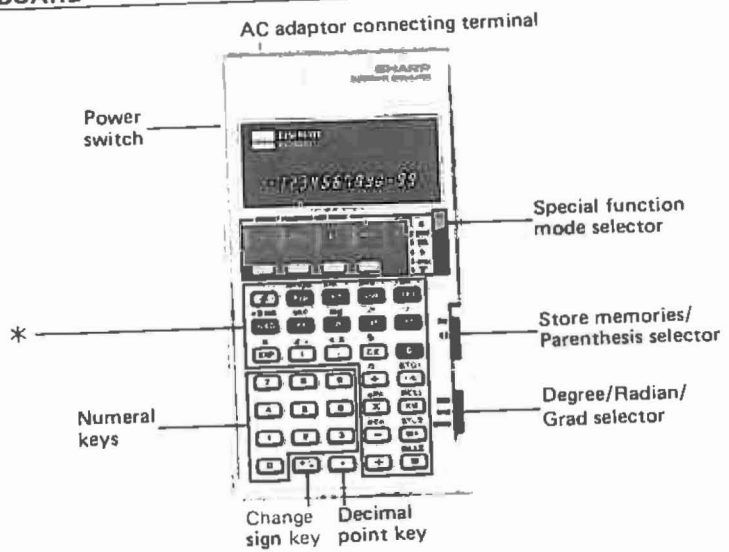
OPERATIONAL NOTES

To insure trouble free operation of your SHARP calculator, we recommend the following:

1. The calculator should be kept in areas free from extreme temperature fluctuation, moisture and dust.
2. A soft, dry cloth should be used to clean the calculator. Do not use solvents or a wet cloth.
3. If the calculator will not be operated for an extended period of time, remove the batteries to aboid possible damage caused by battery leakage.
4. When you are using an AC adaptor/charger, turn off the power switch prior to connecting or disconnecting the AC cord.
5. Do not incinerate used batteries when disposing of them.
6. If service of your calculator is required, use only an authorized SHARP service center.

CONTENTS

THE KEYBOARD



* [F] Function key

[hyp] Hyperbolic/arc hyperbolic key

[sin] [cos] [tan] Trigonometric/inverse trigonometric function key

[°'"] [DEG] Degree/minute/second ↔ Decimal degrees conversion key

[10^x] [e^x] Natural/common antilogarithm key

[log] [ln] Natural/common logarithm key

[$\sqrt{\ }$] [x^2] Square and square root key

[y^x] $Y^X/\sqrt[X]{Y}$ key

[π] [EXP] Exponent/Pi key

[A%] [(] Open parenthesis/percent change key

[1/x] [)] Close parenthesis/reciprocal key

[$\sqrt[3]{\ }$] [CE] Clear entry/cube root key

[C] Clear key

[n!] [÷] Division/factorial key

[STO 1] [x→M] Memory-in/store 1st memory key

[nPr] [×] Multiplication/permutation key

[RCL 1] [RM] Recall memory/recall 1st memory key

[nCr] [−] Subtraction/combination key

[STO 2] [M+] Memory plus/store 2nd memory key

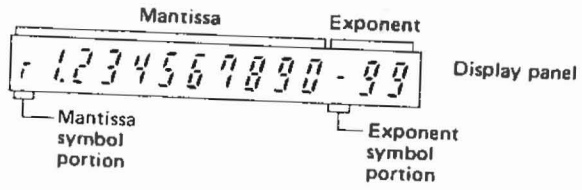
[+] Addition key

[RCL 2] [=] Equals/recall 2nd memory key

OPERATING CONTROLS

ON OFF **Power switch**

When the power switch is turned on, the calculator is ready for operation.



All entries or answer will be displayed in either floating decimal or scientific notation.
(See page 30)

DEG RAD GRAD **Degree/Radian/Grad selector**

- Used for calculation of trigonometric, inverse trigonometric and coordinate conversion.

"DEG" position — Entires and answers are in decimal degrees.
"RAD" position — Entires and answers are in radians.
"GRAD" position* — Entires and answers are in grads.

*GRAD: A new degree system which is being used in Europe

$(100^g = 90^\circ = \frac{\pi}{2}$ [rad]).

2M ( ) **Store memories / parenthesis selector**

The EL-5001 has two memories (1st memory, M_1 and 2nd memory, M_2) in addition to the independent memory.

"2M" position — M_1 and M_2 are used as store memories.
"( )" position — M_1 and M_2 are used as parentheses.

Note: This selector is effective when special function mode selector is set at "N".

Special function mode selector

There are six (6) kinds of special functions available, any of which can be accessed through this selector. While operating this selector, you will see both the corresponding designation number for each function & symbols assigned to four (4) special function keys through the symbol display window.

Symbol display at each position of the selector

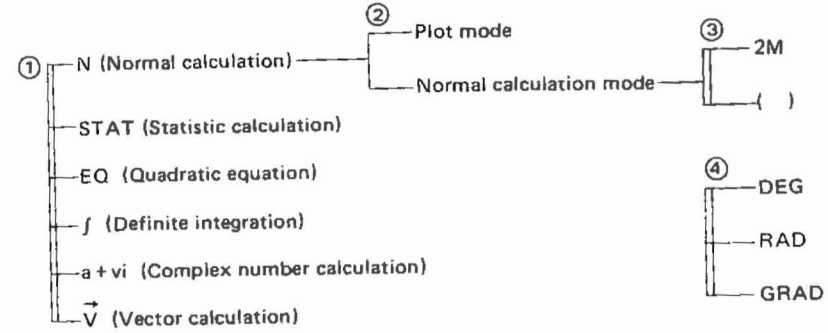
Symbol	The symbol display window				Mode number	Calculation function of each mode
	I	II	III	IV		
N	Plot	x_0	Δx	x_n	1	Normal calculations & plot calculation
STAT	$n\ \Sigma x$	$\bar{x}\ \Sigma x^2$	s σ	DATA CD	2	Statistic calculation
EQ	a	b	c	$\alpha\ \beta$	3	Quadratic equation
$\int$	a	b	k	$x^n dx$	4	Definite integration
a+bi	a	b	$\rightarrow r\theta$	$\rightarrow xy$	5	Complex number and coordinate conversion
$\vec{V}$	V_1	V_2	$\rightarrow r\theta$	$\rightarrow xy$	6	Vector and coordinate conversion

Note: • Normal calculation must be done in N mode.
• When operating the 2M/( ) selector and special function mode selector, all of the numbers and the instructions except for the number on the display will be cleared.

Special function keys

Used to perform each of the six (6) special functions.

• The format between each mode and the calculation



Note: ① : Speical function mode selector
② : Can be set by the one of the special function keys
③ : 2M/( ) selector
④ : DEG/RAD/GRAD Selector

0 ~ 9 **Numeral keys**
Used to enter numbers.

Ex. 123 → 1 2 3

· **Decimal point key**
Positions the decimal point in an entered number.

Ex. 12.3 → 1 2 · 3
0.4 → · 4

+/− **Change sign key**
Changes the sign of the displayed number from a positive to a negative or from a negative to a positive.

F **Function key**
This key is to be operated when designating the second function (labeled in orange) of the function keys or the special function keys. (i.e. log, $\cos^{-1}$, $\sqrt[3]{x}$, etc.).

23 F $\overset{\log}{\ln}$ → log 23

·5 F $\overset{\cos^{-1}}{\cos}$ → $\cos^{-1}$ 0.5

- In the calculation examples shown below, the operation of function keys are represented as follows;

$\overset{\log}{\ln}$ (1) ln (First function)
(2) F log (Second function)

n! **Division/factorial key**
÷
- Orders division.
- If depressed following the F key, calculates the factorial of the displayed number.
  Factorial of n (n!) = n·(n−1)·(n−2)····· 2·1

  Ex. 9! = 9 F n! → 362880.

nPr **Multiplication/permutation key**
×
- Orders multiplication.
- If depressed following the F key, a permutation nPr will be calculated.

  Ex. ${}_7P_3$ = 7 F nPr 3 = → 210.

nCr **Subtraction/combination key**
−
- Orders subtraction.
- If depressed following the F key, a combination, nCr will be calculated.

  Ex. ${}_7C_3$ = 7 F nCr 3 = → 35.

+ **Addition key**
Order addition.

STO1 **Memory-in/store 1st memory key**
x→M
- Clears the contents of the independent memory and replaces it with the number in the display. To clear the memory depress the C key followed by the x→M key.
- If depressed following the F key, clears the contents of the 1st memory and replaces it with the number in the display.

RCL1 **Recall memory/recall 1st memory key**
RM
- Displays the contents of the independent memory.
- If depressed following the F key, displays the contents of the 1st memory. The contents of the 1st memory remain unchanged.

STO2 **Memory plus/store 2nd memory key**
M+
- Used to add the number displayed or a calculated result to the contents of the independent memory.

  Ex. Multiply 5 by 9 and add the answer to the contents of the memory.

Key operation		Display
5 × 9 M+	→	45.

- If depressed following the F key, clears the contents of the 2nd memory and replaces it with the number in the display.

RCL2 **Equals/recall 2nd memory key**
=
- Completes the arithmetic function (+, −, ×, ÷), y^x, $\sqrt[x]{y}$, nPr and nCr calculations.
- If depressed following the F key, displays the contents of the 2nd memory. The contents of the 2nd memory remain unchanged.

$\sin^{-1}$ **Trigonometric/inverse trigonometric function key**
sin
- Used to obtain the sine, cosine or tangent of a displayed number.

