CATIGA®

SCIENTIFIC CALCULATOR

USER MANUAL

CS-229

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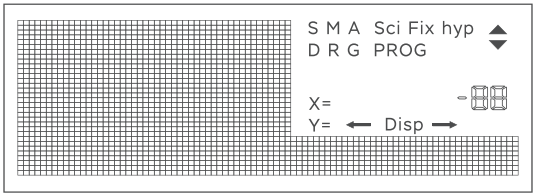
Chapter 1. General Description

1. Display



- S :Indicates SHIFT key has been pressed.
- A :Indicates ALPHA key has been pressed.
- M :Indicates MODE key has been pressed.
- DISH :Indicates intermediate result is displayed.
- D :Indicates angular measurement in units of "degrees".
- R :Indicates angular measurement in units of "radians".
- G :Indicates angular measurement in units of "gradients".
- FIX :Indicates specification of number of decimal places is being executed.
- SCI :Indicates specification of number of significant digits is being executed.
- hyp :Indicates hyp key has been pressed.
- i :Indicates the display of an imaginary number.
- ← → :Indicates number of characters exceeds limitation of screen. Non-displayed characters can be viewed by "scrolling" right or left, as indicated by arrow(s).
- PROG :Indicates the calculator is in programming mode.

2. Operation modes

When using CS-229, it is necessary to select the proper mode to meet your requirements. This can be done by pressing MODE to view the main menu and select the appropriate mode by moving the cursor to the right or the left.

Press MODE once to read the first page of the main menu.

```
MODE?          →
COMP    CMPLX
```

Press → to select the mode.

```
MODE?          →
COMP    CMPLX
```

As the icons "→" or "←"appear, one can press → or ← correspondingly to view the hidden menu.

```
MODE?          ←
SD  REG BASE-N
```


After locating the desired mode, press = to confirm and leave the main menu.
As you press MODE again, you can move to the menu to select function graph or parametric graph.

```
GRAPH?
FUNCT   PARAM
```

Or if you want to define the "degree" or "radian" or "gradient," you can press MODE again during the display of "graph -selection" menu mentioned above. Press MODE again.

(This sub-menu will be skipped in Base-N mode.)

```
ANGLE?
Deg  Rad  Gra
```

Select the angular unit by pressing ← or → followed by =. Or if you want to define the answer display format, you can proceed to the following page by pressing MODE further.

(This sub-menu will be skipped in Base-N mode.)

```
FORMAT?
Fix  Sci  Norm
```

Press MODE once to leave the menu.

```
_
```

Calculation modes

COMP mode: General calculations, including function calculations, can be executed.

COMPLEX mode: Calculations, including complex numbers, can be executed. "CMPLX" appears on the display.

SD mode: Standard deviation calculation can be executed. "SD" appears in the display.

REG mode: Regression calculations can be performed . "LR" appears in the display.

BASE-N mode: Binary, octal, decimal, hexadecimal conversion and calculations, as well as logical operations can be carried out. "BASE-N" appears on the display.

Note 1: The five calculation modes listed above are totally independent, and cannot be used together.

Note 2: The calculation mode last selected is retained in memory when the power is switched OFF.

Angular measurement modes

Deg mode: Specify measurement in degrees. D symbol appears in the display window.

Radian mode: Specify measurement in radians. R symbol appears in the display window.

Gradient mode: Specify measurement in gradients. G symbol appears in the display window.

With the exception of the BASE-N mode, these three angular measurement modes can be used in combination with the manual calculation modes.

Display modes

Fix mode: Specify number of decimal places. "FIX" symbol appears in the display window.

Sci mode: Specify number of significant digits. "SCI" symbol appears in display window.

Norm mode: Cancels "Fix" and "Sci" specifications. This operation also changes the range of the exponent display. When the results exceed the following limits, the exponent is to be displayed.

Norm 1: $10^{-2} > |x|$, or $|x| \geqq 10^{10}$
Norm 2: $10^{-9} > |x|$, or $|x| \geqq 10^{10}$
In combination with Fix, Sci or Norm mode, you can cause the exponent display for the number being displayed to change in multiples of 3 by pressing ENG.

Note 1: With the exception of the BASE-N mode, Fix, Sci, and Norm modes can be used in combination with the manual calculations.
Note 2: Engineering display format is not available in Complex mode.
Note 3: The display mode last selected is retained in memory when the power is switched OFF.

3. Calculation priority sequence

This calculator employs true algebraic logic to calculate the parts of a formula in the following order:

A) Coordinate transformation/integration, Pol (x,y) Rec (r, θ) ∫dx. Type A functions:
B) These functions are those in which the value is entered and then the function key is pressed, such as x^2, x^{-1} ,x!, °'", engineering symbols.
C) Power/root, x^y ,$\sqrt[x]{}$.
D) Fractions, $a^b/_c$.

E) Abbreviated multiplication format in front of π memory or parenthesis, such as 2π, 5A, πR, etc.
F) Type B functions:
These functions are those in which the function key is pressed and then the value is entered, such as , √,$\sqrt[3]{}$, log, ln,e^x,10^x, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, Int, Frac, Abs, (-), (following in BASE-N mode only) d, H, b, o, Neg, Not.
G) Abbreviated multiplication format in front of Type B functions, such as $2\sqrt{3}$, A log2, etc.
H) ×,÷
I) +, -
J) and (in BASE-N mode only).
K) or, xor, xnor (in BASE-N mode only).

Note 1: When functions with the same priority are used in a series, execution is performed from right to left for: $e^x \ln\sqrt{120} \rightarrow e^x\{\ln(\sqrt{120})\}$. Otherwise, execution is from left to right.
Note 2: Operations enclosed in parentheses are performed first.

4. Number of stacks

There is a memory area known as a "stack" for the temporary storage of low priority numeric values and commands (functions, etc.). The numeric value stack has nine levels, while the command stack has 24. If a complex formula is employed that exceeds the stack space available, a stack error (Stk ERROR) message will appear on the display.

Calculations are performed in the order of the highest calculation priority first. Once a calculation is executed, it is cleared from the stack.

5. Number of input/output digits and calculation digits

The allowable input/output range (number of digits) of this unit is 10 digits for a mantissa and 2 digits for the exponent. Calculations, however, are performed internally, with a range of 12 digits for a mantissa and 2 digits for an exponent.

Example: $3 \times 10^5 \div 7 =$

3 EXP 5 ÷ 7 =

D
42857.14286

3 EXP 5 ÷ 7 − 4 5 8 5 7

D
3E5 ÷7-42857

=

D
0.14285714

Once a calculation is completed, the mantissa is rounded off to 10 digits and displayed.

Example: $3 \times 10^5 \div 7 =$

3 EXP 5 ÷ 7 =

D
42857.14286

− 4 5 8 5 7 =

D
0.14285714

6. Overflow and errors

If the operational range of the unit is exceeded, or incorrect inputs are made, an error message will appear on the display and subsequent operation will be impossible. This is carried out by the error check function. The following operations will result in errors:

A) The answer. whether intermediate or final, or any value in memory exceeds the value of $\pm 9.999999999 \times 10^{99}$.
B) An attempt is made to perform function calculations that exceed the input range.
C) Improper operation during statistical calculations, e.g., attempting to obtain x or xon without data input.
D) The capacity of the numeric value stack or the command stack is exceeded.
E) Input errors are made, e.g., 5 × × 3 =.

When error message appears, most keys will become inoperative. In this case, press the AC key to return to normal operation. You can also press the ← or → key to cause the cursor to show the position of the error.

The following error messages will be displayed for the operations listed above:

case (1) to case (3)	Ma ERROR
case (4)	Stk ERROR
case (5)	Syn ERROR
case (6)	Range ERROR

7. Number of input characters

This calculator features a 79-step area for calculation execution. One function comprises one step. Each press of numeric or +, −, ×, and ÷ keys comprise one step. Though such operations as SHIFT × (x^{-1} key) require two key operations, they actually comprise only one function, and therefore, only one step. These steps can be confirmed using the cursor. With each press of the ← or → key, the cursor is moved one step.
Input characters are limited to 79 steps. Usually, the cursor is represented by a blinking "-".

When numeric values or calculation commands are input, they appear on the display from the left. Calculation results, however, are displayed from the right.

8. Corrections

To make corrections in a formula that is being input, use the ← and → keys to move to the position of the error and press the correct keys.

Example: To change an input of 122 to 123:

1 2 2

D
122 _

←

D
122

3

D
123_

Example: To change an input of cos60 to sin60:

COS 1 0

D
cos60_

← ← ←

D
cos60

Sin

D
Sin60

If, after making corrections, input of the formula is complete, the answer can be obtained by pressing =. If, however, more is to be added to the formula, advance the cursor using the → key to the end of the formula for input.
If an unnecessary character has been included in a formula, use the ← and → keys to move to the position of the error and press the DEL key. Each press of DEL will delete one command (one step).

