MASTER

CASIO®

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SCIENTIFIC CALCULATOR
CALCULADORA CIENTIFICA

CASIO *fx-180P*

OPERATION MANUAL
MANUAL DE OPERACION

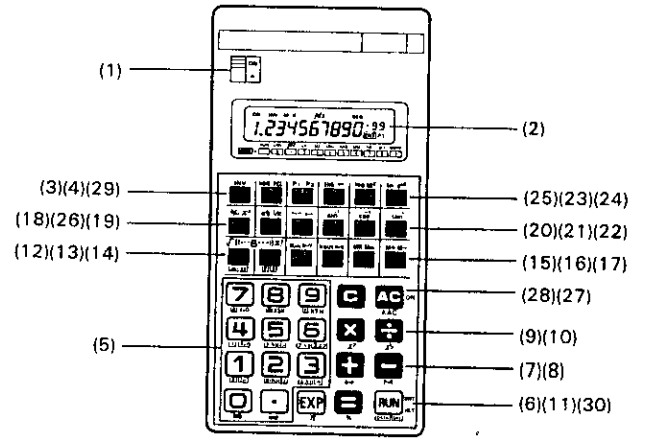
Dear customer,
Thank you very much for purchasing our scientific calculator.
This high-performance, pocket-size calculator employs true algebraic logic (judging the precedence of operations) and allows the use of up to 18 nesting parentheses at six levels. Its major features are 55 functions, seven memory registers, regression analysis, integrals, and up to 38 programmable steps for repeated calculation.
This booklet will familiarize you with the many ways this highly capable unit can serve you.

INDEX

■ Internal registers (user registers)

X-register (display)	• Used in arithmetic and functional calculations
Y (L1)-register	
L2-register	• Used in calculations with nesting parentheses and for judging the precedence of addition/subtraction and multiplication/division.
L3-register	
L4-register	
L5-register	
L6-register	
M-register	• Independent memory register (RM, M+, M−, MR)
K1 (Σx^2) register	• Constant memory registers (Kin, Kout, 1 − 6)
K2 (Σx) register	• For storing intermediate results (Σx^2, Σx, n, etc.) of statistical calculations.
K3 (n) register	
K4 (Σy^2) register	
K5 (Σy) register	
K6 (Σxy) register	

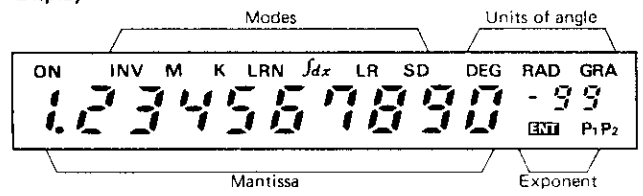
1/NOMENCLATURE



(1) Power switch

Move the switch to the right to activate the calculator and "ON" is displayed. Even when power is off, the contents held in independent memory and constant memory registers, and the programs are not lost.

(2) Display



The display shows input data, intermediate results and results of operation. The mantissa section displays up to 10 digits (9 for negative numbers). The exponent section displays up to ±99.
The fraction and angle in the sexagesimal scale are displayed as follows:

$456\frac{12}{23}$ is displayed . . . . . 456⌟12⌟23.

12°34'56.7" is displayed . . . 12°34°56.7

"E" (error check, see page 10) may be displayed in the position of the mantissa's least significant digit. "DEG", "RAD" or "GRA" (angular unit), "INV" (when the INV key has been pressed), "M" (when data is stored in independent memory), "K" (during calculation with constants), "SD" (during calculation of standard deviation), "LR" (during calculation of regression analysis), and/or "$\int dx$" (during execution of integral), as well as "LRN" and "ENT" will be displayed to indicate the operating mode.

Auto power-off

If the calculator is left with the power switch at the "ON" position (except while programmed calculation), the auto power-off function automatically turns off the power in approximately 6 minutes, thereby saving battery life. Power is resumed either by pressing the AC key or by re-operating the ON-OFF switch.
(Even when power is off, the contents of memories and written programs as well as the angular unit and operating mode are not lost.)

(3) INV Inverse key (symbolized by INV)

Activates the functions printed in brown on the keyboard.
When the INV key is pressed, "INV" appears on the display and the subsequent pressing of INV makes "INV" disappear.

(4) MODE Mode key (symbolized by MODE)

To put the calculator into the desired operating mode or select a specific angular unit, press MODE first, then ·, 1, ... , or 9.

- MODE · : Manual and programmed calculations can be executed.
- MODE 0 : "LRN" is displayed. Programs can be written.
- MODE 1 : "$\int dx$" is displayed. Integral can be carried out.
- MODE 2 : "LR" is displayed. Calculation of regression analysis can be executed.

- MODE 3 : "SD" is displayed. Calculation of standard deviation can be executed.

To carry out manual or programmed calculation, select the RUN mode (press MODE and ·).

- MODE 4 : "DEG" is displayed, indicating that "degrees" is selected as the unit of angle.
- MODE 5 : "RAD" is displayed, indicating that "radians" is selected as the unit of angle.
- MODE 6 : "GRA" is displayed, indicating that "gradient" is selected as the unit of angle.

(Note: 90 degrees = $\pi/2$ radians = 100 gradients)

- MODE 7 : "Fix" assignment (assignment for the number of fractional digits). Specify the number of digits of the fractional part after pressing MODE and 7. (Example: MODE 7 3 (three fractional digits are effective))
- MODE 8 : "Scientific" assignment (assignment for the number of significant digits). Specify the number of significant digits after pressing MODE and 8. (Example: MODE 8 4)
- MODE 9 : "Normal" assignment. Press in this sequence to release the "fix" or "scientific" assignment.

To clear programs, press this key, following the INV key. (INV CA denotes this "program clear" sequence.)
Once power is off, the "fix" and "scientific" assignments will be released but the operating mode ("LRN", "$\int dx$", "LR" or "SD") and the angular unit ("DEG", "RAD" or "GRA") will be kept.

(5) 0 – 9, · Numeral and decimal point keys

Enters numerals. For decimal places, use the · key in its logical sequence.
Varying functions will be designated when you press INV and a numeral key, as summarized below.

- INV 0 (x=0) : Cutting off internal data
  The internal data (held in the Y-register) will be cut off so as to be equal to the displayed data.
- INV · (RAN#) : Random number generation
  A random number between 0.000 and 0.999 will be generated.

Use following sequences in calculation of standard deviation and in regression analysis. For more details, refer to the chapter 6 "STATISTICAL CALCULATIONS".

- INV 4 (x̄) : Calculation of $\bar{x}$ (average of x)
- INV 5 (σn) : Calculation of $x\sigma_n$ (population standard deviation of x)
- INV 6 (σn-1) : Calculation of $x\sigma_{n-1}$ (sample standard deviation of x)
- INV 7 (ȳ) : Calculation of $\bar{y}$ (average of y)
- INV 8 (yσn) : Calculation of $y\sigma_n$ (population standard deviation of y)
- INV 9 (yσn-1) : Calculation of $y\sigma_{n-1}$ (sample standard deviation of y)
- INV + (A) : Calculation of A (constant terms in regression equations)
- INV − (B) : Calculation of B (regression coefficients)
- INV × (r) : Calculation of r (correlation coefficients)

* Different functions will be designated when you press [Kout], then a numeral key as summarized below.

- [Kout] [Σx^2] : Calculation of Σx^2 (square sum of x)
- [Kout] [Σx] : Calculation of Σx (total sum of x)
- [Kout] [n] : Calculation of n (number of data)
- [Kout] [Σy^2] : Calculation of Σy^2 (square sum of y)
- [Kout] [Σy] : Calculation of Σy (total sum of y)
- [Kout] [Σxy] : Calculation of Σxy (inner product)

* Use [INV][$\hat{x}_{y=0}$], [INV][$\hat{y}_{x=0}$] and [INV][$\hat{x}_{M=K}$] only for writing programs (in "LRN" mode).

- [INV][$\hat{x}_{y=0}$] : Conditional jump
  "Return to the first step of the program when the contents of the X-register (display) is positive and otherwise go to the next step."
- [INV][$\hat{y}_{x=0}$] : Conditional jump
  "Return to the first step of the program when the contents of the X-register is equal to or smaller than those of the M-register (independent memory) and otherwise go to the next step."
- [INV][$\hat{x}_{M=K}$] : Unconditional jump ("Return")
  Press these keys to return to the first step of the program unconditionally.

(6) [EXP/π] Exponent/Pi entry key

- Enters the exponent of ten up to ±99. To enter 2.34×10^{56}, for example, press [2][.][3][4][EXP][5][5] in sequence **(symbolized by [EXP])**.
- Enters circular constant in 10 digits (3.141592654) when pressed after [×], [÷], [−], [INV] or a function command key **(symbolized by [π])**.

(7) [+/$R \to P$] Addition/Rectangular → polar key

- Enters summands.
- Performs rectangular to polar co-ordinates conversion when pressed after the [INV] key.

(8) [−/$P \to R$] Subtraction/Polar → rectangular key

- Enters minuend.
- Performs polar to rectangular co-ordinates conversion when pressed after the [INV] key.

(9) [×/x^y] Multiplication/Power key

- Enters multiplicand.
- Raises the base x to yth power when pressed after the [INV] key.

(10) [÷/$\sqrt[y]{x}$] Division/Root key

- Enters dividend.
- Calculates the yth root of x when pressed after the [INV] key.

(11) [=/%] Equal/Percent key

- Obtains answer.
- Perform regular percentages, add-ons, discounts, ratios and increase/decrease values when pressed after the [INV] key.