$\cos^{-1}$
cos

$\tan^{-1}$
tan

Ex. Find the sine 30 in degrees
Find the cosine 0.8 in radian
Find the tangent 40 in grads

Key operation			Display
DEG	30 sin	→	0.5
RAD	.8 cos	→	6.967067094−01
GRAD	40 tan	→	7.265425277−01

- If depressed following the F key, the inverse trigonometric functions are calculated.

  Ex. Find the arc sine of 0.5 in degrees
  Find the arc cosine of 0.7 in radians
  Find the arc tangent of 1 in grads

	Key operation		Display
DEG	.5 [F] [sin⁻¹]	→	30.
RAD	.7 [F] [cos⁻¹]	→	7.953988295–01
GRAD	1 [F] [tan⁻¹]	→	50.

[archyp] [hyp] **Hyperbolic/arc hyperbolic key**

- If depressed before a trigonometric key, the hyperbolic function (sin h, cos h, tan h) will be calculated.

Ex. sinh 0.7 .7 [hyp] [sin] → 7.585837015-01

- When the [F] [archyp] keys are depressed before a trigonometric key, the inverse hyperbolic function ($\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$) is calculated.

Ex. $\cosh^{-1} 2$ 2 [F] [archyp] [cos] → 1.316957897

[$\sqrt[x]{y}$] [y^x] Y^x/ $\sqrt[x]{y}$ **key**

- Raises a number to a power.

Ex. Calculate $4^{2.7}$ and $(5 \times 7)^4$

Key operation		Display
4 [y^x] 2.7 [=]	→	42.22425313
5 [×] 7 [y^x] 4 [=]	→	1500624.998

- If depressed following the [F] key, calculates the Xth root of y.

Ex. Calculate $\sqrt[5]{243}$

Key operation		Display
243 [F] [$\sqrt[x]{y}$] 5 [=]	→	3.

[$\sqrt{\ }$] [x^2] **Square and square root key**

- Gives the square of the number displayed.
- If depressed following the [F] key, calculates the squre root of the number displayed.

Ex. 14^2 = 14 [x^2] → 196.

$\sqrt{196}$ = 196 [F] [$\sqrt{\ }$] → 14.

[log] [ln] **Natural/Common logarithm key**

- Used to obtain the logrithm base e (e ≒ 2.718281828) & base 10.of the number displayed.

Ex. Calculate ln 8

Key operation		Display
8 [ln]	→	2.079441542

Ex. Calculate log 30

Key operation		Display
30 [F] [log]	→	1.477121255

[10^x] [e^x] **Natural/Common antilogarithm key**

- Calculates the antilogarithm base e & base 10 of the number displayed.

Ex. Calculate e^4

Key operation		Display
4 [e^x]	→	54.59815002

Ex. Calculate $10^{12.3}$

Key operation		Display
12.3 [F] [10^x]	→	1.995262313 12

[°'" ⇔ DEG] **Degree/minute/second ⇔ Decimal degrees conversion key**

- Converts degrees/minutes/seconds to their decimal equivalents.

Ex. Converts 12°30'45" to its decimal equivalents.

Key operation		Display
12.3045 [°'" ⇔ DEG]	→	12.5125

- If depressed following the [F] key, converts decimal degrees to degree/minute/second.

Ex. Converts 12.5125 degrees to degree/minute/second.

Key operation		Display
12.5125 [F] [°'" ⇔ DEG]	→	12.304500 (12°30'45")

[C] **Clear key**

Clears the contents of the calculation registers in accordance with the position of the selector for selectable special functions.

Special function mode selector		Function of the [C] key
• N (Neutral & plot mode)	"2M" (2 memories)	Clears the numbers and instructions except for all memories (M, M_1, M_2)
	"( )" and plot mode	Clears the numbers and instructions except for the independent memory (M)
•STAT (STAT mode) •EQ (Equation mode) • ∫ (Integration mode) •a + bi (Complex number mode) •$\vec{V}$ (Vector mode)		Clears all of the numbers and instructions in the calculator.

$3\sqrt{\ }$ **CE** **Clear entry and cube root key**

- Used to clear an incorrectly entered number.

Ex. • When 213 instead of 231 is entered by mistake.

213	→	213.
CE	→	0.
231	→	231.

- If depressed following the F key, calculates the cube root of the number displayed.
- $\sqrt[3]{343}$ = 343 F $3\sqrt{\ }$ → 7.

1/x **)** **Close parenthesis/reciprocal key**

- Used to close parenthesis.
- If depressed following the F key, calculate the reciprocal of the number displayed.

Ex. Calculate $\frac{1}{8}$

Key operation		Display
8 F 1/x	→	0.125

Δ% **(** **Open parenthesis/percent change key**

- Used to open parenthesis. This key works up to 2 levels.

Ex. 123 ÷ [39 x 12 ÷ (52 + 65)] =

N mode, ( ), $\overline{\text{PLOT}}$ *:

123 ÷ (39 X 12 ÷ (52 + 65)) = → 30.75

* $\overline{\text{PLOT}}$: means no set PLOT mode

Note: The (and) keys are not effective in the following conditions;

- When any mode except for N mode is set in the special function mode selector.
- When the position of the store memories/parenthesis selector is in the "2M".
- When PLOT mode is set.

- If depressed following the F key, gives the percent multiplication and division, and percent increase.

Ex. 650 x 15% =

650 X 15 F Δ% → 97.5

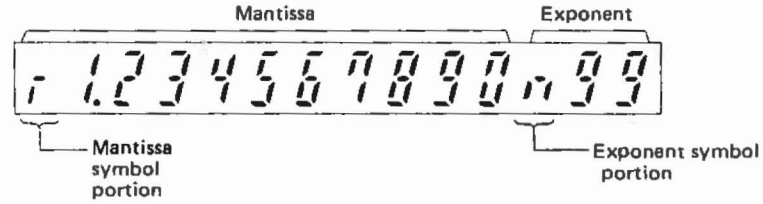
π **EXP** **Exponent/Pi key**

- Used to enter the exponent of a number.

Ex.	Key operation	Display
2.3×10^{24}	2.3 EXP 24	2.3 24
2.3×10^{-9}	2.3 EXP 9 +/-	2.3 −09
1×10^{-7}	EXP 7 +/-	1. −07

- If depressed following the F key, the constant π ($\pi \fallingdotseq 3.141592653$) is entered.

DISPLAY FORMAT



All entries or answer will be displayed in either floating decimales or scientific notation. (See page 30.) When operating in scientific notation, the minus symbol will be displayed to the left of the number (i.e.: mantissa or exponent).

The following symbols are displayed in the symbol portion.

: Minus symbol

Indicates that the number in the display following the "−" is negative. (Minus symbol of the mantissa floats in accordance with the number of the digits of the mantissa.)

: Error symbol
Appears on the mantissa symbol portion when an overflow or error is detected.

: Independent memory symbol
Appears on the mantissa symbol portion when a number other than 0 is stored in the independent memory.

: 1st memory (M_1) and 2nd memory (M_2) symbol
Appear on the exponent symbol portion when numbers other than 0 are stored in the 1st & 2nd memories.
These symbol appear in both "2M" and "( )" position. But in the case of "( )" position, when the open parenthesis/percent change key ($\frac{\Delta\%}{C}$) is depressed following the function keys (i.e. ×, ÷, +, −), these symbols appear.

: Plot symbol
Appears on the mantissa symbol portion when the plot mode is selected.

: Imaginary number symbol
Appears on the mantissa symbol portion when the root is an imaginary number in a quadratic equation.

: Answer symbol
Appears on the mantissa symbol portion when the complex number, vector and coordinate conversion calculations are being performed.

BATTERY REPLACEMENT

Dimming of the display indicates that the batteries should be replaced or recharged.
(The right most digit and the left most digit of the display become darker than the other digits.)
Batteries: Two "AA" dry batteries or the Ni-Cd battery pack EA-18B.
Recharger: EA-17

1. Turn off the power switch.
2. Remove the battery cover by sliding it in the direction of the arrow on the cover. (Fig. 1)
3. Replace the battery. Be sure that the "+" and "−" mark on the battery correspond to the "+" and "−" mark in the case. (Fig. 1)
4. Replace the battery cover.

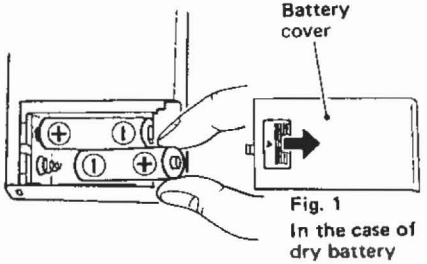


Fig. 1
In the case of
dry battery

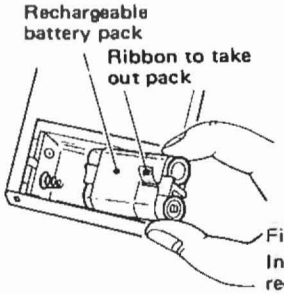


Fig. 2
In the case of
rechargeable battery

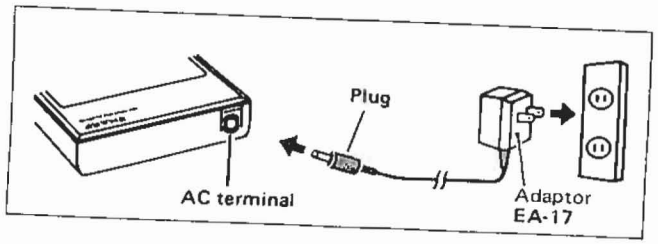
Note
- Keeping the dead battery in the battery compartment may result in the damage to the calculator due to the solvent leakage of the battery. So remove the dead battery promptly.
- Always replace both batteries at the same time.
- When installing the Ni-Cd battery pack EA-18B, refer to Fig. 2.