Example: To correct an input of 369**2 to 369*2:

3 6 9 × × 2

D
369× ×2_

← ← DEL

D
369×2

If a character has been omitted from a formula, use the ← or → key to move to the position where the character should have been input, and press SHIFT followed by INS key. Each

press of SHIFT INS will create a space for input of one command.

Example: To correct an input of 2.36^2 to sin 2.36^2:

2 . 3 6 x^2

D
2.36^2_

← ← ← ← ←

D
2.36^2

SHIFT INS (DEL)

D
[ ].36^2

Sin

D
Sin [ ].36^2

When SHIFT INS are pressed, the space that is opened is displayed as"[ ]". The function or value assigned to the next key you press will be inserted in the "[ ]". To exit from the insertion mode, move the cursors, or press SHIFT INS or press = .

Even after the = key has been pressed to calculate a result, it is possible to use this procedure for correction. Press the ← key to move the cursor to the place where the correction is to be made.

Chapter 2. Manual Calculations

1. Arithmetic operations & parenthesis calculations

Arithmetic operations are performed by pressing the keys in the same order as noted in the formula.

For negative values, press (-) before entering the value.

For mixed basic arithmetic operations, multiplication and division are given priority over addition and subtraction, assuming that display mode Norm 1 is selected.

EXAMPLE	OPERATION	DISPLAY
23+4.5-53=-25.5	23[+]4.5[-]53[=]	-25.5
56×(-12)÷(-2.5)=268.8	56[×][(-)12[)][÷][(-)2.5[)][=]	268.8
12369×7532×74103=6.903680613×10^12	12369[×]7532[×]74103[=]	6.903680613^{12}
(4.5×10^75)×(-2.3×10^-79)=-1.035×10^-3	4.5[EXP]75[×]-2.3[EXP]-79[=]	-1.035^{-03}

EXAMPLE	OPERATION	DISPLAY
(2+3)×10^2=500	[(]2[+]3[)][×]1[EXP]2[=]	500.
(1×10^5)÷7=14285.71429	1[EXP]5[÷]7[=]	14285.71429
(1×10^5)÷7-14285=0.7142857 Please note that internal calculation is calculated in 12 digits for a mantissa and the result is displayed rounded off to 10 digits.	1[EXP]5[÷]7[-]14285[=]	0.71428571
3+5×6=33	3[+]5[×]6[=]	33.
7×8-4×5=36	7[×]8[-]4[×]5[=]	36.
1+2-3×4÷5+6=6.6	1[+]2[-]3[×]4[÷]5[+]6[=]	6.6
100-(2+3)×4=80	100[-][(]2[+]3[)][×]4[=]	80.
2+3×(4+5)=29	2[+]3[×][(]4[+]5[)][=]29 Closed parentheses occurring immediately before operation of the [=] key may be omitted.	29.
(7-2)×(8+5)=65	[(]7[-]2[)][×][(]8[+]5[)][=] A multiplication sign [×] occurring immedately before an open parantheses can be omitted.	65.
10-{2+7×(3+6)}=-55	10[-][{]2[+]7[×][(]3[+]6[)][}][=]	-55.

2. Percentage calculations

Percentage cannot be executed in Base-N mode or CMPLX mode.

EXAMPLE	OPERATION	DISPLAY
Percentage 26% of $15.00	15[×]26[shift][%](=)	3.9
Premium 15% increase from $36.20	36.2[×]15[shift][%](=)[+]	41.63
Discount 4% discount from $47.50	47.5[×]4[shift][%](=)	45.6
Rate 75 is what % of 250?	75[÷]250[shift][%](=)	30.
Rate of change 141 is an increase of what % from 120?	141[-]120[shift][%](=)	17.5
Ratio of change 240 is decrease of what % from 300?	240[-]300[shift][%](=)	-20.

3. Specifying the format of calculation results

You can change the precision of calculation results by specifying the number of decimal places or the number of significant digits. You can also shift the decimal place of a displayed value three places to the left or the right for one-touch conversions of metric weights and measures.
Upon power-up reset, the display format is defaulted at Norm 1. Each time you can press MODE to enter the menu and select the desired format in the sub-menu "FIX/Sci/Norm". When you choose "Norm", you can further select between Norm 1 or Norm 2 in the following window.

```
Norm  1~2?
```

Key in either 1 or 2 to specify Norm 1 or Norm 2 respectively.

Norm 1: All values less than 10^{-2} or greater than 10^{9} are automatically expressed as exponents.
Norm 2: All values less than 10^{-9} or greater than 10^{9} are automatically expressed as exponents.

Note: You cannot specify the display format (Fix. Sci) while the calculator is in Base-N mode.

A) Specifying the number of decimal places

The calculator always performs calculations using a 10-digit mantissa and 2-digit exponent, and results are stored in memory as a 12-digit mantissa and 2-digit exponent no matter how many decimal places you specify. Intermediate results and final results are then automatically rounded off to the number of decimal places you have specified.
It should be noted that displayed results are rounded to the specified number of decimal places, but stored results are normally not rounded.
To specify the number of decimal places (Fix), select "FIX" in the sub-menu "Fix/Sci/Norm" and then you are asked to enter a value indicating the number of places (0~9), as below.

```
Fix  0~9?
```

At this time, you should be able to see "FIX" on the display. The number of decimal places specified will remain in effect until Norm 1 or Norm 2 is specified, as described above, or significant digits are specified by selecting "SCI" in the sub -menu "FIX/Sci/Norm".

EXAMPLE	OPERATION	DISPLAY
100÷6=16.66666666...	10[÷]6[=]	16.6666667
Specify 4 decimal places	[Mode][Mode][Mode] [Mode][=][4]	16.6667
Cancel specification	[Mode][Mode][Mode] [Mode][→][→][=][1]	16.66666667
200÷7×14=400	200[÷]7[×]14[=]	400.
Rounded to 3 decimal place	[Mode][Mode][Mode] [Mode][=][3]	400.000
	200[÷]7[=] The intermediate result is automatically rounded to the specified three decimal places.	28.571
The stored 10-digit result (28.571421857) is used when you continue the calculation by simply pressing [×] or any other arithmetic function key.		
	14[=] (The final result is automatically rounded to the specified three decimal places.)	400.000
Cancel specification by specifying Norm 1 again.	[Mode][Mode][Mode] [Mode][→][→][=][1]	400.

B) Rounding the intermediate result

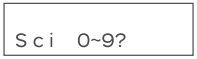
As the number of decimal places is specified, the intermediate result will be automatically rounded to the specified decimal places. However, the stored intermediate result is not rounded. In order to match the displayed value and the stored value, SHIFT RND can be input.
You can compare the final result obtained in the previous example with the final result of the following example.

EXAMPLE	OPERATION	DISPLAY
200÷7×14=400	200[÷]7[×]14[=]	400.
Rounded to 3 decimal place	[Mode][Mode][Mode] [Mode][=][3]	400.000
	200[÷]7[=] The intermediate result is automatically rounded to the specified three decimal places.	28.571

EXAMPLE	OPERATION	DISPLAY
Round the stored intermediate result to the specified three decimal places	[Shift][RND](0)	28.571
	[×]	Ans ×
	14[=]	399.994
Cancel specification by specifying Norm 1 again	[Mode][Mode][Mode] [Mode][→][→][=][1]	399.994

C) Specifying the number of significant digits

This specification is used to automatically round intermediate results and final results to the number of digits you have specified.
As with the number of decimal places, displayed results are rounded to the specified number of digits, but stored results are normally not rounded.
To specify the number of significant digits (Sci), select "SCI" in the sub-menu "Fix/Sci/Norm" and then you will be asked to enter a value indicating the number of significant digits (0~9), as below.



(Note: "0" indicating 10 significant digits.)

Meanwhile, the "SCI" indicator will appear on the display.

EXAMPLE	OPERATION	DISPLAY
100÷6=16.66666666...	10[÷]6[=]	16.6666667
Specify 5 significant digits	[Mode][Mode][Mode] [Mode][→][=][5]	16.667^{01}
Cancel specification by specifying Norm 1 again	[Mode][Mode][Mode] [Mode][→][→][=][1]	16.66666667

D) Shifting the decimal place

You can use the key ENG to shift the decimal point of the displayed value three places to the left or right. Each 3-place shift to the left is the same as dividing the value by 1000, and each shift to the right is the same as multiplying by 1000. This means that this function is useful when converting metric weights and measures to other metric units.