(12) [(/$\sqrt{\ }$/Σ-] Open parenthesis/Square root/Regression analysis data input key

- Opens the parentheses. Nesting of up to 18 parentheses at six levels is allowed.
- Extracts the square root of the displayed number when pressed after the [INV] key. (In this manual this sequence is represented by [INV][$\sqrt{\ }$]. Other sequences described below are also represented in the same way.)
- Enters data (x) in regression analysis ("LR" mode).

(13) [)/n!/$\hat{y}$/$\hat{x}$] Close parenthesis/Factorial/Regression analysis estimator key

- Closes the parentheses.
- Obtains the factorial of the displayed number when pressed after the [INV] key.
- Obtains an estimator of regression in regression analysis ("LR" mode). $\hat{y}$ will be obtained if you press it immediately after data entry and $\hat{x}$ if you press it following [INV] after data entry.

(14) [STO] Constant memory entry/Register exchange key

- Enters numbers into each constant memory, through operation of ENTRY [Kin][1] (to [5]).

Example: To enter 12.3 into constant memory 3.
12[.]3[Kin][3]

- Exchanges the displayed number (X-register) with the content of the working register (Y-register) when pressed after the [INV] key.

(15) [RCL] Constant memory recall/Register exchange key

- Recalls the contents in each constant memory without clearing, through operation of [Kout][1] (to [5]).

Example: To recall the contents of constant memory 5.
[Kout][5]

- Exchanges the displayed number (X-register) with the contents of a constant memory (K-register) when pressed after the [INV] key.

Example: To exchange the contents of constant memory 2 with the displayed number.
[INV][x⇔K][2]

(16) [M−] Independent memory recall/Independent memory entry key

- Recalls the contents of the independent memory (M-register) without clearing.
- Puts the displayed number in the independent memory when pressed after the [INV] key. Old data held in the memory will be automatically erased.

(17) [M+] Memory plus (minus) key

- Adds the displayed number to the contents of the independent memory, and obtains answer in 4 basic calculations/$x^y/\sqrt[y]{x}$ and automatically adds it to the contents of the memory.
- Subtracts the displayed number from the contents of the independent memory, and obtains answer in 4 basic calculations/$x^y/\sqrt[y]{x}$ and automatically subtracts it from the contents of the memory when pressed after the [INV] key.

(18) [+/−/x^2] Sign change/Square key

- Changes the sign of the displayed number from plus to minus and vice versa.
- Obtains the square of the displayed number when pressed after the [INV] key.

(19) [°'"] Sexagesimal/Decimal conversion key

- Converts the sexagesimal figure to decimal notation.
- Converts the decimal notation to sexagesimal notation when pressed after the [INV] key.

(20) [sin] Sine/Arc sine key

- Obtains the sine of the displayed angle.
- Obtains the angle when pressed after the [INV] key.

(21) [cos] Cosine/Arc cosine key

- Obtains the cosine of the displayed angle.
- Obtains the angle when pressed after the [INV] key.

3/BEFORE USING THE CALCULATOR

Select the SD mode (press MODE 3) for standard deviation, the LR mode (press MODE 2) for regression analysis, the $\int dx$ mode (MODE 1) for carrying out integral, and the RUN mode (MODE ·) for ordinary arithmetic and functional calculations.
Select the LRN mode (MODE 0) to write a program.
Whatever angular unit is displayed does not matter in calculation which does not use angular data.

■ Precedence of operations and precedence levels

- This calculator automatically evaluates precedence of operations and executes in the proper sequence thus determined. The precedence of operations is as follows.
  ① Functions
  ② x^y, $\sqrt[y]{\ }$
  ③ Multiplication and division
  ④ Addition and subtraction
  Operations of the same precedence will be carried out in the order of input. An expression enclosed with a pair of parentheses will be given the highest precedence level.
- Internal registers L1 to L6 are used to retain intermediate results of operations, including expressions enclosed with parentheses, which have low precedence levels. Therefore, intermediate results of up to six levels may be retained.
- Up to three nested parentheses will be given the same precedence level. As a result, parentheses can be nested up to 18 pairs.
- How to evaluate precedence levels (an example of 4 levels and 5 pairs of nested parentheses)

Expression: $2\times\{\{(3+4\times\{(5+4)\div3\})\div5\}+9\}=$

Entry operation: 2 × (((3 + 4 × ((5 + 4) ÷ 3)) ÷ 5) + 9) =

1 level 1 level 1 level 1 level Ⓐ

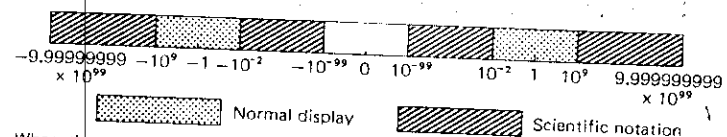
Contents of registers when entry has proceeded to Ⓐ

X	4
L1	((5+
L2	4x
L3	(((3+
L4	2x
L5	
L6	

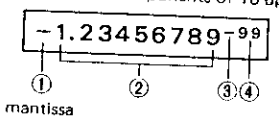
■ Correction

- If you are aware of data entry error before pressing a command key, press C and re-input the correct data.
- In a series of calculations, you can correct a wrong intermediate result of a functional calculation or within nested parentheses: press C and calculate the correct value, then resume the interrupted sequence of calculations.
- If you have pressed +, −, ×, ÷, INV $\sqrt[y]{\ }$ or INV x^y by mistake, you may press the correct key immediately. Note that, though the correct operation overrides the wrong one designated first, the precedence of operation of the first command remains effective.

■ Calculation range and scientific notation



When the answer exceeds the normal display capacity, it is automatically shown by scientific notation, 10-digit mantissa and exponents of 10 up to ±99.



① The minus (−) sign for mantissa
② The mantissa
③ The minus (−) sign for exponent
④ The exponent of ten

The whole display is read: $-1.23456789\times10^{-99}$

* Entry can be made in scientific notation by using the EXP key after entering the mantissa.

EXAMPLE

-1.23456789×10^{-3}
$(=-0.00123456789)$

OPERATION	READ-OUT
1 · 23456789 %	−1.23456789
EXP	−1.23456789 00
3 %	−1.23456789 −03

■ Overflow or error check

Overflow or error is indicated by the "E." or "Ɛ." sign and stops further calculations.

Overflow or error occurs:

1) When an answer, whether intermediate or final, or accumulated total in the independent memory is more than 1×10^{100} ("E." sign appears).
2) When function calculations are performed with a number exceeding the input range ("E." sign appears).
3) When unreasonable operations are performed in statistical calculations ("E." sign appears).
   Ex.) You attempt to obtain $\bar{x}$ or σ_n without any input data ($n = 0$).
4) When the total number of levels of explicitly and/or implicitly (with addition-subtraction versus multiplication-division including x^y and $\sqrt[y]{\ }$) nested parentheses exceeds six, or more than 18 pairs of parentheses are used. ("Ɛ." sign appears.)
   Ex.) You have pressed the (key 18 times continuously before designating the sequence of 2 + 3 ×.

To release these overflow checks:

1), 2), 3) . . . . . Press the AC key.
4) . . . . Press the AC key. Or press the C key, and the intermediate result just before the overflow occurs is displayed and the subsequent calculation is possible.

(22) tan Tangent/Arc tangent key
- Obtains the tangent of the displayed angle.
- Obtains the angle when pressed after the INV key.

(23) log 10^x Common logarithm/Antilogarithm key
- Obtains the common logarithm (base 10) of the displayed number.
- Calculates the xth power of 10 when pressed after the INV key.

(24) ln e^x Natural logarithm/Exponential key
- Obtains the natural logarithm (base e) of the displayed number.
- Calculates the xth power of e (2.718281828) when pressed after the INV key.

(25) ENG Engineering key
Allows the displayed number to be shown with exponents of ten that are multiples of three (e.g., 10^3, 10^{-6}, 10^9).

Ex.) 12□3456

	12.3456
ENG	12.3456 00
ENG	12345.6 -03
ENG	12345600. -06
ENG	12345600. -06

12□3456

	12.3456
INV ENG	0.0123456 03
INV ENG	0.000012345 06
INV ENG	0.000000012 09
INV ENG	0.000000012 09
ENG	0.000012345 06
ENG	0.0123456 03

(26) a b/c 1/x Fraction entry/Reciprocal key
- Enters fractions for fraction calculations. To enter the fraction 1-2/3, for example, 1 a b/c 2 a b/c 3 in sequence.
- Obtains the reciprocal of the displayed number when pressed after the INV key.

(27) AC ON All clear key
- Clears the entire machine except the independent and constant memories, and also releases overflow or error check.
- Clears contents of all constant memories when pressed after the INV key.
- It also overrides the auto power-off function.

(28) C Clear key
Clears entry for correction.

(29) P1 P2 Program number key
This calculator is capable of holding two programs of up to 38 steps in total. P1 will be designated if you press this key and P2 if you press it after the INV key.
A sequence must be designated for executing a programmed calculation.

(30) RUN RUN/ENT/HLT/Data entry/delete key
■When a program is being written, depression of this key writes a halt instruction.

In the programmed operation mode, depression of this key restarts execution which has been temporarily suspended.
- EXE : When "LRN" is displayed (i.e.during program loading), depression of this key writes a halt instruction for data entry.
- INV Ans : When "LRN" is displayed, depression of this sequence writes a halt instruction for the display of a result.
- RUN : When execution is at a halt during programmed operation, depression of this key restarts execution.

■When "LR" or "SD" is displayed, this key works as a data entry/deletion key.
- DATA : In the SD mode, operate in the sequence of a data and DATA.
  In the LR mode, operate in the sequence of x data, $x_{on}y$, y data, and DATA.
- INV DEL : To delete the data which has just been input, press this sequence instead of DATA in the above sequences.