RECHARGING AND AC LINE OPERATION

1. **Recharging**
The procedure for operation by AC adaptor-charger is as follows:
1) Turn the EL-5001 power switch to OFF.
2) Insert the adaptor-charger plug into the AC adaptor connecting terminal of the EL-5001 and insert the power plug into AC outlet.
3) A discharged battery will be fully charged after being connected to the adaptor-charger for 15 hours. (See Fig.)
4) To finish charging, remove the adaptor-charger from both the AC outlet and the EL-5001 with the power switch being set at OFF.
5) A fully charged battery provides approximately 7 hours of the continuous operation.

Note: i) When rechargeable battery operation of the calculator is done after purchasing or stored unused for three months or more, please note the following:
The display may not work when the power is turned on.
This is because the capacity of the rechargeable battery is lowered due to the self-discharge.
In this case connect the AC adaptor-charger with AC outlet and then use the calculator on the AC line operation with the calculator switch set at ON. After the calculation, recharge the battery by setting the power switch at OFF.
ii) Never use any AC adaptor or charger except EA-17 & never use any rechargeable batteries except EA-18B.
iii) To avoid any transient voltage from the AC adaptor/charger, the EL-5001 should be turned OFF before plugging it in.

2. **AC Line operation**
The procedure for operation by AC line is as follows:
1) Turn the EL-5001 power switch to OFF.
2) Insert the adapor-charger plug into the AC adaptor connecting terminal of the EL-5001 and then insert the power plug into AC outlet.
3) Turn the EL-5001 power switch to ON.



CAUTION

Use of other than AC adaptor/charger EA-17 & the Ni-Cd battery pack EA-18B may apply improper voltage to your SHARP calculator & will cause damage.

OVERFLOW ERRORS

There are several situations which will cause an overflow or an error condition. When this occurs, E 0. will be displayed. The [C] key must be used to reset the error condition.

The following will cause an overflow and errors.

1. The absolute value of a calculation result is greater than $9.999999999 \times 10^{99}$ or smaller than 1×10^{-99}.
2. When a number is divided by 0 (zero, A ÷ 0);
3. The absolute value of a result of memory calculation is greater than $9.999999999 \times 10^{99}$ or smaller than 1×10^{-99}.
4. When using scientific calculations, an overflow or an error occurs when the calculations which is out of the calculation range on page 91 are performed.

OPERATIONS

BEFORE OPERATION

- In this model, the keys needed in each mode are made effective for the operations and the other keys are electronically locked to avoid mis-calculations.
  (As for the relation between the effective keys and the mode, see page 30.)
- Entries may contain a maximum of 10 digits (9 decimales) when working in floating decimal system. Additional digits entered will be ignored.

Ex.	Enter	Display
	12345678912	1234567891.
	1.2345678912	1.234567891

- The exponent portion of the entry may contain 2 digits. If more than 2 digits are entered, only the last 2 digits entered will be accepted.
  Ex. 5 [EXP] 123 → 5. 23
- In the calculation examples shown below; the special function mode selector must be in the "N" and non-plot mode unless otherwise specified.

Display system

- All answers exceeding 10 integers or with an absolute value smaller than 1 and exceeding 9 decimals (Ex. 0.1234567891) will automatically be converted into scientific notation.
- During the calculation of the machine, "–" on the left most digit of the display (mantissa symbol portion) will be lit.
- To obtain an accurate result, be sure to perform the following operation before starting calculations.

		(Display)
Power switch "ON"	→	0.
111111111 [×] [=]	→	1.234567898 16

The table for the relations between the effective keys and the mode.

Keys \ Mode	N			STAT	EQ	∫	a+bi	$\vec{V}$
	( )	2M	PLOT					
C, CE, 0~9, ·, EXP, +/–	x	x	x	x	x	x	x	x
F, hyp, arc hyp, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, e^x, 10^x, ln, log, x^2, $\sqrt{\ }$, $\frac{1}{x}$, $\sqrt[3]{\ }$, π	x	x	x	x	x	x	x	x

+, −, ×, ÷, =	×	×	−	×	−	×	×	×
y^x, $\sqrt[x]{y}$	×	×	×	×	−	−	−	−
nCr, nPr	×	×	−	×	−	−	−	−
M+, $x \rightarrow M$, RM	×	×	×	−	−	−	−	−
(,)	×	−	−	−	−	−	−	−
STO 1, STO 2, RCL 1, RCL 2	−	×	−	−	−	−	−	−
Δ%	×	×	−	−	−	−	−	−
→DEG, →D.MS, n!	×	×	−	×	×	×	×	×
I, II, III, IV,	Δ	Δ	×	×	×	×	×	×

Note: • × : Effective, Δ : Effective I key (Plot) only, − : Not effective (ineffective)
• I, II, III, IV : Special function keys.

NORMAL CALCULATIONS

1. Four arithmetic calculations

Ex. 1 123 − 45.6 + 789 = ①
Ex. 2 230,000 × (−240) ÷ 0.12 = ②
Ex. 3 $(54 \times 10^3 + 6.76 \times 10^6) \div (1.25 \times 10^{-12})$ = ③

Key operation	Display	Note
123 [−] 45.6 [+] 789 [=]	866.4	Ans. ①
230000 [×] 240 [+/−] [÷]	−55200000.	
.12 [=]	−460000000.	Ans. ②
54 [EXP] 5 [+] 6.76 [EXP] 6 [÷]	12160000.	
1.25 [EXP] 12 [+/−] [=]	9.728 18	Ans. ③

• When entering a negative number, operate as follows; Numeral key(s) [+/−] .

2. Constant calculation

Ex. 1 321 + 357 = ····· ①
654 + 357 = ····· ②
987 + 357 = ····· ③

Constant: addend

Key operation	Display	Note
321 [+] 357 [=]	678.	①
654 [=]	1011.	②
987 [=]	1344.	③

Ex. 2 579 − 159 = ····· ①
456 − 159 = ····· ②
123 − 159 = ····· ③

Constant: subtrahend

Key operation	Display	Note
579 [−] 159 [=]	420.	①
456 [=]	297.	②
123 [=]	−36.	③

Ex. 3 742 × 450 = ····· ①
742 × 235 = ····· ②
742 × 89 × 10^6 = ··· ③

Constant: multiplicand

Key operation	Display	Note
742 [×] 450 [=]	333900.	①
235 [=]	174370.	②
89 [EXP] 6 [=]	6.6038 10	③

Ex. 4 862 ÷ 8 = ····· ①
751 ÷ 8 = ····· ②
−624 ÷ 8 = ····· ③

Constant: Divisor

Key operation	Display	Note
862 [÷] 8 [=]	107.75	①
751 [=]	93.875	②
624 [+/−] [=]	−78	③

3. Memory calculation

- Clear the independent memory by depressing the [C] [x→M] keys before starting a memory calculation. ("Clear" means to make the contents of the memory zero (0) in this case.)

Ex. 1 45 x 67 x 89 = ... ①
+) 567 ÷ 6 ÷ 8 = ... ②
−) 2345 ÷ 25 x 12 = ... ③
Total ④

Key operation	Display	Note
[C] [x→M]	0.	
45 [X] 67 [X] 89 [M+]	268335.	①
567 [÷] 6 [÷] 8 [M+]	11.8125	②
2345 [÷] 25 [X] 12 [=]	1125.6	③
[+/−] [M+] [RM]	267221.2125	④ Total

- When subtracting a number from the memory, depress the [+/−] and [M+] keys in this order.

Ex. 2 (121 + 92 − 27) x (98 + 72) ÷ (214 − 133 + 12) =

Key operation	Display	Note
	"2M"	
214 [x→M] 133 [+/−] [M+] 12 [M+]	12.	
98 [+] 72 [=] [F] [STO1]	170.	
121 [+] 92 [−] 27 [X]	186.	
[F] [RCL1] [÷]	31620.	
[RM] [=]	340.	Ans.

- Even if the [C] and [x→M] keys are not depressed prior to calculation, a previously stored number can be cleared from the independent memory when a new number is stored in the memory by depression of the [x→M] key.
- In the above example, the independent memory and 1st memory (M_1) are used. When you use the 2nd memory, depress the [STO2] and [RCL2] keys instead of the [STO1] and [RCL1] keys.

Ex. 3 $\dfrac{(8 \times 9 + 12) \times (21 \div 7 + 5)}{(2 \times 3 + 5) \times (4 \times 6 - 7)}$ =

Key operation	Display	Note
	"2M"	
2 [X] 3 [+] 5 [=] [x→M]	11.	(2 x 3 + 5)
4 [X] 6 [−] 7 [X]	17.	(4 x 6 − 7)
[RM] [=] [x→M]	187.	
8 [X] 9 [+] 12 [=] [F] [STO2]	84.	(8 x 9 + 12)
21 [÷] 7 [+] 5 [X]	8.	(21 ÷ 7 + 5)
[F] [RCL2] [÷] [RM]	187.	
[=]	3.593582887	Ans.

SCIENTIFIC CALCULATIONS

- The accuracy of functions are described in "SPECIFICATIONS".
- The following functions can be used in chain calculations:
  sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$ hyp, arc hyp, →DEG, →D.MS, e^x, 10^x, ln, log, $\sqrt{\ }$, $\sqrt[3]{\ }$, x^2, $1/x$, π nl, (,) .