EXAMPLE	OPERATION	DISPLAY
123m×456=56088m =56.088km	123[×]456[=]	56088
	[ENG]	56.088^{03}
78g×0.96=74.88g =0.07488kg	78[×]0.96[=]	74.88
	[Shift][←](ENG)	0.07488^{03}

4. Memory

This calculator contains 9 standard memories.
There are two basic types of memories, i.e., "variable" memories, which are accessed by using the STO and RCL keys in combination with the alphabets A, B, C, D, E, F, M, X and Y. The independent memories are accessed by using the M+, SHIFT M- and SHIFT RCL and M keys. The variable memory and independent memory utilize the same memory area. Contents of both the variable and independent memories are protected even when the power is turned OFF.

A) Variable memories

Up to 9 values can be retained in memory at the same time and be recalled when desired.

Example: Input 123 into memory A:

AC 1 2 3 → 123_

STO A (X.T) → A= 123.

AC → _

SHIFT RCL (STO) A (X.T) → A= 123.

When formulas are input, the result of the formula's calculation is retained in memory.

Example: Input the result of 123×456 into memory B:

AC 1 2 3 × 4 5 6 → 123×456_

STO B (,,,) → B= 56088.

AC _



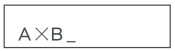
SHIFT RCL (STO) B (⇆) B= 56088.



If a variable expression is entered, the expression is first calculated according to the values stored in the variable memories used in the expression. The result is then stored in the variable memory specified for the result.

Example: Input the result of A*B into memory C:

AC Alpha A (X.T) × Alpha B (⇆) A×B _



STO C (hyp) C= 6898824.





AC _

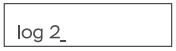
SHIFT RCL (STO) C (hyp) C= 6898824.



Note: Syn ERROR is generated when an attempt is made C= (A×B) or multistatements (such as A×B:C×D) and the existing memory contents are retained. When input is made in a format, such as "A = log 2" where the variable is equal to the formula, the results of the calculation are input into the specified memory.

Example: Executing"A = log2":

AC Alpha A (X.T) Alpha = log B log 2_





= 0.301029995





STO A (X.T) A= 0.301029995

AC _

SHIFT RCL (STO) A (X.T) A= 0.301029995



Deleting memories

To delete all contents of variable memories, press SHIFT followed by Mcl =.

B) Independent memories

Addition and subtraction (to and from sum) results can be stored directly in memory. Results can also be totalized in memory, making it easy to calculate sums. The icon "M" will be lighted as long as M is not empty.

Example: Input 123 to independent memory.

AC 1 2 3 123_



M+ 123.





Recall memory data.

AC _

SHIFT RCL (STO) M (M+) M= 123.



Add 25, subtract 12.

2 5 M+ 1 2 M+ SHIFT M- 12.





Recall memory data.

AC _

SHIFT RCL (STO) M (M+) M= 148.



To clear memory contents, press O STO M.

Addition/subtraction to or from sum in memory cannot be carried out with M+, SHIFT M- keys in SD mode and LR mode.

Difference between STO M M+ and M+ SHIFT M- :
Both STO M and M+ , SHIFT M- can be used to input results into memory; however, when the STO M operation is used, previous memory contents are cleared. When either M+ or SHIFT M- is used, value is added or subtracted to or from the present sum in memory.

Example: Input 456 into memory "M" using STO M procedure. Memory already contains value of 123.

AC 1 2 3 STO M (M+) M= 123.



AC 4 5 6 STO M (M+) → M= 456.

AC → _

SHIFT RCL (STO) M (M+) → M= 456.

Example: Input 456 into memory "M" using STO M.
Memory already contains value of 123.

AC 1 2 3 STO M (M+) → M= 123.

AC 4 5 6 M+ → 456.

AC → _

SHIFT RCL M (M+) → M= 579.

5. Special functions

A) Answer function

This unit has an answer function that stores the result of the most recent calculation. Once a numeric value or numeric expression is entered and = is pressed, the result is stored by this function.
To recall the stored value, press SHIFT ANS. When SHIFT ANS are pressed, "Ans" will appear on the display, and the value can be used in subsequent calculations.

Example: 123 + 456 = 579
789 - 579 = 210

AC 1 2 3 + 4 5 6 = → 579.

7 8 9 − SHIFT ANS (-) → 789-Ans_

= → 210.

Numeric values with 12 digits for a mantissa and 2 digits for an exponent can be stored in the Ans memory. The Ans memory is not erased, even if the power of the unit is turned OFF. Each time =, SHIFT %, M+, SHIFT M-, and STO oc=A~F, M, X, Y) is pressed, the value in the Ans memory is replaced with the new value produced by the calculation execution. When execution of a calculation results in an error, however, the Ans memory retains its current value.

Note: Contents of Ans memory are not altered when SHIFT RCL =A~F, M, X, Y) is used to recall contents of variable memory. Also, contents of Ans memory are not altered when variables are input when the variable input prompt is displayed.

B) Omitting the multiplication sign (×)

When inputting a formula as it is written, from left to right, it is possible to omit the multiplication sign (×) in the following cases:

(1) Before the following functions:
sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, $\cosh^{-1}$ $\tanh^{-1}$, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, log, ln, 10^x, e^x, $\sqrt{}$, $\sqrt[3]{}$, Pol (x,y) Rec (r, θ)
Example, 2sin30, 101og1.2, $2\sqrt{3}$, 2Po1(5,12), etc.

(2) Before fixed numbers, variables, and memories:
Example, 2π , 2AB, 3Ans, etc.

(3) Before parentheses:
Example, 3(5+6), (A+1)(B-1), etc.

C) Continuous calculation function

Even if calculations are concluded with the = key, the result obtained can be used for further calculations. In this case, calculations are performed with 10 digits for the mantissa, which is displayed.

Example: To calculate ÷3.14 continuing after 3×4 = 12:

AC 3 × 4 = → 12.

(Continuing) ÷ 3 . 1 4 → Ans ÷ 3.14_

= → 3.821656051

Example: To calculate 1÷3×3

AC 1 ÷ 3 × 3 = → 1.

1 ÷ 3 = → 0.333333333

(Continuing) [×] [3] → Ans × 3_

[=] → 1.

This function can be used with Type A functions (x^2, x^{-1}, x!), +, -, x^y, $\sqrt[x]{}$ and °'".

Example: Squaring the result of 78÷6=13:

[AC] [78] [÷] [6] [=] → 13.

(Continuing) [x^2] → Ans^2_

[=] → 169.

D) Replay function

This function stores formulas that have been executed. After execution is complete, pressing either the [←] or [→] key will display the formula executed.
Pressing [→] will display the formula from the beginning, with the cursor located under the first character.
Pressing [←] will display the formula from the end, with the cursor located at the space following the last character. After this, using the [→] and [←] to move the cursor, the formula can be checked and numeric values or commands can be changed for subsequent execution.

Example:

[AC] [1] [2] [3] [×] [4] [5] [6] [=] → 56088.

[→] → 123×456

[=] → 56088.

[←] → 123×456_

Example: 4.12×3.58+6.4=21.496
4.12×3.58-7.1=7.6496

[AC] [4] [.] [1] [2] [×] [3] [.] [5] [8] [+] [6] [.] [4] [=] → 21.1496

[←] → 4.12×3.58+6.4_

[←] [←] [←] [←] → 4.12×3.58±6.4

[−] [7] [.] [1] → 4.12×3.58-7.1_

[=] → 7.6496

The replay function is not cleared, even when [AC] is pressed or when power is turned OFF, so contents can be recalled, even after [AC] is pressed.
Replay function is cleared when mode or operation is switched.

E) Error position display function

When an ERROR message appears during operation execution, the error can be cleared by pressing the [AC] key, and the values of formula can be re-entered from the beginning. However, by pressing the [←] or [→] key, the ERROR message is cancelled and the cursor moves to the point where the error was generated.

Example: 14 ÷ 0 × 2.3 is input by mistake.

[AC] [1] [4] [÷] [0] [×] [2] [.] [3] [=] → Ma ERROR

[←] (Or [→]) → 14÷0×2.3

Correct the input by pressing:

[←] [SHIFT] [INS] (DEL) [1] → 14÷10×2.3

[=] → 3.22

F) Multistatement function

Note 1: The multistatement function (using "◢"to separate formulas or statements) available in program calculations can also be used for manual calculations.

Note 2: When [=] is pressed to execute a formula input using the multistatement format, the formula is executed in order from the beginning. The calculation results up to the point of "◢" will be displayed till you press [=] again to continue the calculation.