2/BATTERY MAINTENANCE

Two AA size manganese dry batteries (UM-3) give approximately 7,000 hours continuous operation (approx. 8,300 hours on type SUM-3).
When battery power decreases, the whole display darkens. Batteries should then be renewed. Be sure to switch OFF the power before changing.

Replacement of batteries:
1) Slide open the battery compartment lid on the back of the unit.
2) Remove dead batteries.
3) Insert new batteries with polarity as indicated.
4) Replace the battery compartment lid.
5) Press MODE 0 INV PCL MODE . INV AC ON INV Ans MODE 4 in sequence.

* Be sure to replace both batteries.
* Never leave dead batteries in the battery compartment as they may cause malfunctions.
* It is recommended that batteries be replaced once a year to prevent the chance of malfunctions due to battery leakage.

4/NORMAL CALCULATIONS

* Set the function mode to "RUN" by pressing MODE ·.
* Calculations can be performed in the same sequence as the written formula (true algebraic logic).
* Nesting of up to 18 parentheses at six levels is allowed.

4-1 Four basic calculations

* Parenthesis calculations can not be performed with the function mode at "LR".

EXAMPLE	OPERATION	READ-OUT
23+4.5−53=−25.5	23 + 4 · 5 − 53 =	−25.5
56×(−12)÷(−2.5)=268.8	56 × 12 +/− + 2 · 5 +/− =	268.8
2÷3×(1×10^20)=6.666666667×10^19	2 + 3 × 1 EXP 20 =	6.666666667 19
3+5×6 (=3+30)=33	3 + 5 × 6 =	33.
7×8−4×5 (=56−20)=36	7 × 8 − 4 × 5 =	36.
1+2−3×4÷5+6=6.6	1 + 2 − 3 × 4 + 5 + 6 =	6.6
$\frac{6}{4\times5}=0.3$	4 × 5 + 6 INV x⇄y =	0.3

* The number of depression of the (key can be displayed.

2×{7+6×(5+4)}=122	2 × (	Ⅰ01 0.
	7 + 6 × (	Ⅰ02 0.
	5 + 4)) =	122.
(2+3)×4=20	(2 + 3) × 4 =	20.
$\frac{3+4\times5}{5}$=(3+4×5)÷5=4.6	(3 + 4 × 5) ÷ 5 =	4.6

* It is unnecessary to press the) key before the = key.

10−{7×(3+6)}=−53	10 − (7 × (3 + 6 =	−53.

Another operation:

10 − (7 × (3 + 6)) =

4-2 Assignment for the number of fractional digits and the number of significant digits

* To designate the number of fractional digits, press MODE 7 *n* in sequence.
  To designate the number of significant digits, press MODE 8 *n*.
* The "FIX" and/or "SCI" assignment will not be released until another assignment is made or MODE 9 is pressed. (Power-off and auto power-off release the assignments.)
* Even when "FIX" and/or "SCI" is assigned, internal data use 11-digit mantissa. Press in the sequence INV RND to make the internal and displayed data equal.
* Press ENG and the data will be converted to representation with the exponent of which is a multiple of three.

EXAMPLE	OPERATION	READ-OUT
100÷6=16.66666666.....	100 ÷ 6 =	16.66666667
(Specifies four fractional digits)	MODE 7 4	16.6667
(Releases assignment)	MODE 9	16.66666667
(Specifies five significant digits)	MODE 8 5	1.6667 01
	MODE 9	16.66666667

* When an assignment for the number of digits is made, the data displayed is rounded up or down lowest digit position in the specified range but internal data remain unchanged in the registers. The assignment can be made at any time before or in the middle of calculation.

200÷7×14=400	MODE 7 3	0.000
	200 ÷ 7 =	28.571
(Continues calculation with internal data consisting of 11 digits.)	× 14 =	400.000

To perform the same calculation with internal rounding

	200 ÷ 7 =	28.571
(Internal rounding)	INV RND × 14 =	399.994
(Releases assignment)	MODE 9	399.994
123m×456=56088m	123 × 456 =	56088.
=56.088km	ENG	56.088 03
7.8g÷96=0.08125g	7 · 8 ÷ 96 =	0.08125
=81.25mg	ENG	81.25 -03

EXAMPLE	OPERATION	READ-OUT
12% of 1200 . . . . . 144 18% of 1200 . . . . . 216 23% of 1200 276	1200 × × 12 % 18 % 23 %	K 144. K 216. K 276.
26% of 2200 . . . . . 572 26% of 3300 . . . . . 858 26% of 3800 988	26 × × 2200 % 3300 % 3800 %	K 572. K 858. K 988.
Percentage of 30 against 192 . . . . . 15.625% Percentage of 156 against 192 . . . . . 81.25%	192 − + 30 % 156 %	K 15.625 K 81.25
600 grams was added to 1200 grams. What percent is the total to the initial weight? . . . . . 150% 510 grams was added to 1200 grams. What percent is the total to the initial weight? 142.5%	1200 + + 600 % 510 %	K 150. K 142.5
How many percent down is 138 grams to 150 grams? . . . . . down 8% How many percent down is 129 grams to 150 grams? . . . . . down 14%	150 − − 138 % 129 %	K −8. K −14.

5/FUNCTION CALCULATIONS

* Scientific function keys can be utilized as subroutines of four basic calculations (including parenthesis calculations).
* In some scientific functions, the display disappears momentarily while complicated formulas are being processed. So do not enter numerals or press a function key until the previous answer is displayed.
* For each input range of the scientific functions, refer to page 39.

5-1 Degree-Minute-Second ↔ Decimal conversion

The ° ' " key converts the sexagesimal figure (degree, minute and second) to decimal notation. Operation of INV ° ' " converts the decimal notation to the sexagesimal notation.

EXAMPLE	OPERATION	READ-OUT
14°25'36"=14.42666667°	14 ° ' "	14.
	25 ° ' "	14.41666667
	36 ° ' "	14.42666667
	INV ° ' "	14°25°36.

5-2 Trigonometric/Inverse trigonometric functions

EXAMPLE	OPERATION	READ-OUT
$\sin(\frac{\pi}{6}\text{rad})=0.5$	"RAD" (MODE 5) π ÷ 6 − sin	0.5
$\cos 63°52'41"=0.440283084$	"DEG" (MODE 4) 63 ° ' " 52 ° ' " 41 ° ' "	63.87805555
	cos	0.440283084
$\tan(-35\text{gra})=-0.61280078$	"GRA" (MODE 6) 35 +/- tan	−0.61280078
$2\cdot\sin 45°\times\cos 65°=0.597672477$	"DEG" 2 × 45 sin × 65 cos =	0.597672477
$\sin^{-1}\frac{1}{2}=30°$	"DEG" 1 ÷ 2 = INV sin	30.
$\cos^{-1}\frac{\sqrt{2}}{2}=0.785398163\text{rad}$	"RAD" 2 INV √ ÷ 2 = INV cos	0.785398163
$\tan^{-1}0.6104=31.39989118°$	"DEG" . 6104 INV tan	31.39989118
$=31°23'59.61"$	INV ° ' "	31°23°59.61
$\sin^{-1}0.8-\cos^{-1}0.9$	"DEG" . 8 INV sin − . 9 INV cos =	27.28816959
$=27°17'17.41"$	INV ° ' "	27°17°17.41

5-3 Common & Natural logarithms/Exponentiations (Antilogarithms, Exponentials, Powers and Roots)

EXAMPLE	OPERATION	READ-OUT
$\log 1.23\ (=\log_{10}1.23)=0.089905111$	1 . 23 log	0.089905111
$\ln 90\ (=\log_e 90)=4.49980967$	90 ln	4.49980967
$\log 456\div\ln 456=0.434294481$	456 INV 10^x log + M ln =	M 0.434294481
$10^{1.23}=16.98243652$	1 . 23 INV log	16.98243652
$e^{4.5}=90.0171313$	4 . 5 INV ln	90.0171313
$10^{0.4}+5\cdot e^{-3}=2.760821773$	. 4 INV log + 5 × 3 +/- INV ln =	2.760821773

4-3 Constant calculations

* The "K" sign appears when a number is set as a constant.

EXAMPLE	OPERATION	READ-OUT
3+2.3=5.3	2 ⊡ 3 ⊞ ⊞ 3 ⊟	K 5.3
6+2.3=8.3	6 ⊟	K 8.3
7−5.6=1.4	5 ⊡ 6 ⊟ ⊟ 7 ⊟	K 1.4
−4.5−5.6=−10.1	4 ⊡ 5 ⊠ ⊟	K −10.1
2.3×12=27.6	12 ⊠ ⊠ 2 ⊡ 3 ⊟	K 27.6
(−9)×12=−108	9 ⊠ ⊟	K −108.
74÷2.5=29.6	2 ⊡ 5 ⊞ ⊞ 74 ⊟	K 29.6
85.2÷2.5=34.08	85 ⊡ 2 ⊟	K 34.08
17+17+17+17=68	17 ⊞ ⊞ ⊟	K 34.
	⊟	K 51.
	⊟	K 68.
$1.7^2=2.89$	1 ⊡ 7 ⊠ ⊠ ⊟	K 2.89
$1.7^3=4.913$	⊟	K 4.913
$1.7^4=8.3521$	⊟	K 8.3521
3×6×4=72	3 ⊠ 6 ⊠ ⊠	K 18.
3×6×(−5)=−90	4 ⊟	K 72.
	5 ⊠ ⊟	K −90.
$\frac{56}{4\times(2+3)}=2.8$	4 ⊠ (2 ⊞ 3) ⊞ ⊞	K 20.
	56 ⊟	K 2.8
$\frac{23}{4\times(2+3)}=1.15$	23 ⊟	K 1.15

4-4 Memory calculations using the independent memory

* When a new number is entered into the independent memory by the M+ key, the previous number stored is automatically cleared and the new number is put in the independent memory.
* The "M" sign appears when a number is stored in the independent memory.
* The contents accumulated into the independent memory are preserved even after the power switch is turned off.
  To clear the contents press ⓞ INV M+ or 2nd INV M+ in sequence.