1. Trigonometric function

Ex. 1 $\cos \frac{\pi}{4}$ = ①

Ex. 2 $\sin^2 67° - \sin^2 32°$ = ②

Key operation		Display	Note
RAD [F] [π] [÷] 4 [=] [cos]		7.071067813 −01	Ans. ①
DEG	67 [sin] [x^2] [−]	8.473291857 −01	$\sin^2 67°$
	32 [sin] [x^2] [=]	0.566514759	Ans. ②

2. Inverse trigonometric function
($\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$)

- A calculation result of inverse trigonometric function can be obtained in the following ranges:

$\theta = \sin^{-1} x$, $\tan^{-1} x$

DEG: $-90 \leqq \theta \leqq 90$

RAD: $-\frac{\pi}{2} \leqq \theta \leqq \frac{\pi}{2}$

GRAD: $-100 \leqq \theta \leqq 100$

$\theta = \cos^{-1} x$

DEG: $0 \leqq \theta \leqq 180$

RAD: $0 \leqq \theta \leqq \pi$

GRAD: $0 \leqq \theta \leqq 200$

Ex. 1 $\sin^{-1} 0.5 =$ ①

Ex. 2 $\tan^{-1} \frac{\sqrt{1-0.6^2}}{0.6} =$ ②

Key operation	Display	Note
GRAD .5 [F] [sin⁻¹]	33.33333334	Ans. [g] ①
DEG 1 [−] .6 [x²] [=]	0.64	
[F] [√] [÷] .6 [=] [F] [tan⁻¹]	53.13010235	Ans. [°] ②

3. Angle conversion

To convert degree/minute/second to decimal equivalents, degrees and minutes/seconds should be entered as integer and decimal respectively.

Ex. 12°39'18" → Enter 12.3918

- When decimal degrees are converted into degree/minute/second, the display (answer) indicates that the integer portion is degrees, 1st and 2nd decimal digits are minutes and the 3rd and 4th digits are the seconds.
- The 5th through end decimal digits are decimal degrees.

Ex. 1 Convert degree/minute/second to its decimal equivalent.
12°39'18" = ①

Ex. 2 Convert decimal degrees to degree/minute/second.
12.655 = ②

Ex. 3 Hour/minute/second + hour/minute/second.
7 hours 45 minutes 13 seconds + 12 hours 29 minutes 54 seconds = ③

Key operation	Display	Note
12.3918 [→DEG]	12.655	Ans. 12.655° ①
12.655 [F] [→DMS]	12.391800	Ans. 12°39'18" ②
7.4513 [→DEG] [+]	7.753611111	
12.2954 [→DEG] [=]	20.25194444	Ans. ③
[F] [→DMS]	20.150700	20 hours 15 minutes 7 seconds

4. Hyperbolic function

Ex. 1 sinh 4 = ①

Ex. 2 $(\cosh 1.5 + \sinh 1.5)^5 =$ ②

Ex. 3 $1 - \tanh^2 \frac{3}{4} =$ ③

Key operation	Display	Note
4 [hyp] [sin]	27.28991719	Ans. ①
1.5 [hyp] [cos] [+] 1.5 [hyp] [sin]	2.129279455	
[y^x] 5 [=]	1808.042412	Ans. ②
"( )"		
1 [−] [(] 3 [÷] 4 [)]	0.75	
[hyp] [tan] [x²] [=]	5.965858084 −01	Ans. ③

5. Inverse hyperbolic function

Ex. 1 $\sinh^{-1} 9 =$ ①

Ex. 2 $\sqrt{5^2 + 7^2}\ \cosh^{-1}\left(2 + \tanh^{-1}\frac{5}{7}\right) =$ ②

Key operation	Display	Note
9 F arc sin	2.893443986	①
"( )"		
5 x^2 + 7 x^2 =	74.	
F $\sqrt{}$ × (2 +	2.	
(5 ÷ 7) F arc tan	8.958797342 -01	
F arc cos =	14.84069736	Ans. ②

6. Exponential calculation

Ex. 1 $e^7 + e^3 =$ ①

Ex. 2 $e^{\frac{1}{5}} \ln 37 =$ ②

Ex. 3 $10^{3.5 - 3.1} =$ ③

Ex. 4 $1.5 \times 10^{-3} \times 10^{\frac{63}{20}} =$ ④

Key operation	Display	Note
7 e^x + 3 e^x =	1116.718694	Ans. ①
5 F 1/x × 37 ln = e^x	2.058924136	Ans. ②
2.5 − 3.1 = F 10^x	2.511886431 −01	Ans. ③
"( )" 1.5 EXP 3 +/− ×	0.0015	
(65 ÷ 20) F 10^x =	2.667419115	Ans. ④

7. Logarithmic function

Ex. 1 $\frac{1}{2} \cdot \ln 21 =$ ①

Ex. 2 $5^3 \cdot \ln 5 =$ ②

Ex. 3 $\frac{32^4}{\log 32} =$ ③

Ex. 4 $\log \frac{\sqrt{7^2 - 1}}{7} =$ ④

Key operation	Display	Note
2 F 1/x × 21 ln =	1.522261219	Ans. ①
5 y^x 3 × 5 ln =	201.179739	Ans. ②
32 y^x 4 ÷ 32 F log =	696658.8142	Ans. ③
7 x^2 − 1 = F $\sqrt{}$	6.92820323	$\sqrt{7^2 - 1}$
÷ 7 = F log	−4.477421282 −03	Ans. ④

8. Square and cube root

Ex. 1 $\sqrt{75 + 91} \times \sqrt{24} =$ ①

Ex. 2 $\sqrt[3]{52^2 + 72^2} =$ ②

Key operation	Display	Note
75 + 91 = F $\sqrt{}$	12.88409873	$\sqrt{75+91}$
× 24 F $\sqrt{}$ =	63.11893536	Ans. ①
52 x^2 + 72 x^2 =	7888.	52^2+72^2
F $\sqrt[3]{}$	19.90622769	Ans. ②

9. Power function (y^x)

Ex. 1 $23.5^{2.5} =$ ①

Ex. 2 $(7 + 5)^{-4} = \frac{1}{(7 + 5)^4} =$ ②

Ex. 3 $258^{\frac{1}{4}} = \sqrt[4]{258} =$ ③

Ex. 4 $(51.3^4)^{2.4} =$ ④

Key operation	Display	Note
23.5 y^x 2.5 =	2677.1312	Ans. ①
7 + 5 y^x 4 +/− =	4.822530866 −05	Ans. ②
258 y^x 4 F $1/x$ =	4.007789715	Ans. ③
51.3 y^x 4 y^x 2.4 =	2.612923548 16	Ans. ④

Ex. 5 8^5 = ... ①
12^5 = ... ②
23^5 = ... ③

Constant: 5

Key operation	Display	Note
8 y^x 5 =	32768.	①
12 =	248831.9997	② ≒ 248832
23 =	6436342.995	③ ≒ 6436343

10. $\sqrt[x]{y}$ (x th root of y)

Ex. 1 $\sqrt[4]{256}$ = ①

Ex. 2 $\sqrt[3]{7 \times 9} + \sqrt[3]{72 + 83}$ = ②

Key operation	Display	Note
256 F $\sqrt[x]{y}$ 4 =	4.	Ans. ①
"( )" 7 X 9 F $\sqrt[x]{y}$ 3 +	3.979057207	$\sqrt[3]{7 \times 9}$
(72 + 83 F $\sqrt[x]{y}$	155. ′	72 + 83
2.5) =	11.49758274	Ans. ②

Ex. 3 $\sqrt[5]{127}$ = ... ①
$\sqrt[5]{1024}$ = ... ②
$\sqrt[5]{6895}$ = ... ③

Constant (x) : 5

Key operation	Display	Note
127 F $\sqrt[x]{y}$ 5 =	2.634879412	①
1024 =	4.	②
6895 =	5.857426586	③

11. Factorial

Ex. 1 7! + 9! = ①

Ex. 2 $\frac{12!}{3! \times 4! \times 5!}$ = ②

Key operation	Display	Note
7 F $n!$ +	5040.	7!
9 F $n!$ =	367920.	Ans. ①
"( )" 12 F $n!$ ÷	479001600.	12!
(3 F $n!$ X 4 F $n!$	24. ′	4!
X 5 F $n!$) =	27720.	Ans. ②

12. Permutation

Ex. 1 ${}_{7+2}P_6$ = ①

Ex. 2 $\frac{{}_6P_4}{4}$ = ②

Ex. 3 $5 \times {}_7P_3$ = ③

Key operation	Display	Note
7 + 2 F nPr 6 =	60480.	Ans. ①
6 F nPr 4 ÷ 4 =	90.	Ans. ②
"( )" 5 X (7 F nPr	7. ′	
3) =	1050.	Ans. ③

Ex. 4 $_{12}P_6$ = ... ①
$_{10}P_6$ = ... ②
$_{8}P_6$ = ... ③

Constant (r) = 6

Key operation	Display	Note
12 [F] [nPr] 6 [=]	665280.	①
10 [=]	151200.	②
8 [=]	20160.	③

13. Combination

Ex. 1 $_{10}C_7 + {}_8C_6$ = ①

Ex. 2 $_9H_5 = {}_{9+5-1}C_5$ = ②

Key operation	Display	Note
"( )" 10 [F] [nCr] 7 [+]	120.	$_{10}C_7$
[(] 8 [F] [nCr] 6 [)] [=]	148.	Ans. ①
9 [+] 5 [−] 1 [F] [nCr] 5 [=]	1287.	Ans. ②

Ex. 3 $_{12}C_5$ = ... ①
$_{10}C_5$ = ... ②
$_{8}C_5$ = ... ③

Constant (r) = 5

Key operation	Display	Note
12 [F] [nCr] 5 [=]	792.	①
10 [=]	252.	②
8 [=]	56.	③

14. Percent calculation

Ex. 1 45% of 2,780 → $2{,}780 \times \frac{45}{100}$ = ①

82% of 2,780 → $2{,}780 \times \frac{82}{100}$ = ②

Ex. 2 What percent of 360 does 126 correspond to? → $\frac{126}{360} \times 100$ = ③

What percent of 360 does 207 correspond to? → $\frac{207}{360} \times 100$ = ④

Key operation	Display	Note
2780 [×] 45 [F] [Δ%]	1251.	①
82 [F] [Δ%]	2279.6	②
126 [÷] 360 [F] [Δ%]	35.	③
207 [F] [Δ%]	57.5	④

Ex. 3 Calculation of percent change $\frac{547 - 473}{473} \times 100$ =

Key operation	Display	Note
547 [−] 473 [F] [Δ%]	15.64482029	Ans. [%].