Example: 6.9×123=848.7
123÷3.2=38.4375

AC 1 2 3 STO A (X,T) 6 . 9 × Alpha A (X,T) Alpha ◢ (x^3) Alpha A (X,T) ÷ 3 . 2 =

Disp
848.7

"Disp" appears on the display when "◢" is used.

=

38.4375

Note 1: Even if "◢" is not input at the end of a formula, the final result will be displayed.

Note 2: Consecutive calculations containing multistatements cannot be performed.
123×456◢×5
[]Invalid

Note 3: Calculations can be performed while an intermediate result is displayed during execution interrupted by "◢."

Example: 5×6◢7×8:

AC 5 × 6 Alpha ◢ 7 × 8

D
5×6◢7×8_

=

D DISP
30.

sin SHIFT Ans

D DISP
sin Ans

=

D DISP
0.5

When interrupt operation is completed, press = once again to execute.

=

D
56.

6. Scientific functions

A) Trigonometric functions and inverse trigonometric functions

Note 1: Be sure to set the unit of angular measurement before performing trigonometric function and inverse trigonometric function calculations.

Note 2: The unit of angular measurement (degrees, radians, grads) is selected in the sub-menu.

Note 3: Once a unit of angular measurement is set, it remains in effect until a new unit is set. Settings are not cleared when power is switched OFF.

Note 4: This operation is invalid in the BASE-N mode. When in the BASE-N mode, go back to COMP mode by selecting "COMP" in the main menu.

EXAMPLE	OPERATION	DISPLAY
Sin 63°52'41" =0.897859012	[Mode][Mode][Mode] [=] → "D" [Sin]63[°, ,,]52[°, ,,]41 [°, ,,][=]	0.897859012
Cos (π /3 rad)=5	[Mode][Mode][Mode] [→][=] → "R" [Cos][(][Shift][π](EXP) [÷]3[)][=]	0.5
tan(-35 gra) =-0.612800788	[Mode][Mode][Mode] [→][→][=] → "G" [tan][-]35[=]	-0.612800788
2sin45° × cos65° =0.597672477	[Mode][Mode][Mode] [=] → "D" 2[sin]45[cos]65[=]	0.597672477
$\sin^{-1}0.5=30$	[Shift][$\sin^{-1}$](sin)0.5[=]	30.
$\cos^{-1}(\sqrt{2}/2)$ =0.785398163 =π/4(rad)	[Mode][Mode][Mode] [→][=] → "R" [Shift][$\cos^{-1}$](cos)([)[√] 2[÷]2[)][=] [÷][Shift][π](EXP)[=]	0.785398163 0.25
$\tan^{-1}$ 0.741 =36.53844577° =36°32'18.4" If the total number of digits for degrees /minutes seconds exceed 11 digits, the higher order values are stored in memory.	[Mode][Mode][Mode] [=]→ "D" [Shift][$\tan^{-1}$](tan)0.741[=] [Shift][°, ,,] Given display priority, and any lower-order values are not displayed. However, the entire value is stored within.	36.53844577 36°32'18.4" The unit as a decimal value.
2.5×($\sin^{-1}$0.8-$\cos^{-1}$0.9) =68°13'13.53"	2.5[×][(][Shift][$\sin^{-1}$](sin) 0.8[-][Shift][$\cos^{-1}$](cos) 0.9[)][=][Shift][°, ,,]	68°13'13.53"

B) Logarithmic and exponential functions

The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out the calculation after selecting "COMP" mode in main menu.

EXAMPLE	OPERATION	DISPLAY
Log1.23 $=8.9905111\times10^{-2}$	[log][1.23][=]	0.089905111
ln90=4.49980967	[ln]90[=]	4.49980967
Log456÷ln456 =0.434294481	[log]456[÷][ln]456[=]	0.434294481
$10^{1.23}$=16.98243652	[Shift][10^x](log)1.23[=]	16.98243652
$e^{4.5}$=90.0171313	[Shift][e^x](ln)4.5[=]	90.0171313
$10^4\cdot e^{-4}+1.2\cdot10^{2.3}$ =422.5878667	[Shift][10^x](log)4[×][Shift][e^x](ln)[-]4[+]1.2[×][Shift][10^x](log)2.3[=]	422.5878667
$(-3)^4$=81	[(][-]3[)][x^y]4[=]	81.
-3^4=-81	[-]3[x^y]4[=]	-81.
$5.6^{2.3}$=52.58143837	5.6[x^y]2.3[=]	52.58143837
$\sqrt[7]{123}$ =1.988647795	7[Shift][$\sqrt[x]{}$][(x^y)123[=]	1.988647795
$(78-23)^{-12}$ $=1.305111829\times10^{-21}$	[(]78[-]23[)][x^y][-]12[=]	1.305111829^{-21}
$2+3\times\sqrt[3]{64}-4=10$	2[+]3[×]3[Shift][x^y] 64[-]4[=]	10.
$2\times3.4^{(5+6.7)}$ =3306232.001	2[×]3.4[x^y][(]5[+]6.7[)][=]	3306232.001

C) Performing hyperbolic and inverse hyperbolic functions

The following operation is invalid in the BASE-N mode. When the user is in the BASE-N mode he/she should go back to COMP mode before carrying out the calculation.

EXAMPLE	OPERATION	DISPLAY
sinh 3.6=18.28545536	[hyp][sin]3.6[=]	18.28545536
cosh 1.23=1.856761057	[hyp][cos]1.23[=]	1.856761057
tanh 2.5=0.986614298	[hyp][tan]2.5[=]	0.986614298
cosh 1.5-sinh 1.5 =0.22313016	[hyp][cos]1.5[-][hyp][sin]1.5[=]	0.22313016
$\sinh^{-1}$30=4.094622224	[hyp][Shift][$\sin^{-1}$] 30[=]	4.094622224
$\cosh^{-1}$ (20/15) =0.795365461	[hyp][Shift][$\cos^{-1}$](cos)[(]20[÷]15[)][=]	0.795365461

EXAMPLE	OPERATION	DISPLAY
x=($\tanh^{-1}$0.88)/4 =0.343941914	[hyp][Shift][$\tan^{-1}$](tan)0.88[÷]4[=]	0.343941914
$\sinh^{-1}$2×$\cosh^{-1}$1.5 =1.389388923	[hyp][Shift][$\sin^{-1}$](sin)2[×][hyp][Shift][$\cos^{-1}$]1.5[=]	1.389388923
$\sinh^{-1}$(2/3)$\tanh^{-1}$(4/5) =1.723757406	[hyp][Shift][$\sin^{-1}$](sin)[(]2[÷]3[)][+][hyp][Shift][$\tan^{-1}$](tan)[(]4[÷]5[)][=]	1.723757406

D) Coordinate transformation

Note 1: This scientific calculator lets you convert between rectangular coordinates and polar coordinates. i.e., P(x,y) ↔ P(r, θ)

Note 2: Calculation results are stored in variable memory E and variable memory F. Contents of variable memory E are displayed initially. To display contents of memory F, press RCL F.

Note 3: With polar coordinates, θ can be calculated within a range of -180°< θ ≦ 180°. (Calculated range is the same with radians or grads.)

Note 4: The following operation is invalid in the BASE-N mode. Before carrying out the calculation, one should switch back to COMP mode.

EXAMPLE	OPERATION	DISPLAY
x=14 and y=20.7, what are r and θ°?	[Mode][Mode][Mode][=] →"D"[Shift][Pol(](+)14 [Shift][,](hyp)20.7[)][=] [Shift][RCL](STO)[F](tan) [Shift][,,,]	24.98979792(r) 55°55'42.2"(θ)
x=7.5 and y=10, what are r and θ rad?	[Mode][Mode][Mode] ➡ [=]→"R"[Shift][Pol(](+)7.5 [Shift][,][-]10[)][=] [Shift][RCL](STO)[F](tan)	12.5(r) F= -0.927295218(θ)
Y=25 and θ=56°, what are x and y?	[Mode][Mode][Mode][=] →"D" [Shift][Rec(](-)25[Shift][,] (hyp)56[)][=] [Shift][RCL](STO)[F](tan)	13.9782259(x) 20.72593931(y)
r=4.5 and θ=2π/3rad, what are x and y?	[Mode][Mode][Mode] ➡ [=]→"R" [Shift][Rec(](-)4.5[Shift][,] (hyp)[(]2[÷]3[×][Shift][π] [EXP][)][)][=] [Shift][RCL](STO)[F](tan)	-2.25(x) 3.897114317(y)

E) Other functions(√, x^2, x^{-1}, x!, $\sqrt[3]{}$, Ran#)

The following operation is invalid in the BASE-N mode. When in the BASE-N mode, carry out the calculation after going back to COMP mode.