EXAMPLE	OPERATION	READ-OUT
53+6= 59	53 ⊞ 6 ⊟ INV M+	M 59.
23−8= 15	23 ⊟ 8 M+	M 15.
56×2=112	56 ⊠ 2 M+	M 112.
+) 99÷4= 24.75	99 ⊞ 4 M+	M 24.75
210.75	MR	M 210.75

7+7−7+(2×3)+(2×3)+(2×3)−(2×3)=19

	7 INV M+ M+ INV M− 2 ⊠ 3 M+ M+ M+ INV M− MR	M 19.

EXAMPLE	OPERATION	READ-OUT
12×3= 36	3 ⊠ ⊠ 12 ⊟ INV M+	M K 36.
+) 45×3=135	45 INV M−	M K 135.
78×3=234	78 M+	M K 234.
135	MR	M K 135.

4-5 Memory calculations using 6 constant memories

* When a new number is entered into a constant memory by operating ENTRY Kin (1 to 6), the previous number stored is automatically cleared and the new number is put in the constant memory.
* The contents stored in the constant memories are preserved even after the power switch is turned off.
  To clear the contents press ⓞ Kin 1 (to 6) or 2nd Kin 1 (to 6) in sequence.

EXAMPLE	OPERATION	READ-OUT
193.2÷23=8.4	193 ⊡ 2 Kin 1 ⊞ 23 ⊟	8.4
193.2÷28=6.9	Kout 1 ⊞ 28 ⊟	6.9
193.2÷42=4.6	Kout 1 ⊞ 42 ⊟	4.6

* Another operations by using the independent memory:

193 ⊡ 2 INV M+ ⊞ 23 ⊟, MR ⊞ 28 ⊟, MR ⊞ 42 ⊟

EXAMPLE	OPERATION	READ-OUT
$\frac{9\times6+3}{(7-2)\times8}=1.425$	9 × 6 + 3 = Kin 1	57.
	ON/C 7 − 2 × 8 = Kin 2	40.
	Kout 1 + Kout 2 =	1.425

* Calculations in constant memory registers can also be performed by using the +, −, × and ÷ keys.

	7 Kin 1 × 8 Kin 2 × 9 Kin 3 = INV M−	M 504.
	4 Kin + 1 × 5 Kin + 2 × 6 Kin + 3 M+	M 120.
	3 Kin + 1 × 6 Kin + 2 × 9 Kin + 3 M+	M 162.
7 × 8 × 9=504	Kout 1	M 14.
4 × 5 × 6=120	Kout 2	M 19.
3 × 6 × 9=162	Kout 3	M 24.
(Total) 14 19 24 786	MR	M 786.

12× (2.3+3.4) −5=63.4
30× (2.3+3.4+4.5) −15 ×4.5=238.5

12 × ON/C 2 . 3 + 3 . M+ MR Kin 1 − 5 =	63.4
30 × 4 . 5 Kin + 1 INV x⇄K 1 − 15 × Kout 1 =	238.5

↓
To exchange the displayed number (4.5) with the contents of constant memory 1.

4-6 Fraction calculations

* The display capacity of a fraction, whether entry or result, is limited to a max. 3 digits for each integer, numerator or denominator part and at the same time to a max. 8 digits in the sum of each part. When an answer exceeds the above capacity, it is automatically converted to the decimal scale.
* A fraction can be transferred to the independent memory and the constant memories.
* A fraction answer can be converted to the decimal scale by pressing the a b/c key. However, a decimal answer cannot be converted to the fraction scale.

EXAMPLE	OPERATION	READ-OUT
$4\frac{5}{6}\times(3\frac{1}{4}+1\frac{2}{3})\div7\frac{8}{9}=3\frac{7}{568}$	4 a b/c 5 a b/c 6 × ON/C 3 a b/c 1 a b/c 4 +	
	1 a b/c 2 a b/c 3 ↔ + 7 a b/c 8 a b/c 9 =	3⌟7⌟568.
(=3.012323944)	a b/c	3.012323944

EXAMPLE	OPERATION	READ-OUT
$2\frac{4}{5}+\frac{3}{4}-1\frac{1}{2}=2\frac{1}{20}$	2 a b/c 4 a b/c 5 + 3 a b/c 4 −	3⌟11⌟20.
	a b/c	3.55
	1 a b/c 1 a b/c 2 =	2⌟1⌟20.
$(1.5\times10^7)-\{(2.5\times10^6)\times\frac{3}{100}\}$		
=14925000	1 . 5 EXP 7 − 2 . 5 EXP 6 × 3 a b/c 100 =	14925000.

* During a fraction calculation, a figure is reduced to the lowest terms by pressing a function command key (+, −, × or ÷) or the = key if the figure is reducible.

$3\frac{456}{78}=8\frac{11}{13}$ (Reduction)	3 a b/c 456 a b/c 78	3⌟456⌟78.
	=	8⌟11⌟13.
$\frac{12}{45}-\frac{32}{56}=-\frac{32}{105}$	12 a b/c 45 −	4⌟15.
	32 a b/c 56 =	−32⌟105.

* The answer in a calculation performed between a fraction and a decimal is displayed as a decimal.

$\frac{41}{52}\times78.9=62.20961538$	41 a b/c 52 ×	41⌟52.
	78 . 9 =	62.20961538

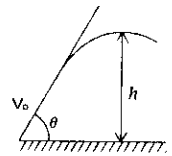
4-7 Percentage calculations

EXAMPLE	OPERATION	READ-OUT
12% of 1500 180	1500 × 12 INV %	180.
Percentage of 660 against 880 . . 75%	660 + 880 INV %	75.
15% add-on of 2500 2875	2500 × 15 INV % +	2875.
25% discount of 3500 2625	3500 × 25 INV % −	2625.
300cc is added to a solution of 500cc. What is the percent of the new volume to the initial one?	300 + 500 INV %	160. (%)
If you made $80 last week and $100 this week, what is the percent increase?	100 − 80 INV %	25. (%)

■Parabolic movement

Ex.)
Obtain the height of a ball 3 seconds after throwing it at a 50° angle and at an initial velocity of 30 m/sec. (not calculating air resistance).

Formula: $h = V_0 t \sin\theta - \frac{1}{2} g t^2$

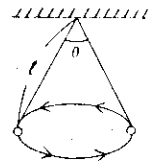


h : Height of ball at T seconds after thrown (m)
V_0 : Initial velocity (m/sec.)
t : Time (sec.)
θ : Throwing angle to level surface
g : Gravitational acceleration (9.8 m/sec.^{2})

	OPERATION	READ-OUT	
"DEG"			
(MODE 4)	30 × 3 × 50 sin − 1 ab/c 2 × 9 ÷ 8 × 3 x^2 =	24.84399988	(m)

■Cycle of a conical pendulum

Ex.)
How many seconds is the cycle of a conical pendulum with a cord length of 30 cm and maximum swing angle of 90°?



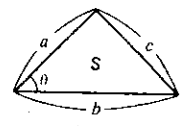
Formula: $T = 2\pi \cdot \sqrt{\frac{\ell \cdot \cos\frac{\theta}{2}}{g}}$

T : Cycle (sec.)
ℓ : Cord length (m)
θ : Maximum cord swing angle
g : Gravitational acceleration (9.8 m/sec.^{2})

	OPERATION	READ-OUT	
"DEG"			
(MODE 4)	2 × π × (3 ÷ 90 + 2) cos + 9 ÷ 8) $\sqrt{}$ =	0.924421332	(sec.)

■Triangle

Ex.)
Calculate the interior angle (θ) and area (S) of the triangle when the lengths of three sides (a, b and c) are given.



a: 18 m, b: 21 m, c: 12 m

Formula: $\cos\theta = \frac{a^2 + b^2 - c^2}{2ab}$

$S = \frac{1}{2} ab \cdot \sin\theta$

	OPERATION	READ-OUT	
"DEG"			
(MODE 4)	18 Kin 1 x^2 + 21 Kin 2 x^2 − 12 x^2 = =	34°46°19.	(θ)
	Rnd Kout 1 × Kout 2 × x^2 Min 2 = ÷ cos x^2 =	107.7888561	(m^2)

■Pro-rating

Division	Sales amount	%
A	$ 84	22.4
B	153	40.8
C	138	36.8
Total	375	100.0

OPERATION	READ-OUT	
84 + 153 + 138 =	375.	
100 + + 84 = x^2 Min	M K 22.4	
153 M+	M K 40.8	
138 M+	M K 36.8	
MR	M K 100.	

■Time calculations

1 hr. 27 min. 58 sec.
1 hr. 35 min. 16 sec.
+) 1 hr. 41 min. 12 sec.
4 hr. 44 min. 26 sec.
Average: 1 hr. 34 min. 48.67 sec.