SPECIAL CALCULATIONS

1. Plot calculation

This calculation is to plot a function by entering the initial value and the pitch value.
The special function mode selector must be set at "N".

Note: As for the functions available in plot calculation, refer to the table on page 30.

1) The functions assigned to the special function keys.

[PLOT] [x_0] [Δx] [xn] [1]
[ ] [ ] [ ] [ ]

[PLOT] Used to set the plot mode.
When the plot mode is set, the symbol (⌟) is displayed and the numbers and the instruction in the calculation except for the independent memory will be cleared.

[x_0] Used to enter the initial value into the calculator in plot calculation.

[Δx] Used to enter the pitch value (Δx) into the calculator in plot calculation.

[xn] Displays the value of ($x_0 + n\Delta x$). Whereby n = 0, 1, 2, ...

2) Calculation method

1. To perform the plot calculation of scientific functions except for y^x and $\sqrt[x]{y}$;

i) Set the plot mode by depressing the [PLOT] key.

ii) Enter the initial value (x_0) and the pitch (Δx) to the calculator by the [x_0] and [Δx] keys respectively.

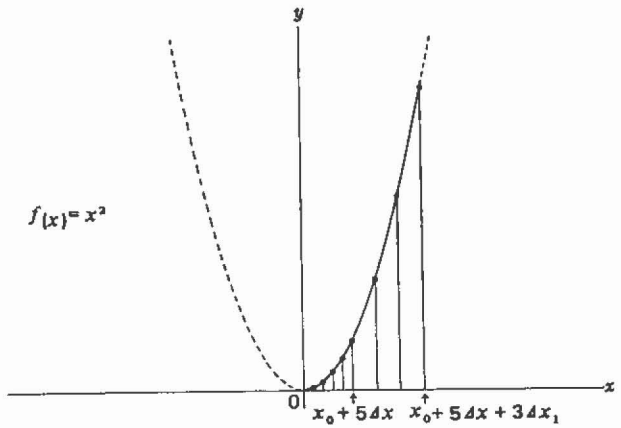
iii) Depress the key of the desired function consecutively, then the answers at the poin $x_0 + n\Delta x$ will be displayed.

Ex. Plot calculation of the x^2 ($f(x) = x^2$)

$x_0 = 0$, $\Delta x = 0.2$ (change Δx to 0.5 in the middle)

Key operation		Display	Data	Note
"N"	[PLOT]	0.		Set the plot mode
	[x_0]	0.		Input the initial value x_0 (0)
.2	[Δx]	0.2		Input the pitch Δx (0.2)
	[x^2]	0.	0.	Start the plot calculation
	[x^2]	0.04	0.2	$f(x_0 + \Delta x)$

Key operation		Display	Data	Note
	[x^2]	0.16	0.4	$f(x_0 + 2\Delta x)$
	[x^2]	0.36	0.6	
	[x^2]	0.64	0.8	
	[x_n]	0.8		Current value of x
	[x^2]	1.	1.0	
5	[Δx]	0.5		Change the pitch Δx to 0.5 (Δx_1)
	[x^2]	2.25	1.5	
	[x^2]	4.	2.0	
	[x^2]	6.25	2.5	
	[C]	0.		Reset the plot mode



If you want to change the initial value (x_0) or pitch (Δx), just reenter the new initial value o pitch.

When you change the kind of scientific function from one to another, up-to-date values of x ($= x_0 + n\Delta x$) & Δx on the previous scientific function will remain unchanged, so that you can continu plotting from x_{n+1} on the new scientific function with the same Δx.

1. To perform the plot calculation of the functions, y^x and $\sqrt[x]{y}$;

i) Set the plot mode.

ii) Enter the initial value (x_0) and the pitch (Δx) to the calculator through the [x_0] and [Δx] keys.

iii) Enter the constant A followed by the [y^x] or [F] [$\sqrt[x]{y}$] keys.

Ex. Plot calculation of y^x $x_0 = 2$, $\Delta x = 2$ and A = 3

Key operation		Display	Data	Note
"N"	[PLOT]	0.		Set plot mode
2	[x_0]	2.		Entry of x_0 (2)
	[Δx]	2.		Entry of Δx (2)
3	[y^x]	9.	3^2	Entry of A start plotting
	[y^x]	81.	3^4	$A^{(x_0 + \Delta x)}$
	[y^x]	729.	3^6	$A^{(x_0 + 2\Delta x)}$
	[y^x]	65661.	8^8	$A^{(x_0 + 3\Delta x)}$
	[y^x]	59049.	3^{10}	$A^{(x_0 + 4\Delta x)}$
	[y^x]	531440.9993	3^{12}	$A^{(x_0 + 5\Delta x)}$

Key operation	Display	Data	Note
y^x	4782968.992	3^{14}	$A(x_0+6\Delta x)$
y^x	43046720.92	3^{16}	$A(x_0+7\Delta x)$
y^x	387420488.1	3^{18}	$A(x_0+8\Delta x)$
C	0.		Reset the plot mode

- It is impossible to change to the y^x or $\sqrt[x]{y}$ function from other functions except for the y^x and $\sqrt[x]{y}$ during the plot calculation. In order to change, the new initial data must be entered. However, it is possible to change to any one of the scientific functions from y^x and $\sqrt[x]{y}$ during the plot calculation.

2. Statistical calculation

- By entering the data into the calculator, sum of x (Σx), mean of x ($\bar{x}$), sum of x^2 (Σx^2) and standard deviation of samples and populations can be obtained.
- To perform statistical calculations set the special function mode selector at the "STAT" mode.

1) The functions assigned to the special function keys.

2) Each of these four keys have two functions, the symbols printed in the light color can be addressed by touching the key, the symbols printed in the dark color, can be addressed, by first touching the F key.

n Σx | x̄ Σx² | Sσ | DATA CE | 2

n Σx	Displays the number of samples entered.
F n Σx	Used to obtain the sum of the data (Σx).
x̄ Σx²	Used to obtain the mean value of the data ($\bar{x}$).
F x̄ Σx²	Used to obtain the sum of x^2 (Σx^2)
Sσ	Used to obtain the standard deviation of the samples (s).
F Sσ	Used to obtain the standard deviation of the population (σ).
DATA CE	Used to enter the data (numbers).
F DATA CE	Used to correct the mis-entry. (delete function)

2) Calculation method

Two kinds of standard deviation can be calculated by the EL-5001. One of them is standard deviation of samples (s) and the other is that of the population (σ).

The formulas used in the two standard deviation calculations are;

$$S = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - n\bar{x}^2}{n-1}} \qquad \sigma = \sqrt{\frac{\sum_{i=1}^{n} x_i^2 - n\bar{x}^2}{n}}$$

Ex. 1 Calculate the mean value and the standard deviations

No.	x values	Frequency
1	30	1
2	40	2
3	50	4
4	60	4
5	70	8
6	80	9
7	90	5
8	100	2

Key operation	Display	Note
"STAT" C	0.	
30 DATA CE	1.	Number of samples
40 X 2 DATA CE	3.	Number of samples
50 X 4 DATA CE	7.	Number of samples
60 X 4 DATA CE	11.	Number of samples
70 X 8 DATA CE	19.	Number of samples
80 X 9 DATA CE	28.	Number of samples
90 X 5 DATA CE	33.	Number of samples
100 X 2 DATA CE	35.	Number of samples
x̄ Σx²	70.85714285	Mean value
F n Σx	2480.	Sum of x
F x̄ Σx²	185800.	Sum of x^2
n Σx	35.	Number of samples
Sσ	17.2134402	Standard deviation of samples

Key operation	Display	Note
F Sσ	16.96575189	Standard deviation of the populations
C	0.	Clears the numbers and the instructions

Note: Be sure to operate the C key before and after a statistical calculation.

3) Interrupt calculation
Even when the statistical calculation mode is set, interrupt calculations can be done. In this case, however, the calculation using any one of M+, Σ→M, RM, (,), STO1, STO2, RCL1, RCL2 and Δ% keys are forbidden.

Ex. 2 When the following interrupt calculation is done during the entry of the data in above example;

log 70 = ①
50 x sin 48 = ②

Key operation	Display	Note
"STAT" "DEG"		
C	0.	
30 DATA	1.	Number of samples
40 X 2 DATA	3.	Number of samples
70 F log	1.84509804	Interrupt calculation
50 X 4 DATA	7.	Number of samples
60 X 4 DATA	11.	Number of samples
50 X 48 sin =	37.15724129	Interrupt calculation
70 X 8 DATA	19.	Number of samples
⋮	⋮	

Note: The followings can be used at the input data in statistical calculation

- Entry number
- Calculated result of a scientific calculation
- Product (Entry number x number of samples or calculated result of scientific calculation x number of samples)

To enter the above data, depress the DATA or F DATA keys following the data.

4) Correction of the data

Ex. 3 When 55 instead of 50 is entered by mistake in No.3 step in the example 1, correct the data.