EXAMPLE	OPERATION	DISPLAY
$\sqrt{2}+\sqrt{5}=3.65028154$	$\sqrt{}$ 2 + $\sqrt{}$ 5 =	3.65028154
$2^2+3^2+4^2+5^2=54$	2 x^2 + 3 x^2 + 4 x^2 + 5 x^2 =	54.
$(-3)^2=9$	((-) 3) x^2 =	9.
$-3^2=-9$	(-) 3 x^2 =	-9.
$1/(1/3-1/4)=12$	(3 SHIFT x^{-1} (x^2) − 4 x^{-1} SHIFT) SHIFT x^{-1} (x^2) =	12.
$8!=40320$	8 SHIFT x! (√‾) =	40320.
$\sqrt[3]{(36\times42\times49)}=42$	SHIFT $\sqrt[3]{}$ (x^3) (36 × 42 × 49) =	42.
Random number generation (number is in the range of 0.000 to 0.999)	SHIFT Ran# (•) =	0.792
$\sqrt{(1-\sin^2 40)}=0.766044443$	MODE MODE MODE = →"D" √‾ (1 - (sin 40) x^2) = SHIFT $\cos^{-1}$ (cos) SHIFT Ans ((-)) =	0.766044443 40.
$1/2!+1/4!+1/6!+1/8!=0.543080357$	2 SHIFT x! (√‾) SHIFT x^{-1} (x^2) + 4 SHIFT x! (√‾) SHIFT x^{-1} (x^2) + 6 SHIFT x! (√‾) SHIFT x^{-1} (x^2) + 8 SHIFT x! (√‾) SHIFT x^{-1} (x^2) =	0.543080357

F) Fractions

Fractions are input and displayed in the order of integer, numerator, and denominator.

EXAMPLE	OPERATION	DISPLAY
$2/5+3\frac{1}{4}=3\frac{13}{20}=3.65$	2 $a\frac{b}{c}$ 5 + 3 $a\frac{b}{c}$ 1 $a\frac{b}{c}$ 4 = (Conversion to decimal) $a\frac{b}{c}$ Fractions can be converted to decimals, and then converted back to fractions.	3⌟13⌟20. 3.65
$3^{456}/_{78}=8^{11}/_{13}$	3 $a\frac{b}{c}$ 456 $a\frac{b}{c}$ 78 = SHIFT $\frac{d}{c}$ ($a\frac{b}{c}$)	8⌟11⌟13. 115⌟13.
$^1/_{2578}+{}^1/_{4572}=6.066202547\times10^{-4}$	1 $a\frac{b}{c}$ 2578 + 1 $a\frac{b}{c}$ 4572 = When the total number of characters, including integer, numerator, denominator and delimiter mark exceeds 10, the input fraction is automatically displayed in decimal format.	6.066202547^{-4}
$^1/_2\times0.5=0.25$	1 $a\frac{b}{c}$ 2 × 0.5 =	0.25
$^1/_3\times(-{}^4/_5)-{}^5/_6=-{}^{11}/_{10}$	1 $a\frac{b}{c}$ 3 × -4 $a\frac{b}{c}$ 5 − 5 $a\frac{b}{c}$ 6 =	-1⌟1⌟10.
$^1/_2\times{}^1/_3+{}^1/_4\times{}^1/_5={}^{13}/_{60}$	1 $a\frac{b}{c}$ 2 × 1 $a\frac{b}{c}$ 3 + 1 $a\frac{b}{c}$ 4 × 1 $a\frac{b}{c}$ 5 =	13⌟60.
$(^1/_2)/_3={}^1/_6$	(1 $a\frac{b}{c}$ 3) $a\frac{b}{c}$ 3 =	1⌟6.
$1/(^1/_3+{}^1/_4)={}^5/_7$	1 $a\frac{b}{c}$ (1 $a\frac{b}{c}$ 3 + 1 $a\frac{b}{c}$ 4) =	1⌟5⌟7.

7. Degrees, minutes, seconds calculations

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

EXAMPLE	OPERATION	DISPLAY
To express 2.258 degrees in deg/min/sec.	2.258[°,,,][=]	2°15′28.8″
To peform the calculation: 12°34′56″×3.45	12[°,,,]34[°,,,]56 [°,,,][×]3.45[=]	43°24′31.2″

8. Binary, octal, decimal, hexadecimal calculations

Note 1: Binary, octal, decimal, hexadecimal calculations; conversions; and logical operations are performed in BASE-N mode (pres MODE → → → → =).

Note 2: The number system (2,8,10,16) is set by respectively pressing BIN , OCT , DEC , HEX . A corresponding symbol "b", "o", "d", or "h" appears on the display.

Note 3: Number systems are specified for specific values by pressing SHIFT, then the numbers system designator (b, o, d, h), immediately followed by the value.

Note 4: General function calculations cannot be performed in the BASE-N mode.

Note 5: Only integers can be handled in the BASE-N mode. If a calculation produces a result that includes a decimal value, the decimal portion is cut off.

Note 6: If values not valid for the particular number system are used, attach the corresponding designator (b, o, d, or h), or an error message will appear.

NUMBER SYSTEM	VALID VALUES
Binary	0,1
Octal	0,1,2,3,4,5,6,7
Decimal	0,1,2,3,4,5,6,7,8,9
Hexadecimal	0,1,2,3,4,5,6,7,8,9,A,B,C,D,E,F

Note 1: Negative numbers in binary, octal, hexadecimal are expressed as two's complements.

Note 2: Number of digits displayed in each number system.

NUMBER SYSTEM	NUMBER OF DIGITS DISPLAYED
Binary	Up to 10 digits
Octal	Up to 10 digits
Decimal	Up to 10 digits
Hexadecimal	Up to 8 digits

Note 1: Calculation range (in BASE-N mode)

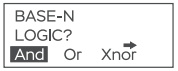
Binary Positive: 0111111111 ≧ x ≧ 0
Negative: 1111111111 ≧ x ≧ 1000000000

Octal Positive: 3777777777 ≧ x ≧ 0
Negative: 7777777777 ≧ x ≧ 4000000000

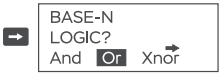
Decimal Positive: 2147483647 ≧ x ≧ 0
Negative: -1 ≧ x ≧ -2147483647

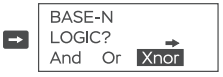
Hexadecimal Positive: 7FFFFFFF ≧ x ≧ 0
Negative: FFFFFFFF ≧ x ≧ 80000000

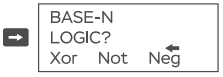
Note 2: Sub-menu for BASE-N operation
In the sub-menu, you can select operators AND, OR, XNOR, XOR, NOT, and NEG.
Press SHIFT LOGIC to open the menu.



Press → consecutively to select the operator.







After locating the desired operator, press = to confirm and go back to input mode.

A) Binary, octal, decimal, hexadecimal conversions

Conversion using number system specification key

Value from a different number system input when a specific number system mode is being used.

EXAMPLE	OPERATION	DISPLAY
What are the decimal values for $2A_{16}$ and 274_8?	MODE → → → →	BASE-N
	= DEC (√‾) → "d"	$_d$
	SHIFT [h] (x^2) 2	
	SHIFT A(X,T) =	42^d
	SHIFT [o] (ln)274 =	188^d

EXAMPLE	OPERATION	DISPLAY
What are the hexadecimal values for $123_{10}$and 1010_2?	[HEX] (x^2) → "h" [SHIFT] [d] $(\sqrt{\ })$123 [=] [SHIFT] [b] (log)1010 [=]	 $7B^h$ A^h
What are the octal values for 15_{16} and 1100_2?	[OCT] (ln) → "o" [SHIFT] [h] (x^2) 15 [=] [SHIFT] [b] (log)1100 [=]	 25° 14°
What are the binary values for 36_{10} and $2C_{16}$?	[BIN] (log) → "b" [SHIFT] [d] $(\sqrt{\ })$ 36 [=] [SHIFT] [h] (x^2)2 [SHIFT] C [=]	 100100^b 101100^b

Conversion using number system mode key

Calculation results can be converted to any specified number system by using the corresponding number system mode key.