OPERATION	READ-OUT	
1 27 58 +		
1 35 16 +		
1 41 12 = Rnd	4°44°26.	
+ 3 = Rnd	1°34°48.67	

EXAMPLE	OPERATION	READ-OUT
$5.6^{2.3}=52.58143837$	5 ▫ 6 INV x^y 2 ▫ 3 =	52.58143837
$123^{\frac{1}{7}}\ (=\sqrt[7]{123})=1.988647795$	123 INV x^y 7 =	1.988647795
$(78-23)^{-12}$ $=1.30511183\times10^{-21}$	⌦ 78 − 23 (−) INV x^y 12 +/− =	1.30511183 -21
$3^{12}+e^{10}=553467.4658$	3 INV x^y 12 + 10 INV e^x =	553467.4658
log sin 40° + log cos 35°	("DEG" (MODE 4)) 40 sin log + 35 cos log =	−0.27856798
$=-0.27856798$	INV 10^x	0.526540784
(The antilogarithm . . . . . 0.526540784)		
$15^{\frac{1}{5}}+25^{\frac{1}{6}}+35^{\frac{1}{7}}=5.090557037$	15 INV $\sqrt{x}$ 5 + 25 INV $\sqrt{x}$ 6 + 35 INV $\sqrt{x}$ 7 =	5.090557037

* x^y and $x^{\frac{1}{y}}$ can be registered as a constant.

$4^{\underline{2.5}}=32$	2 ▫ 5 INV x^y INV x^y 4 =	K 32.
$0.16^{\underline{2.5}}=0.01024$	▫ 16 =	K 0.01024
$9^{\underline{2.5}}=243$	9 =	K 243.

5-4 Square roots, Squares, Reciprocals, Factorials & Random numbers

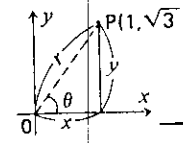
EXAMPLE	OPERATION	READ-OUT
$\sqrt{2}+\sqrt{3\times\sqrt{5}}=5.287196908$	2 $\sqrt{x}$ + 3 INV $\sqrt{x}$ × 5 INV $\sqrt{x}$ =	5.287196908
$123+30^2=1023$	123 + 30 INV x^2 =	1023.
$\frac{1}{\frac{1}{3}-\frac{1}{4}}=12$	3 INV $\frac{1}{x}$ − 4 INV $\frac{1}{x}$ = INV $\frac{1}{x}$	12.
$8!\ (=1\times2\times3\times\cdots\cdots\times7\times8)=40320$	8 INV $x!$	40320.
Generate a random number between 0.000 and 0.999.	INV Ran#	0.570 (Example)

5-5 Rectangular to polar co-ordinates conversion

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

$\theta=\tan^{-1}\frac{y}{x}\quad(-180^\circ<\theta\leqq180^\circ)$

Ex.)
Find the length r and angle θ in radian when the point P is shown as $x=1$ and $y=\sqrt{3}$ in the rectangular co-ordinates.



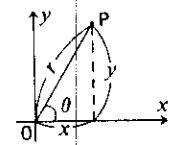
OPERATION	READ-OUT	
("RAD" (MODE 5)) 1 INV R→P 3 =	2.	(r)
INV x⇔y	1.047197551	(θ in radian)

5-6 Polar to Rectangular co-ordinates conversion

Formula: $x=r\cdot\cos\theta$

$y=r\cdot\sin\theta$

Ex.)
Obtain the values of x and y when the point P is shown as $\theta=60^\circ$ and length $r=2$ in the polar co-ordinates.



OPERATION	READ-OUT	
("DEG" (MODE 4)) 2 INV R→P 60 =	1.	(x)
INV x⇔y	1.732050808	(y)

5-7 Applications

■Decibel (dB) conversion

Ex.)
How many dB of amplifier gain is in an amp with 5mW of input power and 43W of output power?

Formula: $dB=10\cdot\log_{10}\frac{P_2}{P_1}$

P_1 : Input power (W)
P_2 : Output power (W)

OPERATION	READ-OUT	
10 × ⌦ 43 ÷ 5 EXP 3 +/− log =	39.34498451	(dB)

6/STATISTICAL CALCULATIONS

* Be sure to press [INV] [AC] in sequence prior to starting a statistical calculation.

6-1 Standard deviation

* Set the function mode to "SD" by pressing [MODE] [3].

Ex.) Find σ_{n-1}, σ_n, $\bar{x}$, n, Σx and Σx^2 based on the data 55, 54, 51, 55, 53, 53, 54, 52.

	OPERATION	READ-OUT
"SD"	[INV] [AC] 55 [DATA] 54 [DATA] 51 [DATA] 55 [DATA] 53 [DATA] [DATA]	
	54 [DATA] 52 [DATA]	52.
(Sample standard deviation)	[INV] [$x\sigma_{n-1}$]	1.407885953
(Population standard deviation)	[INV] [$x\sigma_n$]	1.316956719
(Arithmetic mean)	[INV] [$\bar{x}$]	53.375
(Number of data)	[K.out] [n]	8.
(Sum of value)	[K.out] [Σx]	427.
(Sum of square value)	[K.out] [Σx^2]	22805.

Calculate the unbiased variance and the deviation between each data item and the average.

(Subsequently) [INV] [$x\sigma_{n-1}$] [INV] [x^2]	1.982142857	(Unbiased variance)
[INV] [$\bar{x}$] [−] [−] 55 [=]	1.625	(55 − $\bar{x}$)
54 [=]	0.625	(54 − $\bar{x}$)
51 [=]	−2.375	(51 − $\bar{x}$)
⋮	⋮	

Note: The sample standard deviation σ_{n-1} is defined as

$$\sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n-1}}$$

the population standard deviation σ_n is defined as

$$\sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}{n}}$$

and the arithmetical mean $\bar{x}$ is defined as $\frac{\Sigma x}{n}$

* Pressing [$x\sigma_{n-1}$], [$x\sigma_n$], [$\bar{x}$], [n], [Σx], or [Σx^2] key need not be done sequentially.

Ex.) Find n, $\bar{x}$ & σ_{n-1} based on the data: 1.2, −0.9, −1.5, 2.7, −0.6, 0.5, 0.5, 0.5, 0.5, 1.3, 1.3, 1.3, 0.8, 0.8, 0.8, 0.8, 0.8.

	OPERATION	READ-OUT
"SD"	[INV] [AC] 1 [.] 2 [DATA] [.] 9 [+/−] [DATA]	−0.9
① (Mistake)	2 [.] 5 [+/−]	−2.5
① (To correct)	[C]	0.
	1 [.] 5 [+/−] [DATA]	−1.5
	2 [.] 7 [DATA]	2.7
② (Mistake)	[DATA]	2.7
③ (Mistake)	1 [.] 6 [+/−] [DATA]	−1.6
③ (To correct)	[INV] [DEL]	−1.6
	[.] 6 [+/−] [DATA]	−0.6
② (To correct)	2 [.] 7 [INV] [DEL]	2.7
	[.] 5 [×]	0.5
	4 [DATA]	0.5
④ (Mistake)	1 [.] 4 [×]	1.4
④ (To correct)	[AC]	0.
	1 [.] 3 [×] 3 [DATA]	1.3
	[.] 8 [×]	0.8
⑤ (Mistake)	6 [DATA]	0.8
⑤ (To correct)	[.] 8 [×] 6 [INV] [DEL]	0.8
	[.] 8 [×] 5 [DATA]	0.8
	[K.out] [n]	17.
	[INV] [$\bar{x}$]	0.635294117
	[INV] [$x\sigma_{n-1}$]	0.95390066

6-2 Regression analysis

* Set the function mode to "LR" by pressing MODE 2.

■Linear regression

Formula: $y = A + Bx$

$$B = \frac{n\cdot\Sigma xy - \Sigma x\cdot\Sigma y}{n\cdot\Sigma x^2 - (\Sigma x)^2}$$

$$A = \frac{\Sigma y - B\cdot\Sigma x}{n}$$

$$r = \frac{n\cdot\Sigma xy - \Sigma x\cdot\Sigma y}{\sqrt{\{n\cdot\Sigma x^2 - (\Sigma x)^2\}\{n\cdot\Sigma y^2 - (\Sigma y)^2\}}}$$

Ex.) Results from measuring the length and temperature of a steel bar.

temp.	length
10°C	1003 mm
15	1005
20	1010
25	1008
30	1014

Find the constant term (A), regression coefficient (B), correlation coefficient (r) and estimated values ($\hat{x}$, $\hat{y}$) using the above figures as a basis.

	OPERATION	READ-OUT	
"LR"	INV SCI RAC 10 x_0,y_0	10.	
	1003 DATA	1003.	
	15 x_0,y_0 1005 DATA	1005.	
	20 x_0,y_0 1010 DATA	1010.	
	25 x_0,y_0 1008 DATA	1008.	
	30 x_0,y_0 1014 DATA	1014.	
	INV A	998.	(A)
	INV B	0.5	(B)
	INV r	0.919018277	(r)
(When the temp. is 18°C)	18 $\hat{y}$	1007.	(mm)
(When the length is 1000 mm)	1000 INV $\hat{x}$	4.	(°C)

Note: Σx^2, Σx, n, Σy^2, Σy, Σxy, $\bar{x}$, $x\sigma_n$, $x\sigma_{n-1}$, $\bar{y}$, $y\sigma_n$, $y\sigma_{n-1}$, A, B and r are respectively obtained by pressing a numeral key (1 to 9) after the K.out or INV key.

* **Correction of data entry**

Ex.)

xi	2	3	2	3	2	4
yi	3	4	4	5	5	5

	OPERATION	READ-OUT
"LR"	INV SCI RAC 2 x_0,y_0 3 DATA	3.
① (Mistake)	4	4.
①' (To correct)	C	0.
	3 x_0,y_0	3.
	4 DATA	4.
② (Mistake)	3 x_0,y_0	3.
②' (To correct)	2 x_0,y_0	2.
	4 DATA	4.
③ (Mistake)	1 x_0,y_0	1.
	5 DATA	5.
③' (To correct)	INV DEL	5.
	3 x_0,y_0 5 DATA	5.
	2 x_0,y_0	2.
④ (Mistake)	4 DATA	4.
	4 x_0,y_0	4.
⑤ (Mistake)	6 DATA	6.
⑤' (To correct)	INV DEL	6.
	4 x_0,y_0 5 DATA	5.
④' (To correct)	2 x_0,y_0 4 INV DEL	4.
	2 x_0,y_0 5 DATA	5.