Key operation	Display	Note
"STAT" C	0.	
30 DATA	1.	
40 X 2 DATA	3.	
55 X 4 DATA	7.	Incorrect operation

Key operation	Display	Note
55 X 4 F DATA	3.	} Correction
50 X 4 DATA	7.	
60 X 4 DATA	11.	
⋮	⋮	

3, Calculation of quadratic equation

- Formula; $ax^2 + bx + c = 0$
- Set the special function mode selector at the "EQ" mode.

1) The functions assigned to the special function keys.

a b c αβ 3

[ ] [ ] [ ] [ ]

a Used to enter a.

b Used to enter b.

c Used to enter c.

[αβ] Performs the equation and displays the root α. The [α] key must be depressed after the entry of the value a, b and c.
Note: In case of imaginary root, only real number portion is displayed.

[F] [αβ] If depressed following the [F] key, displays the root of β
Note: In case of imaginary root, only imaginary number portion is displayed.

2) Calculation method

i) Enter the value of a, b and c in this order .

ii) Depress the [αβ] and [F] [αβ] keys in this orders, the following answers are obtained;

	Real root	Imaginary root
[αβ]	$\frac{-b+\sqrt{b^2-4ac}}{2a}$	n *) $\frac{-b}{2a}$
[F] [αβ]	$\frac{-b-\sqrt{b^2-4ac}}{2a}$	n *) $\frac{\sqrt{4ac-b^2}}{2a}$

Note: * n shows imaginary root.

Ex. 1 Solve the quadratic equation

① $6x^2 + 7x + 2 = 0$
② $2x^2 - 3x + 4 = 0$

Key operation	Display	Note
"EQ" [C]	0.	
6 [a]	6.	Entry of a
7 [b]	7.	Entry of b
2 [c]	2.	Entry of c
[αβ]	−0.5	Root (α)
[F] [αβ]	−6.666666667 −01	Root (β)
2 [a]	2.	Entry of a
3 [+/−] [b]	−3.	Entry of b
4 [c]	4;	Entry of c
[αβ]	n 0.75	Root (α) real number portion
[F] [αβ]	n 1.19895788	Root (β) imaginary number portion

- When you want to correct any number entered, just enter the right numbers.
  Note: The number of a, b and c must be entered in this orders.

3) Interrupt calculation
The interruption by scientific calculations is possible during the entry or after depressing the [αβ] and/or [F] [αβ] keys.
And the calculated result of the interrupt calculation can be used as the data for a, b and c in the quadratic equation.

Ex. $\log 1000\ (\log x)^2 + 5\log x - \log 100 = 0$
$\log x = y$
$\log 1000 \times y^2 + 5y - \log 100 = 0$
$\log x = y \quad \therefore x = 10^y$

Key operation	Display	Note
"EQ" [C]	0.	
1000 [F] [log]	3.	Interruption
[a]	3.	Entry of a (log 1000)
5 [b]	5.	Entry of b
100 [F] [log]	2.	Interruption
[+/−] [c]	−2.	Entry of c (−log 100)
[αβ]	3.333333333 −01	y (logx)
[F] [10^x]	2.154434689	x
[F] [αβ]	−2.	y (log x)
[F] [10^x]	0.01	x

4. Integration

This calculator can perform the definite integration of the function x^n in the "∫" mode.

Formula: $\int_a^b K x^n dx$

1) The functions assigned to the special function keys.

[a] [b] [K] [∫dx] [4]

[ ] [ ] [ ] [ ]

[a] Used to enter a.

[b] Used to enter b.

[K] Used to enter the coefficient (k).

[∫dx] Used to enter n. and perform the definite integration.

2) Calculation method

Ex.1 Calculates $\int_1^3 4x^2 dx$

Key operation	Display	Note
"∫" [C]	0.	
1 [a]	1.	Entry of a
3 [b]	3.	Entry of b
4 [K]	4.	Entry of k
2 [∫dx]	34.66666667	Ans.

- Since the machine assumes that, as soon as one of a, b or k values have been entered, the integration has started, there will be no arithmetic functions working until the integration has been completed by the [∫dx] key.
- If you want change any values of a, b & k, simply reenter the desired numbers.

Ex. 2 Calculates $\int_0^4 (5x^4 + 4x^2 - 3x)\,dx$

$$\int_0^4 (5x^4 + 4x^2 - 3x)\,dx = \int_0^4 5x^4 dx + \int_0^4 4x^2 dx - \int_0^4 3x\,dx$$

Key operation	Display	Note
"∫" [C]	0.	
0 [a] 4 [b] 5 [K] 4 [∫dx] [+]	1024.	
0 [a] 4 [b] 4 [K] 2 [∫dx] [−]	1109.333333	
0 [a] 4 [b] 3 [K] 1 [∫dx] [=]	1085.333333	Ans.

Ex.3 $\frac{1}{2} \times 7 \times 12 \times \sin 52 + \int_{-1}^{3} 3x dx - \int_{-1}^{3} (\frac{1}{3}x^2 + 1) dx =$

Key operation	Display	Note
"∫" "DEG" [C]	0.	
2 [F] [1/x] [×] 7 [×]	3.5	
12 [×] 52 [sin] [+]	33.09645165	
1 [+/−] [a] 3 [b]	3.	
3 [K] 1 [∫dx] [−]	45.09645165	
1 [+/−] [a] 3 [b]	3.	
3 [F] [1/x] [K] 2 [∫dx] [+]	41.98534053	
1 [+/−] [a] 3 [b] 1 [K] 0 [∫dx]	4.	
[=]	45.98534053	Ans.

5. Complex number calculation and coordinate conversion

- This calculator can perform the four (4) arithmetics and chain calculations of complex numbers in the "a + bi" mode.

- Set the special function mode selector at the "a + bi" mode.

1) The functions assigned to the special function keys.

[a] [b] [→rθ] [→xy] [S]
[ ] [ ] [ ] [ ]

[a]
- Used to enter the real number portion of the complex number and display the real number portion of the calculated result.
- Used to enter the value of x in rectangular coordinates or the value of r in polar coordinates.
- And also used to display the value of x or r of the calculated result.

[b]
- Used to enter the imaginary number portion of the complex number and display the imaginary number portion of the calculated result.
- Used to enter the value of y in rectangular coordinate or the value of θ in polar coordinates.
- And also used to display the value of y or θ of the calculated result.

[→rθ] Used to convert rectangular coordinates into polar coordinates.

[→xy] Used to convert polar coordinates into rectangular coordinates.

2) Calculation method

a) Complex number calculation

Four (4) arithmetic calculations of the complex number will be performed by the following method.

Addition	$(a+bi) + (c+di) = (a+c) + i(b+d)$
Subtraction	$(a+bi) - (c+di) = (a-c) + i(b-d)$
Multiplication	$(a+bi) \times (c+di) = (ac-bd) + i(ad+bc)$
Division	$(a+bi) \div (c+di) = \frac{ac+bd}{c^2+d^2} + i\,\frac{bc-ad}{c^2+d^2}$

Ex. 1 $(5 + 4i) + (6 + 3i) =$

Key operation		Display	Note
"a+bi"	[C]	0.	
	5 [a]	5.	Entry of real number portion
	4 [b]	4.	Entry of imaginary number portion
	[+]	0.	
	6 [a]	6.	Entry of real number portion

Key operation		Display	Note
	3 [b]	3.	Entry of imaginary number portion
	[=]	R 0.	Execution
	[a]	11.	Ans. Real number portion
	[b]	7.	Ans. Imaginary number portion

Note:
- Even when both of a and b are zero, either a or b must be entered, otherwise the four (4) arithmetic calculations will become impossible.
- To correct a mis-entry of a or b, simply re-enter the right number.

Ex. 2 $(12 - 6i) + (7 + 15i) - (11 + 4i) =$

Key operation		Display	Note
"a+bi"	[C]	0.	
12 [a] 6 [+/-] [b]	[+]	0.	
7 [a] 15 [b]	[−]	0.	
11 [a] 4 [b]	[=]	R 0.	
	[a]	8.	Ans. real number portion
	[b]	5.	Ans. imaginary number portion
	[a]	8.	Recall the real number portion

Ex. 3 4 x (7 − 9i) x (−12 + 11i) =

Key operation		Display	Note
"a+bi" C		0.	
4 a X		0.	
7 a 9 +/− b X		0.	
12 +/− a 11 b =	R	0.	
a		60.	Ans. real number portion
b		740.	Ans. imaginary number portion

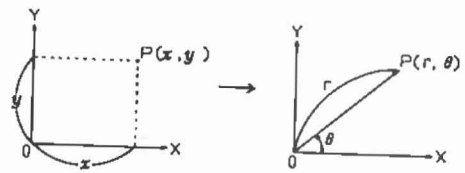
Ex. 4 16 (sin 30 + i cos 30) ÷ (sin 50 + i cos 50) =

Key operation		Display	Note
"a+bi" "DEG" C		0.	
16 a X		0.	
30 sin a		0.5	
30 cos b ÷		0.	
50 sin a		0.766044443	
50 cos b =	R	0.	
a		15.03508193	Ans. Real number portion
b		5.472322287	Ans. Imaginary number portion

b) Coordinate conversion

Before starting calculations, set the DEG/RAD/GRAD selector to a proper angular mode depending upon necessity.