EXAMPLE	OPERATION	DISPLAY
How is 22_{10} expressde in binary, octal and hexadecimal number system?	[MODE] [→] [→] [→] [→] [=] → "d" 22 [=] [BIN] (log) [OCT] (ln) [HEX] (x^2)	 22^d 10110^b 26° 16^h

B) Basic arithmetic operations using binary, octal, decimal, hexadecimal values

EXAMPLE	OPERATION	DISPLAY
10111_2 + 11010_2 =110001_2	[MODE] [→] [→] [→] [→] [=] [BIN] (log) → "d" 10111 [+] 11010 [=]	 110001^b
$B47_{16}$-DF_{16}=$A68_{16}$	[HEX] (x^2) → "h" B (,,,) 47 [−] D(sin)F(tan) [=]	 $A68^h$

EXAMPLE	OPERATION	DISPLAY
123_8×ABC_{16} =$37AF4_{16}$=228084_{10}	[SHIFT] [o] (ln)123 [×] A(x.T) B (,,,) C(hyp) [=] [DEC] $(\sqrt{\ })$	 $37AF4^h$ 228084^d
$1F2D_{16}$-100_{10}=7881_{10} =$1EC9_{16}$	[SHIFT] [h] (x^2) 1F(tan)2D(sin) [−] 100 [=] [HEX] (x^2)	 7881^d $1EC9^h$
7654_8÷12_{10} =334.3333333_{10} =516_8	[DEC] $(\sqrt{\ })$ → "d" [SHIFT] [o] (ln)7654 [÷] 12 [=] [OCT] (ln)	 334^d 516°
1234_{10}+$1EF_{16}$÷24_8 =2352_8 =1258_{10}	[SHIFT] [d] $(\sqrt{\ })$1234 [+] [SHIFT] [h] (x^2) 1E(cos)F (tan) [÷] 24 [=] [DEC] $(\sqrt{\ })$	 2352° 1258^d

C) Negative expressions

EXAMPLE	OPERATION	DISPLAY
How is 110010_2 expressed as a negative?	[MODE] [→] [→] [→] [→] [=] [BIN] (log) → "b" [LOGIC] (x^3) [→] [→] [→] [→] [→] [=] 110010 [=]	 1111001110^b
How is 72_8 expressed as a negative?	[OCT] (ln) → "o" [LOGIC] (x^3) [→] [→] [→] [→] [→] [=] 72 [=]	 7777777706^o
How is $3A_{16}$ expressed as a negative?	[HEX] (x^2) → "h" [LOGIC] (x^3) [→] [→] [→] [→] [→] [=] 3A(x.T) [=]	 $FFFFFFC6^h$

D) Logical operations

Logical operations are performed through logical products (and), logical sums (or), negative (Not), exclusive logic sums (xor), and negation of exclusive logical sums (xnor).

EXAMPLE	OPERATION	DISPLAY
19_{16} AND $1A_{16}=18_{16}$	MODE → → → → = HEX (x^2) → "h" 19 LOGIC (x^3) = 1A(x.T) =	18^h
1110_2 AND $36_8=110_2$	BIN (log) → "b" 1110 LOGIC (x^3) = SHIFT [h] (x^2) 36 =	110^b
23_8 OR $61_8=63_8$	OCT (ln) → "o" 23 LOGIC (x^3) → = 61 =	63°
120_{16} OR $1101_2=12D_{16}$	HEX (x^2) → "o" 120 LOGIC (x^3) → = SHIFT [b] (log)1101 =	$12D^h$
1010_2 AND (A_{16} OR 7_{16})$=1010_2$	BIN (log) → "b" 1010 LOGIC (x^3) = (SHIFT [h] (x^2) A(x.T) LOGIC (x^3) → = SHIFT [h] (x^2) 7) =	1010^b
5_{16} × XOR$3_{16}=6_{16}$	HEX (x^2) → "h" 5 LOGIC (x^3) → → → = 3 =	6^h
$2A_{16}$ × XNOR $5D_{16}$ $=FFFFFF88_{16}$	HEX (x^2) → "h" 2A(x.T) LOGIC (x^3) → → = 5D(sin) =	$FFFFFF88^h$
Negation of 1234_8	OCT (ln) → "o" LOGIC (x^3) → → → → → = 1234 =	7777776544^o

EXAMPLE	OPERATION	DISPLAY
Negation of $2FFFED_{16}$	HEX (x^2) → "h" LOGIC (x^3) → → → → → = 2F(tan)FFE(cos)D(sin) =	$FFD00013^h$

9. Statistical calculations

This unit can be used to make statistical calculations, including standard deviation in the SD mode and regression calculation in the RED mode.

A) Standard deviation

In the SD mode, calculations including 2 types of standard deviation formulas, mean, number of data, sum of data, and sum of square can be performed.

Data input

1. Press MODE → → = to specify SD mode.
2. Press SHIFT Scl = to clear the statistical memories.
3. Input data by pressing DT key (= M+) each time a new piece of data is entered.

Example: Data = 10, 20, 30
Key operation: 10 DT 20 DT 30 DT

Note: When multiples of the same data are input, two different entry methods are possible.

Example 1: Data = 10, 20, 20, 30
Key operation: 10 DT 20 DT DT 30 DT

The previously entered data is entered again each time the DT is pressed without entering data (in this case, 20 is re-entered).

Example 2: Data = 10,20,20,20,20,20,20,30
Key operation: 10 DT 20 SHIFT ; 6 DT 30 DT

By pressing SHIFT and then entering a semicolon followed by the value that represents the number of items the data is repeated (6 in this case) and the DT key, the multiple data entries (for 20, in this case) are made automatically.

Deleting input data

There are various ways to delete value data, depending on how and where it was entered.

Example 1: 40 DT (M+)20 DT 30 DT 50 DT
To delete 50, press SHIFT CL (M+).

Example 2: 40 DT 20 DT 30 DT 50 DT
To delete 20, press 20 SHIFT CL .

Example 3: 30 DT 50 DT 120 SHIFT ; (X.T)
To delete 120 SHIFT ; , press AC .

Example 4: 30 DT 50 DT 120 SHIFT ; 31,
To delete 120 SHIFT ; 31, press AC .

Example 5: 30 DT 50 DT 120 SHIFT ; 31, DT
To delete 120 SHIFT ; 31 DT , press SHIFT CL .

Example 6: 50 DT 120 SHIFT ; 31 DT 40 DT 30 DT
To delete 120 SHIFT ; 31 DT , press 120 SHIFT ; 31 SHIFT CL .

Example 7: √ 10 DT √ 20 DT √ 30 DT
To delete √ 20 DT , press √ 20 = ANS SHIFT CL .

Example 8: √ 10 DT √ 20 DT √ 30 DT
To delete √ 20 DT , press √ 20 SHIFT ; (-) 1 DT .

Performing calculations

The following procedures are used to perform the various standard deviation calculations.

KEY OPERATION	RESULT
SHIFT $x\sigma n$ =	Population standard deviation, $x\sigma n$
SHIFT $x\sigma n\text{-}1$ =	Sample standard deviation, $x\sigma n\text{-}1$
SHIFT $\bar{x}$ =	Mean, x
Alpha Σx^2 =	Sum of square of data, Σx^2
Alpha Σx =	Sum of data, Σx
Alpha n =	Number of data, n

Standard deviation and mean calculations are performed, as shown below:
Population standard deviation $\sigma n = \sqrt{(\sum (xi-x)^2/n)}$ where i=1 to n
Sample standard deviation $\sigma n\text{-}1 = \sqrt{(\sum (xi-x)^2/n)}$ where i=1 to n
Mean $x = \sum x/n$

EXAMPLE	OPERATION	DISPLAY
Data 55, 54, 51, 55,53, 53, 54, 52	MODE → → = → "SD" (Memory cleared)	
	SHIFT Scl (AC) =	0.
	55 DT (M+) 54 DT 51 DT	
	55 DT 53 DT DT 54 DT	
	52 DT	52.
What is deviation of the unbiased variance, the difference between each datum, and the mean of the above data?	(Standard deviation σn)	
	SHIFT $x\sigma n$ (2) =	1.316956719
	(Standard deviation $\sigma n\text{-}1$)	
	SHIFT $x\sigma n\text{-}1$ (3) =	1.407885953
	(Mean x) SHIFT $\bar{x}$ (1) =	53,375
	(Number of data n)	
	Alpha n (1) =	8.
	(Sum total Σx)	
	Alpha Σx (2) =	427.
	(Sum of squares Σx^2)	
	Alpha Σx^2 (3) =	22805.
	(Continuing) (3)	
	SHIFT $x\sigma n\text{-}1$ (3) x^2 =	1.982142857
	55 - SHIFT $\bar{x}$ (1) =	1.625
	54 - SHIFT $\bar{x}$ (1) =	0.625
	51 - SHIFT $\bar{x}$ (1) =	-2.357
What is x and $\sigma n\text{-}1$ for the following table? Class on. Value Frequency 1 110 10 2 130 31 3 150 24 4 170 2 5 190 3	SHIFT Scl (AC) =	0.
	100 SHIFT ; (X.T) 10 DT (M+)	100.
	130 SHIFT ; (X.T) 31 DT (M+)	130.
	150 SHIFT ; (X.T) 24 DT (M+)	150.
	170 DT (M+) DT	170.
	190 DT (M+) DT DT	190.
	Alpha n (1) =	70.
	SHIFT $\bar{x}$ (1) =	136.2857143
	SHIFT $x\sigma n\text{-}1$ (3) =	20.79377196

B) Regression calculation

In the REG mode, calculations including linear regression, logarithmic regression, exponential regression, power regression, quadratic regression, and inverse regression can be performed.