These ways of correction can also be applied to logarithmic, exponential or power regression.

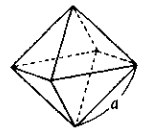
7/PROGRAMMED CALCULATIONS

* This calculator has a program memory of 38 steps. Up to two programmed procedures of calculation may be stored in the memory.
* To store a program (mathematical procedure) in the calculator, execute ordinary (i.e. manual) calculation in the LRN mode (press MODE □) only once.
* Now the calculator has memorized the program. Input data and press the RUN key, and the calculator executes the program with the data. This is very convenient for repeating calculations with varying sets of data.

■ How to store and execute programs

Example 1:
Calculate the surface areas (S) of regular octahedrons whose ridges are respectively 10, 7 and 15 cm long.

Formula: $S = 2\sqrt{3}a^2$



Ridge length (a)	Surface area
10 cm	(346.41) cm²
7	(169.74)
15	(779.42)

* Values enclosed with parentheses are to be obtained.

• The following sequence of key operations realizes a mathematical procedure of the above formula.

2 × 3 √ × 10 x^2 = → S
↑
Value of a (data)

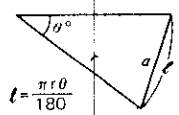
• Operate the above sequence in the LRN mode (MODE □). Note that ENT must be pressed prior to data entry (the value of a in this case).

	OPERATION	READ-OUT	
(Select LRN mode)	MODE □	LRN 0. P1 P2	LRN lit, P1 P2 blinking.
(Designate program No.)	P1	LRN 0. P1	Select a program number, P1 or P2.
	2	LRN 2. P1	
	×	LRN 2. P1	
	3	LRN 3. P1	
	√	LRN 1.732050808 P1	The mathematical procedure is stored in P1.
	×	LRN 3.464101615 P1	
(Input data)	ENT 10	LRN 10. P1	
	x^2	LRN 100. P1	
	=	LRN 346.4101615 P1	S for a = 10

Execution of the program stored (LRN disappears)

(Select RUN mode)	MODE ·	346.4101615
(Designate program No.)	P1	3.464101615 P1
	7 RUN	169.7409791 S for a = 7
	P1 15 RUN	779.4228634 S for a = 15

Example 2:
Calculate the length, ℓ of the arc and the length, a of the chord of a sector with radius and radii making an angle of $\theta°$.



$\ell = \frac{\pi r \theta}{180}$

$a = 2r\sin\frac{\theta}{2}$

Radius (r)	Angle of radii (θ)	Arc length (ℓ)	Chord length (a)
10 cm	60°	(10.47) cm	(10) cm
12	42°34′	(8.91)	(8.71)
15	36°	(9.42)	(9.27)

* The values enclosed with parentheses are to be obtained.

	OPERATION	READ-OUT	
(Select LRN mode)	MODE □	LRN 0. P1 P2	
(Designate program No.)	INV P2	LRN 0. P2	
	MODE 4 ENT 10	LRN DEG 10. P2	r → To K1 register
	Kin 1 × ENT 60	LRN DEG 60. P2	θ → To K2 register
	Kin 2 × π ÷ 180 =		
	INV K1	LRN DEG 10.47197551 P2	HLT for displaying result (ℓ)
	2 Kin × 1 Kin ÷ 2		K1 x 2, K2 ÷ 2
	Kout 2 sin Kin × 1		$\sin\frac{\theta}{2}$ x K1
	Kout 1	LRN DEG 10. P2	Result (a)

Execution of the program stored. (LRN disappears)

(Select RUN mode)	MODE ·	DEG 10.	
(Designate program No.)	INV P2	DEG 10. P2	
(Input r)	12 RUN	DEG 12. P2	
(Input θ)	42 °'" 34 °'" RUN	DEG 8.915141819 P2	Result (ℓ)
(Subsequently)	RUN	DEG 8.711524731	Result (a)
	INV P2 15 RUN 36 RUN	DEG 9.424777961 P2	Result (ℓ)
(Subsequently)	RUN	DEG 9.270509832	Result (a)

■ Logarithmic regression

Formula: $y = A + B \cdot \ln x$

* Input data items are the logarithm of x ($\ln x$), and y which is the same as in linear regression.
* Operation for calculating and correcting regression coefficients are basically the same as in linear regression. Operate the sequence x [ln] [Σ] to obtain estimator $\hat{y}$ and y [INV] [ln] [INV] [Σ] for estimator $\hat{x}$. Note that $\Sigma \ln x$, $\Sigma (\ln x)^2$, and $\Sigma \ln x \cdot y$ are obtained instead of Σx, Σx^2, and Σxy respectively.

Ex.)

xi	29	50	74	103	118
yi	1.6	23.5	38.0	46.4	48.9

Find A, B, r, $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

	OPERATION	READ-OUT	
"LR"	[INV] [CA/AC] 29 [ln] [x_{o,y_o}]	3.36729583	
	1 [·] 6 [DATA]	1.6	
	50 [ln] [x_{o,y_o}] 23 [·] 5 [DATA]	23.5	
	74 [ln] [x_{o,y_o}] 38 [DATA]	38.	
	103 [ln] [x_{o,y_o}] 46 [·] 4 [DATA]	46.4	
	118 [ln] [x_{o,y_o}] 48 [·] 9 [DATA]	48.9	
	[INV] [A]	−111.128397	(A)
	[INV] [B]	34.02014743	(B)
	[INV] [r]	0.994013945	(r)
(When xi is 80)	80 [ln] [Σ]	37.94879479	($\hat{y}$)
(When yi is 73)	73 [INV] [Σ] [INV] [e^x]	224.1541318	($\hat{x}$)

■ Exponential regression

Formula: $y = A \cdot e^{B \cdot x}$

* Input data items are the logarithm of y ($\ln y$) and x which is the same as in linear regression.
* Operation for correction is basically the same as in linear regression. Operate [INV] [A] [INV] [e^x] to obtain coefficient A, x [Σ] [INV] [e^x] for estimator $\hat{y}$, and y [ln] [INV] [Σ] for estimator $\hat{x}$. Note that $\Sigma \ln y$, $\Sigma (\ln y)^2$, and $\Sigma x \cdot \ln y$ are obtained instead of Σy, Σy^2, and Σxy.

Ex.)

xi	6.9	12.9	19.8	26.7	35.1
yi	21.4	15.7	12.1	8.5	5.2

Find A, B, r, $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

	OPERATION	READ-OUT	
"LR"	[INV] [CA/AC] 6 [·] 9 [x_{o,y_o}]	6.9	
	21 [·] 4 [ln] [DATA]	3.063390922	
	12 [·] 9 [x_{o,y_o}] 15 [·] 7 [ln] [DATA]	2.753660712	
	19 [·] 8 [x_{o,y_o}] 12 [·] 1 [ln] [DATA]	2.493205453	
	26 [·] 7 [x_{o,y_o}] 8 [·] 5 [ln] [DATA]	2.140066164	
	35 [·] 1 [x_{o,y_o}] 5 [·] 2 [ln] [DATA]	1.648658626	
	[INV] [A] [INV] [e^x]	30.49758743	(A)
	[INV] [B]	−0.0492037	(B)
	[INV] [r]	−0.99724735	(r)
(When xi is 16)	16 [Σ] [INV] [e^x]	13.87915739	($\hat{y}$)
(When yi is 20)	20 [ln] [INV] [Σ]	8.57486805	($\hat{x}$)

■ Power regression

Formula: $y = A \cdot x^B$

* Input data items are $\ln x$ and $\ln y$.
* Operation for correction is basically the same as in linear regression. Operate [INV] [A] [INV] [e^x] to obtain coefficient A, x [ln] [Σ] [INV] [e^x] for estimator $\hat{y}$, and y [ln] [INV] [Σ] [INV] [e^x] for estimator $\hat{x}$. Note that $\Sigma \ln x$, $\Sigma (\ln x)^2$, $\Sigma \ln y$, $\Sigma (\ln y)^2$, and $\Sigma \ln x \cdot \ln y$ are obtained instead of Σx, Σx^2, Σy, Σy^2, and Σxy respectively.

Ex.)

xi	28	30	33	35	38
yi	2410	3033	3895	4491	5717

Find A, B, r, $\hat{x}$ and $\hat{y}$ using the above figures as a basis.

	OPERATION	READ-OUT	
"LR"	[INV] [CA/AC] 28 [ln] [x_{o,y_o}]	3.33220451	
	2410 [ln] [DATA]	7.787382026	
	30 [ln] [x_{o,y_o}] 3033 [ln] [DATA]	8.017307508	
	33 [ln] [x_{o,y_o}] 3895 [ln] [DATA]	8.267448958	
	35 [ln] [x_{o,y_o}] 4491 [ln] [DATA]	8.409830673	
	38 [ln] [x_{o,y_o}] 5717 [ln] [DATA]	8.651199471	
	[INV] [A] [INV] [e^x]	0.238801299	(A)
	[INV] [B]	2.771865947	(B)
	[INV] [r]	0.998906243	(r)
(When xi is 40)	40 [ln] [Σ] [INV] [e^x]	6587.67582	($\hat{y}$)
(When yi is 1000)	1000 [ln] [INV] [Σ] [INV] [e^x]	20.26225439	($\hat{x}$)

■ Program step

• The program is stored (written) in the calculator as shown below.