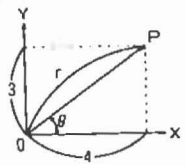
Rectangular coordinate → polar coordinate conversion



$$r = \sqrt{x^2 + y^2}$$

$$\theta = \tan^{-1}\frac{y}{x}$$

Ex.1 Supposing that the rectangular coordinates of point p is (4, 3), the corresponding polar coordinates (r, θ) can be determined as follows;



Key operation		Display	Note
"a+bi" "DEG" C		0.	
4 a		4.	Entry of x
3 b		3.	Entry of y
→rθ	R	0.	Execution
a		5.	Ans. r
b		36.86989765	Ans. θ

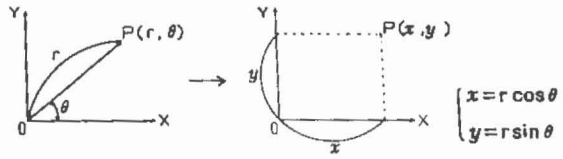
Ex. 2 Calculates the product ($Z_1 \times Z_2$), the absolute value and the amplitude.

$Z_1 = 12 + 9i$

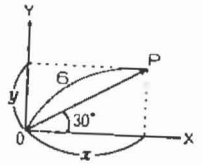
$Z_2 = 7 + 3i$

Key operation	Display	Note
"a+bi" "DEG" [C]	0.	
12 [a] 9 [b] [×]	0.	
7 [a] 3 [b] [=]	R 0.	
[a]	57.	
[b]	99.	
[→rθ]	R 0.	
[a]	114.2365966	Absolute value
[b]	60.06848815	Amplitude

Polar coordinate → rectangular coordinate conversion



Ex. 3 Calculates the values of x and y.



Key operation	Display	Note
"a+bi" "DEG" [C]	0.	
6 [a]	6.	Entry of r
30 [b]	30.	Entry of θ
[→xy]	R 0.	Execution
[a]	5.196152424	Ans. x
[b]	3.	Ans. y

6. Calculation of the vector

This calculator can perform addition, subtraction, inner vector and cross angle of the two vectors, and coordinate conversion similar to the "a + bi" mode.

$\vec{V} = (V_1, V_2)$

1) The functions assigned to the special function keys.

[V1] [V2] [→rθ] [→xy] [6]

[V1]
- Used to enter the component x of the vector and to display the component x of the calculated result in addition and subtraction.
- Used to enter the value of x in rectangular coordinates or the value of r in polar coordinates.
- And also used to display the value of x or r of the calculated result.

[V2]
- Used to enter the component y in the vector and to display the component y of the calculated result in addition and subtraction.
- Used to enter the value of y in rectangular coordinates or the value of θ in polar coordinates.
- And also used to display the value of y or θ of the calculated result.

[→rθ] Used to convert rectangular coordinates into polar coordinates.

[→xy] Used to convert polar coordinates into rectangular coordinates.

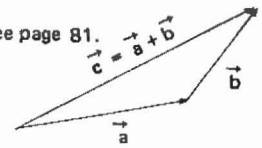
2) Calculation method

As to the calculation method for the coordinate conversions, see page 81.

a) Addition and subtraction of two vectors

Ex. 1 Calculates the component x and y of the vector c.

$\vec{a} = (5, 1)$, $\vec{b} = (2, 3)$, $\vec{c} = \vec{a} + \vec{b}$

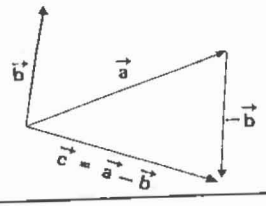


Key operation		Display	Note
"$\vec{V}$"	C	0.	
5	V1	5.	Entry the component x of $\vec{a}$
1	V2	1.	Entry the component y of $\vec{a}$
	+	0.	
2	V1	2.	Entry the component x of $\vec{b}$
3	V2	3.	Entry the component y of $\vec{b}$
	=	A 0.	Execution
	V1	7.	The component x of $\vec{c}$
	V2	4.	The component y of $\vec{c}$

Ex. 2 Calculates the components x and y of the vector c.

$\vec{c} = \vec{a} - \vec{b}$

$\vec{a}$ (7, 2), $\vec{b}$ (1, 4)



Key operation		Display	Note
"$\vec{V}$"	C	0.	
7	V1 2 V2	0.	
	−	0.	
1	V1 4 V2	A 0.	
	=	6.	The component x of $\vec{c}$
	V1	−2.	The components y of $\vec{c}$
	V2		

b) Inner product of two vectors

$(\vec{a}, \vec{b}) = a_1 b_1 + a_2 b_2$

Ex. 3 Calculates the inner product of two vectors

$\vec{a} = (12, 3)$, $\vec{b} = (7, 6)$

Key operation		Display	Note
"$\vec{V}$"	C	0.	
12	V1	12.	Entry of a_1
3	V2	3.	Entry of a_2
	×	0.	
7	V1	7.	Entry of b_1
6	V2	6.	Entry of b_2
	=	102.	Ans.

c) Cross angle

Cross angle of the vector $\vec{a} = (a_1, a_2)$ and $\vec{b} = (b_1, b_2)$ can be obtained by the following formula.

$$\theta = \cos^{-1} \frac{a_1 b_1 + a_2 b_2}{\sqrt{(a_1^2 + a_2^2)(b_1^2 + b_2^2)}}$$

Ex. 4 Vector $\vec{a}$ (12, 3) and $\vec{b}$ (7, 6)

Key operation		Display	Note
"$\vec{V}$" "DEG"	C	0.	
12	V1	12.	Entry of a_1
3	V2	3.	Entry of a_2
	÷	0.	
7	V1	7.	Entry of b_1
6	V2	6.	Entry of b_2
	=	26.56506109	Ans.

CALCULATION RANGE

- **The entry and four (4) arithmetic calculations:**
  1st and 2nd operand, calculated result: $\pm 1 \times 10^{-99} \sim \pm 9.999999999 \times 10^{99}$
- Scientific and special functions:
  The accuracy will become low around singular points and inflection points.

Functions	Max. error	Dynamic range	Note
$\sin x$	±1 at the 9th digit	DEG: $5.729577952\times10^{-49} \leqq \lvert x\rvert < 1\times10^{10}$ GRAD: $6.366197725 \times 10^{-49} \leqq \lvert x\rvert < 1 \times 10^{10}$ RAD: $1 \times 10^{-50} < \lvert x\rvert < 1 \times 10^{10}$, $x = 0$	
$\cos x$	±1 at the 9th digit	DEG: $1\times10^{-99} \leqq \lvert x\rvert < 1 \times 10^{10}$ GRAD: $1\times10^{-99} \leqq \lvert x\rvert < 1 \times 10^{10}$ RAD: $\frac{\pi}{180}\times10^{-96} < \lvert x\rvert < 1\times10^{10}$, $x = 0$	$\pi = 3.141592653$

$\tan x$	±1 at the 9th digit	DEG: $5.729577952\times10^{-98} \leqq \lvert x\rvert < 1\times10^{10}$, $x=0$, $\lvert x\rvert \neq 90\times(2n-1)$ GRAD: $6.366197724\times10^{-98} < \lvert x\rvert < 1\times10^{10}$, $x = 0$, $\lvert x\rvert \neq 100\times(2n-1)$ RAD: $\frac{\pi}{180}\times10^{-96} < \lvert x\rvert < 1\times10^{10}$, $x = 0$, $\lvert x\rvert \neq \frac{\pi}{2}\times(2n-1)$	n : integer
$\sin^{-1} x$ $\cos^{-1} x$	±1 at the 9th digit	$1\times10^{-50} < \lvert x\rvert \leqq 1$, $x = 0$	
$\tan^{-1} x$	±1 at the 10th digit	$1\times10^{-99} \leqq \lvert x\rvert \leqq 1\times10^{99}$, $x=0$	

$\sinh x$ $\cosh x$	±1 at the 9th digit	$1\times10^{-99} \leqq \lvert x\rvert < 227.9559243$ $x = 0$	When the value of x in the vicinity of 0, the accuracy vecomes low.
$\tanh x$	±1 at the 9th digit	$1\times10^{-99} \leqq \lvert x\rvert < 1\times10^{100}$, $x=0$	When the value of x in the vicinity of 0, the accuracy becomes low
$\sinh^{-1} x$	±1 at the 9th digit	$\sqrt{10}\times10^{-50} < \lvert x\rvert < 10^{50}$, $x=0$	$\sqrt{10} = 3.16227766$
$\cosh^{-1} x$	±1 at the 9th digit	$1 \leqq x < 1 \times 10^{50}$	
$\tanh^{-1} x$	±1 at the 9th digit	$1\times10^{-99} \leqq \lvert x\rvert < 1$, $x = 0$	
→ DEG → D.MS	±1 at the 10th digit	$1\times10^{-99} \leqq \lvert x\rvert < 1\times10^{100}$, $x = 0$	

e^x	±1 at the 9th digit	$-227.9559243 < x \leqq -1\times10^{-99}$ $1\times10^{-99} \leqq x < 230.2585093$ $x = 0$	
10^x	±1 at the 9th digit	$-99 \leqq x \leqq -1\times10^{-99}$ $1\times10^{-99} \leqq x < 100$, $x = 0$	
$\ln x$	±1 at the 10th digit	$1 \times 10^{-99} \leqq x < 1 \times 10^{100}$	When the value of x is in the vicinity of 1, the accuracy is low.
$\log x$	±2 at the 10th digit		
x^2	±1 at the 10 digit	$\sqrt{10}\times10^{-50} < \lvert x\rvert < 1 \times 10^{50}$ $x = 0$	
$\sqrt{x}$	±1 at the 9th digit	$1\times10^{-99} \leqq x < 1 \times 10^{100}$, $x = 0$	
$\sqrt[3]{x}$	±1 at the 9th digit	$1 \times 10^{-99} \leqq \lvert x\rvert < 1 \times 10^{100}$, $x = 0$	