1) Linear regression

Linear regression calculations are carried out using the following formula: y = A + Bx.

Data input

1. Press MODE → → → = to specify the REG mode.
2. Press SHIFT Scl (Ac) = to clear the statistical memories.
3. Input data in the following format:
   <x data> , <y data> DT

Note: When multiples of the same data are input, two different entry methods are possible.

Example 1: Data = 10/20, 20/30, 20/30, 40/50
Key operation: 10 SHIFT , 20 DT (M+)
20 SHIFT , 30 DT (M+) DT (M+)
40 SHIFT , 50 DT (M+)

The previously entered data is entered again each time the DT is pressed (in this case, 20/30 is re-entered).

Example 2: Data: 10/20, 20/30, 20/30, 20/30, 20/30, 20/30, 40/50
Key operation: 10 SHIFT , 20 DT (M+)
20 SHIFT , 30 SHIFT ; 5 DT (M+)
40 SHIFT , 50 DT (M+)

By pressing SHIFT and then entering a semicolon followed by the value that represents the number of times the data is repeated (5 in this case) and the DT key, the multiple data entries (for 20/30, in this case) are made automatically.

Deleting input data

There are various ways to delete value data, depending on how and where it was entered.

Example 1: 10 SHIFT , 40 DT (M+)
20 SHIFT , 20 DT (M+)
30 SHIFT , 30 DT (M+)
40 SHIFT , 50
To delete 40 SHIFT , 50 DT, press AC.

Example 2: 10 SHIFT , 40 DT
20 SHIFT , 20 DT
0 SHIFT , 30 DT
40 SHIFT , 50 DT
To delete 40 SHIFT , 50 DT, press SHIFT CL.

Example 3: To delete 20 SHIFT , 20 DT, press 20 SHIFT CL.

Example 4: √ 10 SHIFT , 40 DT
√ 40 SHIFT , 50 DT
To delete √ 20 SHIFT , 20 DT, press √ 20 = ANS , 20 SHIFT CL.

Example 5: To delete √ 20 SHIFT , 20 DT, press √ 20 SHIFT , 20 SHIFT ; (-) 1 DT.

Key operations to recall regression calculation results

KEY OPERATION	RESULT
SHIFT A =	Constant term of regression A
SHIFT B =	Regression coefficient B
SHIFT C =	Regression coefficient C
SHIFT r =	Correlation coefficient r
SHIFT $\hat{x}$ =	Estimated value of $\hat{x}$
SHIFT $\hat{y}$ =	Estimated value of $\hat{y}$
SHIFT $y\sigma n$	Population standard deviation, $y\sigma n$
SHIFT $y\sigma n{-}1$	Sample standard deviation, $y\sigma n{-}1$
SHIFT $\bar{y}$	Mean, $\bar{y}$
SHIFT $x\sigma n$	Population standard deviation, $x\sigma n$
SHIFT $x\sigma n{-}1$	Sample standard deviation, $x\sigma n{-}1$
SHIFT $\bar{x}$	Mean, $\bar{x}$
Alpha Σx^2 =	Sum of square of data, Σx^2
Alpha Σx =	Sum of data, Σx
Alpha n =	Number of data, n
Alpha Σy^2 =	Sum of square of data, Σy^2
Alpha Σy =	Sum of data, Σy
Alpha Σxy =	Sum of data, Σxy

Performing calculations

The following procedures are used to perform the various linear regression calculations.
The regression formula is y = A + Bx. The constant term of regression A, regression coefficient B, correlation r, estimated value of x, and estimated value of y are calculated, as shown below:

$A=(\Sigma y-\Sigma x)/n$

$B=(n\Sigma xy-\Sigma x\Sigma y)(n\Sigma x^2-(\Sigma x)^2)$

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

$y=A+Bx$

$x=(y-A)/B$

EXAMPLE	OPERATION	DISPLAY
Temperature and length of a steel bar Temp Length 10°C 1003mm 15°C 1005mm 20°C 1010mm 25°C 1011mm 30°C 1014mm Using this table, the regression formula and correlation coefficient can be obtained. Based on the coefficient formula, the length of the steel bar at 18°C and the temperature at 1000mm can be estimated, Furthermore, the critical coefficient (r^2)and covariance can also be calculated.	MODE → → → = = → "REG" then select linear regression (Memory cleared) SHIFT Scl (AC) = 10 SHIFT , (hyp)1003 SHIFT DT (M+) 15 SHIFT , (hyp)1005 SHIFT DT (M+) 20 SHIFT , (hyp)1010 SHIFT DT (M+) 25 SHIFT , (hyp)1011 SHIFT DT (M+) 30 SHIFT , (hyp)1014 SHIFT DT (M+) (Constant term A) SHIFT A (7) = (Regression coefficien B) SHIFT B (8) = (Constant coefficien r) SHIFT r (( ) = (Length at 18°C)18 SHIFT $\hat{y}$ (-) (Temperature at 1000mm) 1000 SHIFT $\hat{x}$ (+)	0. 10. 15. 20. 25. 30. 997.4 0.56 0.982607368 1007.48 4.642857143

EXAMPLE	OPERATION	DISPLAY
	(Critical coefficient) SHIFT r (( ) x^2 = (Covariance) (Alpha Σxy (4) - Alpha n (1) x SHIFT $\bar{x}$ (1) x SHIFT $\bar{y}$ (4)) ÷ (Alpha n (1) -) =	0.965517241 23.33333333

2) Logarithmic regression

Logarithmic regression calculations are carried out using the following formula: y = A + B•ln(x).

Data input

1. Press MODE → → → = to specify the REG mode.
2. Press SHIFT Scl = to clear the statistical memories.
3. Input data in the following format:
   <x data> , <y data> DT

Note: To make multiple entries of the same data, follow procedures described for linear regression.

Deleting input data

To delete input data, follow the procedures described for linear regression.

Performing calculations

The logarithmic regression formula y = A + B•ln(x). As x is input, ln(x) will be stored instead of x itself. Hence, we can treat the logarithmic regression formula same as the linear regression formula. Therefore, the formulas for constant term A, regression coefficient B, and correlation r coefficient are identical for logarithmic and linear regression.

EXAMPLE	OPERATION	DISPLAY
xi yi 29 1.6 50 23.5 74 38.0 103 46.4 118 48.9 Through logarithmic regression of the above data, the regression formula and correlation coefficient are obtained. Futhermore, respective estimated values y and x can be obtained for xi=80 and yi=73 using the regression formula.	MODE → → → = → = → "REG" then select logarithmic regression SHIFT Scl (AC) = 29 SHIFT , (hyp)1.6 SHIFT DT (M+) 50 SHIFT , (hyp)23.5 SHIFT DT (M+) 74 SHIFT , (hyp)38.0 SHIFT DT (M+) 103 SHIFT , (hyp)46.4 SHIFT DT (M+) 118 SHIFT , (hyp)48.9 SHIFT DT (M+) (Constant term A) SHIFT A (7) = (Regression coefficient B) SHIFT B (8) = (Correlation coefficient r) SHIFT □ (( ) = (y when xi=80) 80 SHIFT $\hat{y}$ (-) (x when yi=73) 73 SHIFT $\hat{x}$ (+)	0. 29. 50. 74. 103. 118. -111.1283976 34.0201475 0.994913946 37.94879482 224.1541313

A number of logarithmic regression calculation results differ from those produced by linear regression. Note the following:

LINEAR REGRESSION	EXPONENTIAL REGRESSION
Σx	$\Sigma \ln x$
Σx^2	$\Sigma (\ln x)^2$
Σxy	$\Sigma y \bullet \ln x$

3) Exponential regression

Exponential regression calculations are carried out using the following formula:

$Y = A \bullet e^{B \cdot X}$ (lny=lnA+Bx)

Data input

1. Press MODE → → → = to specify the REG mode.
2. Press SHIFT Scl (Ac) = to clear the statistical memories.
3. Input data in the following format:
   <x data> , <y data> DT

Note: To make multiple entries of the same data, follow procedures described for linear regression.