No. of steps	Program
1	P1 2
2	×
3	3
4	INV √
5	×
6	ENT
7	INV x^2
8	=
9	P2 MODE 4
10	ENT
11	Kin 1
12	×
13	ENT
14	Kin 2
15	×
16	π
17	÷
18	1
19	8
20	0
21	=
22	INV HLT
23	2
24	Kin x 1
25	Kin ÷ 2
26	Kout 2
27	sin
28	Kin x 1
29	Kout 1
30	
31	
⋮	⋮
36	
37	
38	

• The program capacity is 38 steps. The program may be divided into two areas (P1 and P2) and each can be used independently of the other.

• An error results ("E" displayed) when there is an attempt to write the 39th step. No subsequent steps can be written. In this case, press AC to release the error check.

• After the program is started, instruction steps are executed one after another and execution does not stop. But it is needed to halt execution for inputting a data or reading a result. This is accomplished by ENT and INV HLT.
When the end of a program is reached, execution stops automatically and the state is displayed. So, HLT may be absent.

• Each function comprises a step of program. The depression of keys in a certain sequence produces a single program step if it generates a single function.

1) Functions generated by the depression of a single key
Ex.) Numeral value, +/−, +, −, ×, ÷, =, [(,)], sin, log, ENT, ...
2) Functions generated by the depression of a two-key sequence
Ex.) INV x^2, INV √, hyp sin, INV $\sin^{-1}$, INV X↔Y, INV x^y, INV R→P, Kin 2, INV RAN#, ...
3) Functions generated by the depression of a three-key sequence
Ex.) INV X↔K 5, INV hyp $\sin^{-1}$, MODE 8 3 (Assignment for the number of significant digits), Kin x 3 (Multiplication with contents of K3 register), ...

* If you have misoperated when writing a program (i.e. in the LRN mode), press the sequence of INV PCL and perform the correct operation.

* The depression of a data entry key (⊡, 0 – 9) followed by STO, RCL, SUM, EXC or CE will not be written in if such a sequence immediately follows the depression of ENT. Note that one of the functions which does not follow a numeric data will be written in as a step.

Example:

ENT 6 EXC 6 EXC 6 EXC

Not written in

ENT 6 EXC EXC EXC

Not written in — Written (2 steps)

■ How to erase a program

An old program will be automatically overwritten by a new program if the same program number is assigned to them.
To erase a program for making corrections or erase all 38 steps, operate the following sequence.

• To erase program P1 or P2:

MODE 0 P1 (or INV P1) INV PCL

↑ Selects the LRN mode

• To erase both P1 and P2:

MODE 0 INV PCL

■ Jump instructions

There are two types of jump instructions as follows.

1. Unconditional return to the first step of program: RTN

Write the sequence of INV RTN at the end of a program to execute it repeatedly.

Example: Let us use the unconditional return instruction in the regular octahedron program explained on page 29. (In this case, the formula must be modified to $S = a^2 \times 2\sqrt{3}$.)

Operation:

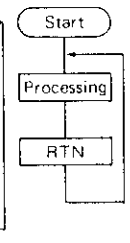
MODE 0 P1

ENT 10 INV x^2 × 2 × 3 INV √ = INV RTN

↑ Value of a ↑ Return instruction

Step No.	Instruction step
1	ENT
2	INV x^2
3	×
4	2
5	×
6	3
7	INV √
8	=
9	INV RTN

Flowchart



OPERATION		READ-OUT	
(Select RUN mode)	MODE ·	0.	
(Designate program No.)	P1	0.	
(For a = 7)	7 RUN	169.7409791	Result S for a = 7
(For a = 15)	15 RUN	779.4228634	Result S for a = 15

* If a program includes an RTN instruction but neither ENT nor HLT, the program will, once started, not stop in an endless loop. To stop the program in such a case, press AC.

2. Return to the first step of program depending on the condition of the contents of the X-register (display):

$x > 0$, $x \leqq M$

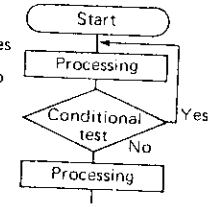
- $x > 0$: Return to the first step of program if the contents of the X-register is greater than zero and go to the next step otherwise.
- $x \leqq M$: Return to the first step of program if the contents of the X-register is equal to or smaller than the contents of the M-register and otherwise go to the next step.

Example: Find the maximum of 456, 852, 321, 753, 369, 741, 684 and 643.

Operation: [MODE] [0] [INV] [P2] [ENT] [INV] [x≦M] [INV] [Mcy] [INV] [RTN]

Step No.	Instruction step	
1	ENT	
2	INV $x \leqq M$	Yes
3	INV Min	No
4	INV RTN	

Flowchart



OPERATION	READ-OUT	
[MODE] [•] [AC] [INV] [Mcy]	0.	Memory cleared
(Designate P2) [INV] [P2]	0. [EXM] P2	
456 [RUN]	456. [EXM] P2	
852 [RUN]	852. [EXM] P2	
321 [RUN]	321. [EXM] P2	
(Input data) 753 [RUN]	753. [EXM] P2	
369 [RUN]	369. [EXM] P2	
741 [RUN]	741. [EXM] P2	
684 [RUN]	684. [EXM] P2	
643 [RUN]	643. [EXM] P2	
[MR]	852. [EXM] P2	Maximum displayed

■ Applications

• Permutation and combination

Calculate nPr and nCr for (n = 10; r = 4) and (n = 25; r = 5).

$$\left[nPr = \frac{n!}{(n-r)!},\ nCr = \frac{n!}{r!\,(n-r)!} \right]$$

Programming:

[MODE] [0] [P1] [ENT] 10 [Kin] [1] [ENT] 4 [Kin] [2]

"LRN" displayed (Value of n) (Value of r)

[Kout] [1] [INV] [Σ] [+] [(-)] [Kout] [1] [−] [Kout] [2] [=] [INV] [Σ] [=] ····· 5040 (Permutation)

[INV] [P1] [ENT] 10 [Kin] [1] [ENT] 4 [Kin] [2]

(Value of n) (Value of r)

[Kout] [1] [INV] [Σ] [÷] [Kout] [2] [INV] [Σ] [+] [(-)] [Kout] [1] [−] [Kout] [2] [=]

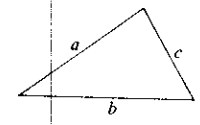
[INV] [Σ] [=] ····· 210 (Combination)

Operation:

[MODE] [•] [P1] 25 [RUN] 5 [RUN] ····· 6375600 (Permutation)

[INV] [P1] 25 [RUN] 5 [RUN] ····· 53130 (Combination)

• Calculate the area of a triangle when the lengths of the three sides are given.



$$\left[s = \frac{a+b+c}{2},\ S = \sqrt{s\,(s-a)\,(s-b)\,(s-c)} \right]$$

How large is S when a = 18, b = 22 and c = 31?

How large is S when a = 9.7, b = 13.4 and c = 6.5?

Programming:

[MODE] [0] [P1] [ENT] 18 [Kin] [1] [+] [ENT] 22 [Kin] [2] [+] [ENT] 31 [Kin] [3]

"LRN" displayed [=] [÷] 2 [=] [Kin] [4]

[×] [(-)] [Kout] [4] [−] [Kout] [1] [=] [×] [(-)] [Kout] [4] [−] [Kout] [2] [=]

[×] [(-)] [Kout] [4] [−] [Kout] [3] [=] [=] [√] ····· 194.2702692 (Area S)

Operation:

[MODE] [•] [P1] 9 [•] 7 [RUN] 13 [•] 4 [RUN] 6 [•] 5 [RUN] ····· 29.61549594 (Area S)

• Sort sales slips by item code and add up the total of each item (for five items).

Code	Amount
3	2870
2	1960
5	3850
5	1250
1	2500
2	2310
3	1850
5	4370
3	5360
1	2220
2	1450
4	6120
1	3100

➡

Code	Amount
1	7820
2	5720
3	10080
4	6120
5	9470

Programming:

MODE D
↓
"LRN" displayed

P1 ENT INV Kout ENT Kin 5
Kin + 5 5 INV x≥M
Kout 5 Kin − 5 Kin + 4 4 INV x≥M
Kout 5 Kin − 4 Kin + 3 3 INV x≥M
Kout 5 Kin − 3 Kin + 2 2 INV x≥M
Kout 5 Kin − 2 Kin + 1 1 INV RTN
INV P2 Kout 1 INV RLT Kout 2 INV RLT
Kout 3 INV RLT Kout 4 INV RLT Kout 5

Operation:

MODE ·

INV CA KAC P1 3 RUN 2870 RUN 2 RUN 1960 RUN 5 RUN 3850 RUN 5 RUN 1250 RUN
1 RUN 2500 RUN 2 RUN 2310 RUN 3 RUN 1850 RUN 5 RUN 4370 RUN
3 RUN 5360 RUN 1 RUN 2220 RUN 2 RUN 1450 RUN 4 RUN 6120 RUN
1 RUN 3100 RUN

INV P1 ..... 7820 (Amount of code No. 1)
RUN ..... 5720 (Amount of code No. 2)
RUN ..... 10080 (Amount of code No. 3)
RUN ..... 6120 (Amount of code No. 4)
RUN ..... 9470 (Amount of code No. 5)

• Calculation for loan-repayment (Equally divided monthly repayment)

Formula: $P = PV \dfrac{i}{1-(1+i)^{-n}}$

P: Amount of monthly repayment
PV: Amount of loan (Kin 1)
i: Monthly interest (Kin 2)
n: Number of times of repayment (Kin 3)

* The amount of repayment will be calculated in units of dollar by counting 50 cents or more as 1 dollar and disregarding the rest.