$1/x$	±1 at the 10th digit	$1\times10^{-99} \leqq \lvert x\rvert \leqq 1\times10^{99}$	
$n!$	±1 at the 10th digit	$0 \leqq n \leqq 69$ (n: integer)	
y^x	±1 at the 9th digit	$-227.9559243 < x\cdot\ln y \leqq -1\times10^{-99}$ and $1\times10^{-99} \leqq x\cdot\ln y < 230.2585093$ $x\cdot\ln y = 0$ $1\times10^{-99} \leqq y < 1\times10^{100}$, $y = 0$	
$\sqrt[x]{y}$	±1 at the 9th digit	$-227.9559243 < \frac{1}{x}\cdot\ln y \leqq -1\times10^{-99}$ and $1\times10^{-99} \leqq \frac{1}{x}\cdot\ln y < 230.2585093$ $\frac{1}{x}\cdot\ln y = 0$ $1\times10^{-99} \leqq y < 1\times10^{100}$, $y = 0$	

nPr	±2 at the 10th digit	$0 \leqq r \leqq n \leqq 69$ (n, r: integer)	
nCr	±3 at the 10th digit		
Quadratic equation	±1 at the 9th digit	$ax^2+bx+c = 0$, $a \neq 0$ $1\times10^{-99} \leqq \lvert x\rvert, \lvert x'\rvert < 10^{100}$ $x, x' = 0$	x : Final result x': Intermediate result
Statistical calculation	· n, Σxi ±1 at the 10th digit · $\bar{x}$, Σx^2 ±1 at the 10th digit	① DATA, CD · $1\times10^{-99} \leqq \lvert\Sigma x_i\rvert < 1\times10^{100}$, $\Sigma xi = 0$ · $1\times10^{-99} \leqq \lvert\Sigma x_i^2\rvert < 1\times10^{100}$, $\Sigma x_i^2 = 0$ · n' : positive integer ② $\bar{x}$ · $0 < n$	number of samples (integer)

Statistical calculation	· s, σ ±1 at the 9th digit	③ s · $1 < n$ · $1\times10^{-99} \leqq \frac{\Sigma xi^2-n\bar{x}^2}{n-1} < 1\times10^{100}$ $\frac{\Sigma xi^2-n\bar{x}^2}{n-1} = 0$ ④ σ · $0 < n$ · $1\times10^{-99} \leqq \frac{\Sigma xi^2-n\bar{x}^2}{n} < 1\times10^{100}$ $\frac{\Sigma xi^2-n\bar{x}^2}{n} = 0$	$S = \sqrt{\frac{\Sigma xi^2-n\bar{x}^2}{n-1}}$ $\sigma = \sqrt{\frac{\Sigma xi^2-n\bar{x}^2}{n}}$

Integration	±1 at the 9th digits	$A = \int_a^b kx^n dx = \frac{k}{n+1}[x^{n+1}]_a^b$; · $0 \leqq n \leqq 98$ (n: integer) · A: Final result · A': Intermediate result · $1\times10^{-99} \leqq \lvert A\rvert, \lvert A'\rvert < 1\times10^{100}$ $A, A' = 0$	
Complex number	· Addition/ subtraction ±1 at the 10th digits · Multiplication ±2 at the 10th digits	$(A+Bi) \overset{+}{\underset{\div}{\times}} (C+Di)$; ① Addition/subtraction $1\times10^{-99} \leqq \lvert A\pm C\rvert < 1\times10^{100}$ $1\times10^{-99} \leqq \lvert B\pm D\rvert < 1\times10^{100}$ $(A\pm C), (B\pm D) = 0$ ② Multiplication $a=(AC-BD)$, $b=(AD+BC)$; a, b: Final result a', b': Intermediate result $1\times10^{-99} \leqq \lvert a\rvert, \lvert b\rvert < 1\times10^{100}$ $1\times10^{-99} \leqq \lvert a'\rvert, \lvert b'\rvert < 1\times10^{100}$ $a, b, a', b' = 0$	

	· Division ±3 at the 10th digits	③ Division $a = \frac{AC+BD}{C^2+D^2}$, $b = \frac{BC-AD}{C^2+D^2}$; a, b: Final result a', b': Intermediate result $1\times10^{-99} \leqq \|a\|, \|b\|, \|a'\|, \|b'\| < 1\times10^{100}$ a, b, a', b' = 0 $C^2 + D^2 \neq 0$	
Coordinate conversion		① $\rightarrow r, \theta$ · $1\times10^{-99} \leqq (x^2+y^2) < 1\times10^{100}$ · $x^2+y^2 = 0$ · $\frac{y}{x}$; x has the same condition as the x of $\tan^{-1}$	$r = \sqrt{x^2+y^2}$ $\theta = \tan^{-1}\frac{y}{x}$

	±1 at the 9th digits	② $\rightarrow x, y$ · $1\times10^{-99} \leqq r < 1\times10^{100}$, $r=0$ · θ has the same condition as the x of sin x and cos x mentioned above. · $1\times10^{-99} \leqq \|r\sin\theta\| < 1\times10^{100}$ $1\times10^{-99} \leqq \|r\cos\theta\| < 1\times10^{100}$ $\|r\sin\theta\|, \|r\cos\theta\| = 0$	$x = r\cos\theta$ $y = r\sin\theta$
Vector	· Add./sub. ±1 at the 10th digits Inner product · Inner product ±2 at the 10th digits	(A, B) $\overset{+}{\underset{\div}{\times}}$ (C, D) ; ① Add./sub. The same condition as the add./sub. of the complex numbers. ② Inner product $x = AC + BD$; x : Final result x' : Intermediate result $1\times10^{-99} \leqq \|x\|, \|x'\| < 1\times10^{100}$ $x, x' = 0$	

	· cross angle ±2 at the 9th digits	③ Cross angle $x = \frac{AC+BD}{\sqrt{(A^2+B^2)(C^2+D^2)}}$; x : Final result x' : Intermediate result $1\times10^{-99} \leqq \|x'\| < 1\times10^{100}$, $x = 0$ $1\times10^{-50} < \|x\| \leqq 1$, $x = 0$ here, $(A^2+B^2)(C^2+D^2) \neq 0$	Cross angle θ of (A, B) (C, D); $\theta = \cos^{-1}\frac{AC+BD}{\sqrt{(A^2+B^2)(C^2+D^2)}}$

SPECIFICATIONS

Model:	EL-5001
Display capacity:	Mantissa 10 digits, Exponent 2 digits
Decimal point system:	Automatic changeover from floating decimal point display system to exponential display system and vice versa.
Symbol:	Minus symbol appears both in mantissa and exponents portion.
Calculations:	Four arithmetic calculations, multiplication and division by constant, memory, Degree/minute/second ↔ decimal degrees conversion, trigonometric function, inverse trigonometric function, logarithmic function, exponential square and power, cube root, square root and $\sqrt[x]{y}$, reciprocal, factorial, coordinate conversion, statistical calculation, hyperbolic and inverse hyperbolic functions, permutation, combination, percent change, plot, quadratic equation, vector, definite integration, etc.
Component:	LSI etc.
Display:	Fluorescent display tube
Power supply:	DC: 3V (AA x 2 pcs.) DC: 2.4V (with rechargeable Ni-Cd battery pack, EA-18B) AC: 120V (with AC adaptor EA-17)
Operating time:	Approx. 8 hours (AA, in the continuous operation) Approx. 7 hours (with EA-18B, in the continuous operation, charging time: 15 hours) Display 55555. at the ambient temperature: 20°C (68°F). The operating time slightly changes depending on the type of battery or the way of use.
Ambient temperature:	0°C ~ 40°C (32°F ~ 104°F)
Power consumption:	DC: 3V 0.25W (with AA) DC: 2.4V 0.25W (with EA-18B) DC: 3V 0.35W (with EA-17 and EA-18B)

Dimensions:	Approx. 87(W) x 164(D) x 26(H) mm 3-7/16"(W) x 6-7/16"(D) x 1"(H)
Weight:	Approx. 215g (0.47 lbs.)

INTERNATIONAL WARRANTY SYSTEM

Within the period of one (1) year from the date of purchase, warranty repair service may be obtained for any Sharp battery-operated consumer calculator at any of the service centers listed below. An International Warranty Certificate must be presented with the calculator.

Australia, Hong Kong, Iran, Japan, Kuwait, Lebanon, Malaysia, Panama, Philippines, Singapore, South Africa, Thailand, United Kingdom, U.S.A., West Germany

The International Warranty Certificate is not required for warranty repair within the continental United States. However, if you plan to travel abroad, an International Warranty Certificate may be obtained free of charge by sending your dated proof of purchase listing the model and serial number of your calculator to Sharp Electronics Corporation, 10 Keystone Place, Paramus, New Jersey 07652. Attn: National Service Manager. Your proof of purchase will be returned to you along with your International Warranty Certificate. Please allow three (3) weeks for processing.

SERVICE CENTER ADDRESS

SHARP ELECTRONICS CORPORATION
10 Keystone Place Paramus, New Jersey 07652
(201) 265-5600

SHARP ELECTRONICS CORPORATION
214 Harvard Avenue, Boston, Massachusetts 02134
(617) 738-1905

SHARP ELECTRONICS CORPORATION
Century Annex
341 Jefferson Davis Highway Arlington, Virginia, 22202
(703)-521-6570

SHARP ELECTRONICS CORPORATION
6478 I-85 Norcross, Georgia 30071
(404) 448-5230

SHARP ELECTRONICS CORPORATION
430 East plainfield Road, Countryside, LaGrange, Illinois 60525
(312) 242-0870

SHARP ELECTRONICS CORPORATION
21580 Wilmington Avenue, Long Beach, California 90810
(213) 830-4470

SHARP ELECTRONICS CORPORATION
1205 Executive Drive, East Richardson, Texas. 75080
(214) 234-1136