1) We borrow $30,000 at an annual interest of 7.65% for 10 years. What is the amount of monthly repayment?
2) We borrow $5,000 at an annual interest of 5.05% for 5 years. What is the amount of monthly repayment?

Programming:

MODE D
↓
"LRN" displayed

P1 ENT 30000 Kin 1
ENT 7 · 65 ÷ 12 EXP 2 = Kin 2
ENT 10 × 12 = Kin 3
Kout 1 × Kout 2 + (− 1 = (− 1 + Kout 2 ⁻¹ INV x² Kout 3 ×
= MODE 7 0 ..... 358 (Amount of monthly repayment)

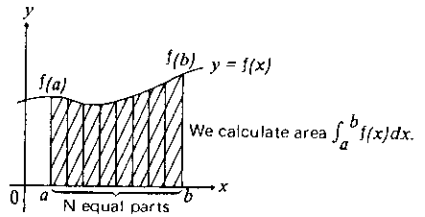
Operation:

MODE ·

P1 5000 RUN 5 · 05 RUN 5 RUN ..... 94 (Amount of monthly repayment)

8/INTEGRALS

* To carry out integrals, ① define (write) function $f(x)$ during the "LRN" mode, then ② designate the interval of integral during the "$\int dx$" mode.



* The approximation method used for integrating the function written in P1 or P2 is the Simpson's rule. This method requires to divide the interval of integral into equal parts. If the number of divisions is not specified, the calculator determines it by itself according to the form of the function. To specify it, designate n (an integer of 1 to 9) which meets $N = 2^n$ where N is the number of divisions.

■ Defining function $f(x)$

1) Select the "LRN" mode (press [MODE] [0]).
2) Designate a program number (press [P1] or [INV] [P2]).
3) Press [INV] [Ans].
   * This is needed, as the first program step, to assign variable x of the function $f(x)$ to the M-register.
4) Write the expression of function $f(x)$ by true algebraic logic. Use [MR] to represent variable x. Write [=] at the end.

Example: For $f(x) = \dfrac{1}{x^2+1}$, write the sequence of 1, ÷, [(, MR, INV x^2, +, 1,)], =.

5) Press [MODE] [1] to select the "$\int dx$" mode.

Note: For a function $f(x)$ whose variable x cannot take the zero value, input an appropriate number in between steps 1) and 2) above.
Do not use constant registers, [CA/AC], [ENT] and [RCL] during expressing a function (step 4).

■ Execution of integral

1) Select the "$\int dx$" mode (press [MODE] [1]).
2) Designate the program number assigned to the function, $f(x)$. (Press [P1] or [INV] [P2].)
3) Press a sequence of n [INV] [RUN] to specify division number N (this will be displayed). This step may be skipped.
4) Designate the interval of integral, $[a, b]$. (Press a [RUN] b [RUN].)
   * In seconds or minutes the result will be displayed in a floating point representation.

At this time the memory registers contain the following data.

K1-register (Press [Kout] [1]) . . . . a
K2-register (Press [Kout] [2]) . . . . b
K3-register (Press [Kout] [3]) . . . . N (= 2^n)
K4-register (Press [Kout] [4]) . . . . $f(a)$
K5-register (Press [Kout] [5]) . . . . $f(b)$
K6-register (Press [Kout] [6]) . . . . $\int_a^b f(x)dx$
M-register (Press [MR]) . . . . . a

■ Example

For $f(x) = 2x^2 + 3x + 4$, calculate $\int_2^5 f(x)dx$ and $\int_2^8 f(x)dx$.

OPERATION	READ-OUT	
(Select "LRN" mode) [MODE] [0]	LRN 0.	Writing $f(x)$
(Designate program No.) [P1]	LRN 0.	
[INV] [Ans]	LRN 0.	
(Write $f(x)$) 2 [×] [MR] [INV] [x^2] [+] 3 [×] [MR] [+] 4 [=]		
(Select "$\int dx$" mode) [MODE] [1]	$\int_a^b$ 4.	
(Designate program No.) [P1]	$\int_a^b$ 0.	
(Input n) 2 [INV] [RUN]	$\int_a^b$ 4.	N displayed
(Input a and b) 2 [RUN] 5 [RUN]	$\int_a^b$ 1.215000000 02	Result displayed in about 4 seconds → $\int_2^5 f(x)dx$
(Designate program No.) [P1]	$\int_a^b$ 0.	
(Input a and b) 2 [RUN] 8 [RUN]	$\int_a^b$ 4.500000000 02	Result displayed in about 6 seconds → $\int_2^8 f(x)dx$

[Kout] [1]	$\int_a^b$ 2.	a
[Kout] [2]	$\int_a^b$ 8.	b
[Kout] [3]	$\int_a^b$ 8.	N
[Kout] [4]	$\int_a^b$ 18.	$f(a)$
[Kout] [5]	$\int_a^b$ 156.	$f(b)$
[Kout] [6]	$\int_a^b$ 450.	$\int_a^b f(x)dx$

■ Remarks for execution of integrals

* If you press [AC] during execution of integral (nothing is displayed), the execution will be aborted and the state selected by the depression of [MODE] [1] entered.
* If no function $f(x)$ is defined (written in), the calculator will carry out integral for $f(x) = x$.
* It is normal to set the angular mode to "RAD" when executing integral of trigonometrics.
* Integral approximated by the Simpson's rule may take much execution time to raise the accuracy of result. Error may be large even when much execution time has been consumed. If the number of significant digits of result is smaller than one, error termination occurs ("E" displayed).

In such cases, dividing the integral interval will reduce execution time and raise accuracy:

1. If the result varies greatly when the integral interval is moved slightly.
   Divide the interval into sections and sum up the results obtained in the sections.
2. For a periodic function or if the value of integral becomes positive or negative depending on the interval:
   Calculate for each period or separately for the sections where the result of integral is positive from where the result is negative, and sum up the results obtained.
3. If long execution time is due to the form of the function defined:
   Divide the function, if possible, into terms, execute integral for each term separately, and sum up the results.

9/SPECIFICATIONS

■ Basic features

- **Basic operations:** 4 basic calculations, constants for $+/-/\times/\div/x^y/\sqrt[y]{x}$, and parenthesis calculations.
- **Built-in functions:** trigonometric/inverse trigonometric functions (with angle in degrees, radians or gradients), logarithmic / exponential functions, reciprocals, factorials, square roots, powers, roots, decimal ↔ sexagesimal conversion, conversion of co-ordinate system (R→P, P→R), random number, π, and percentages.
- **Statistical functions:** standard deviation, linear regression, logarithmic regression, exponential regression, and power regression.
- **Integrals:** Simpson's rule.
- **Memory:** 1 independent memory and 6 constant memories.
- **Capacity:**

	Input range	Output accuracy
Entry/basic functions:	10 digit mantissa, or 10 digit mantissa plus 2 digit exponent up to $10^{\pm 99}$.	
Fraction calculations:	Max. 3 digit mantissa for each integer, numerator or denominator and at the same time max. 8 digit mantissa for the sum of each part.	
Scientific functions:		
$\sin x/\cos x/\tan x$	$\lvert x \rvert < 1440°$ (8π rad, 1600 gra)	±1 in the 10th digit
$\sin^{-1} x/\cos^{-1} x$	$\lvert x \rvert \leqq 1$	— " —
$\tan^{-1} x$	$\lvert x \rvert < 1 \times 10^{100}$	— " —

$\log x/\ln x$	$0 < x < 1 \times 10^{100}$	— " —
e^x	$-227 \leqq x \leqq 230$	— " —
10^x	$\lvert x \rvert < 100$	— " —
x^y	$\lvert x \rvert < 1 \times 10^{100}$ $\begin{cases} x < 0 \rightarrow y : \text{integer} \\ x = 0 \rightarrow y > 0 \end{cases}$	— " —
$x^{\frac{1}{y}}$ ($\sqrt[y]{x}$)	$\lvert x \rvert < 1 \times 10^{100}$, $y \neq 0$	— " —
$\sqrt{x}$	$0 \leqq x < 1 \times 10^{100}$	— " —
x^2	$\lvert x \rvert < 1 \times 10^{50}$	— " —
$1/x$	$\lvert x \rvert < 1 \times 10^{100}$, $x \neq 0$	— " —
$x!$	$0 \leqq x \leqq 69$ (x: natural number)	— " —
POL → REC	$\lvert r \rvert < 1 \times 10^{100}$	— " —
	$\lvert \theta \rvert < 1440°$ (8π rad, 1600 gra)	
REC → POL	$\lvert x \rvert < 1 \times 10^{100}$	— " —
	$\lvert y \rvert < 1 \times 10^{100}$	
° ' "	up to second	
π	10 digits	

■ Programmable features:

- **Total number of steps:** up to 38 (1 step performs a function).
- **Jump:** Unconditional jump (RTN), conditional jump ($x > 0$, $x \leqq$ M).
- **Number of programs storable:** up to 2 (P1 and P2).

■ Decimal point:

Full floating with underflow.

■ Read-out:

Liquid crystal display.

■ Power consumption:

0.00043 W

■ Power source:

Two AA size manganese dry batteries (UM-3) give approximately 7,000 hours continuous operation (approx. 8,300 hours on type SUM-3).

■ Ambient temperature range:

0°C – 40°C (32°F – 104°F)

■ Dimensions:

19.6H x 76W x 149mmD (3/4"H x 3"W x 5-7/8"D)

■ Weight:

132 g (4.7 oz) including batteries.