Deleting input data

To delete input data, follow the procedures described for linear regression.

Performing calculations

If we assume that lny = y and lnA = a', the exponential regression formula $y = A \bullet e^{B \cdot X}$ (lny = lnA + Bx) becomes the linear regression formula y = a' + bx if we store ln(y) instead of y itself. Therefore, the formulas for constant term A, regression coefficient B, and correlation coefficient r are identical for exponential and linear regression.

A number of exponential regression calculation results differ from those produced by linear regression. Note the following:

LINEAR REGRESSION	EXPONENTIAL REGRESSION
Σy	$\Sigma \ln y$
Σy^2	$\Sigma (\ln y)^2$
Σxy	$\Sigma x \bullet \ln y$

EXAMPLE	OPERATION	DISPLAY
xi yi 6.9 21.4 12.9 15.7 19.8 12.1 26.7 8.5 35.1 5.2	MODE → → → = → → = "REG" then select exponential regression SHIFT Scl (AC) = 6.9 SHIFT , (hyp)21.4 SHIFT DT (M+) 12.9 SHIFT , (hyp)15.7 SHIFT DT (M+) 19.8 SHIFT , (hyp)12.1 SHIFT DT (M+)	0. 6.9 12.9 19.8

EXAMPLE	OPERATION	DISPLAY
Through exponential regression of the above dara, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtained the respective estimated values of y and x, when xi=16 and yi=20	26.7 SHIFT , (hyp)8.5 SHIFT DT (M+) 35.1 SHIFT , (hyp)5.2 SHIFT DT (M+) (Constant term A) SHIFT A (7) = (Regression coefficient B) SHIFT B (8) = (Correlation coefficient r) SHIFT r (( ) = (y when xi=16) 16 SHIFT $\hat{y}$ (-) (x when yi=20) 20 SHIFT $\hat{x}$ (+)	26.7 35.1 30.49758743 -0.049203708 -0.997247352 13.87915739 8.574868046

4) Power regression

Power regression calculations are carried out using the following formula:
$y = A \cdot x^B$ ($\ln y = \ln A + B \ln x$)

Data input

1. Press MODE → → → = to specify the REG mode.
2. Press SHIFT Scl = to clear the statistical memories.
3. Input data in the following format:
   <x data> , <y data> DT

Note: To make multiple entries of the same data, follow procedures described for linear regression.

Deleting input data

To delete input data, follow the procedures described for linear regression.

Performing calculations

If we assume that ln y=y and ln A=a', and ln x=x, the power regression formula $y = A \cdot x^B$ ($\ln y = \ln A + B \ln x$) becomes the linear regression formula A=a'+bx if we store ln(x) and ln(y) instead of x and y themselves.
Therefore, the formulas for constant term A, regression coefficient B, and correlation coefficient r are identical to the power and linear regression.

A number of power regression calculation results differ from those produced by linear regression. Note the following:

LINEAR REGRESION	POWER REGRESSION
Σx	$\Sigma \ln x$
Σx^2	$\Sigma (\ln x)^2$
Σy	$\Sigma \ln y$
Σy^2	$\Sigma (\ln y)^2$
Σxy	$\Sigma x \bullet \ln y$

EXAMPLE	OPERATION	DISPLAY
xi yi 28 2410 30 3033 33 3895 35 4491 38 5717 Through power regression of the above dara, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtained the respective estimated values of y and x, when xi=40 and yi=1000.	MODE → → → = → → → = "REG" then select power regression SHIFT Scl (AC) = 28 SHIFT , (hyp)2410 SHIFT DT (M+) 30 SHIFT , (hyp)3033 SHIFT DT (M+) 33 SHIFT , (hyp)3895 SHIFT DT (M+) 35 SHIFT , (hyp)4491 SHIFT DT (M+) 38 SHIFT , (hyp)5717 SHIFT DT (M+) (Constant term A) SHIFT A (7) = (Regression coefficient B) SHIFT B (8) = (Correlation coefficient r) SHIFT r (( ) = (y when xi=40) 40 SHIFT $\hat{y}$ (-) (x when yi=1000) 1000 SHIFT $\hat{x}$ (+)	0. 28. 30. 33. 35. 38. 0.238801072 2.771866153 0.998906254 6587.674584 20.2622568

5) Inverse regression

Power regression calculations are carried out using the following formula:
Y = A + (B/x)

Data input

1. Press MODE → → → = to specify the REG mode.
2. Press SHIFT Scl = to clear the statistical memories.
3. Input data in the following format:
   <x data> , <y data> DT

Note: To make multiple entries of the same data, follow procedures described for linear regression.

Deleting input data

To delete input data, follow the procedures described for linear regression.

Performing calculations

If 1/x is stored instead of x itself, the inverse regression formula y = A + B/x becomes the linear regression formula y = a + bx. Therefore, the formulas for constant term A, regression coefficient B, and correlation coefficient r are identical to the power and linear regression.

A number of power regression calculation results differ from those produced by linear regression. Note the following:

LINEAR REGRESION	POWER REGRESSION
Σx	$\Sigma(1/x)$
Σx^2	$\Sigma(1/x)^2$
Σxy	$\Sigma(y/x)$

EXAMPLE	OPERATION	DISPLAY
xi yi 2 2 3 3 4 4 5 5 6 6	MODE → → → = → → → → = "REG" then select inverse regression SHIFT Scl (AC) = 2 SHIFT , (hyp)2 SHIFT DT (M+)	 0. 2.

EXAMPLE	OPERATION	DISPLAY
Through inverse regression of the above data, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtained the respective estimated values of y and x, when xi=10 and yi=9.	3 SHIFT , (hyp)3	
	SHIFT DT (M+)	3.
	4 SHIFT , (hyp)4	
	SHIFT DT (M+)	4.
	5 SHIFT , (hyp)5	
	SHIFT DT (M+)	5.
	6 SHIFT , (hyp)6	
	SHIFT DT (M+)	6.
	(Constant term A)	
	SHIFT A (7) =	7.272727273
	(Regression coefficient B)	
	SHIFT B (8) =	-11.28526646
	(Correlation coefficient r)	
	SHIFT r (( ) =	-0.950169099
	(y when xi=10)	
	10 SHIFT $\hat{y}$ (-)	6.144200627
	(x when yi=9)	
	9 SHIFT $\hat{x}$ (+)	-6.533575317

6) Quadratic regression

Quadratic regression calculations are carried out using the following formula:
$y = A + Bx + Cx^2$

Data input

1. Press MODE → → → = to specify the REG mode.
2. Press SHIFT Scl = to clear the statistical memories.
3. Input data in the following format:
   <x data> , <y data> DT

Note: To make multiple entries of the same data, follow procedures described for linear regression.

Deleting input data

To delete input data, follow the procedures described for linear regression.

Performing calculations

The following procedures are used to perform the various

linear regression calculations.

The regression formula is y = A + Bx + Cx² where A, B, C are regression coefficients.

$$C=[(n\Sigma x^2-(\Sigma x)^2)(n\Sigma x^2y-\Sigma x^2\Sigma y)-(n\Sigma x^3-\Sigma x^2\Sigma x)(n\Sigma xy-\Sigma x\Sigma y)]\div[(n\Sigma x^2-(\Sigma x)^2)(n\Sigma x^4-(\Sigma x^2)^2)-(n\Sigma x^3-\Sigma x^2\Sigma x)^2]$$

$$B=[(n\Sigma xy-\Sigma x\Sigma y)-C(n\Sigma x^3-\Sigma x^2\Sigma x)]\div(n\Sigma x^2-(\Sigma x)^2)$$

$$A=(\Sigma y-B\Sigma x-C\Sigma x^2)/n$$

To read the value of $\sum x^3$, $\sum x^4$, or $\sum x^2y$, you can recall memory X, Y, or M respectively.

EXAMPLE	OPERATION	DISPLAY
	MODE ➡ ➡ ➡ =	
	➡ ➡ ➡ ➡ ➡ =	
xi yi 29 1.6 50 23.5 74 38 103 46.4 118 48	"REG" then select quadratic regression	
	SHIFT Scl (AC) =	0.
	29 SHIFT , (hyp)1.6	
	SHIFT DT (M+)	29.
	50 SHIFT , (hyp)23.5	
	SHIFT DT (M+)	50.
	74 SHIFT , (hyp)38	
	SHIFT DT (M+)	74.
	103 SHIFT , (hyp)46.4	
	SHIFT DT (M+)	103.
	118 SHIFT , (hyp)48	
	SHIFT DT (M+)	118.
Through power regression if the above data, the regression formula and correlation coefficient are obtained. Furthermore, the regression formula is used to obtained the respective estimated values of y and x, when xi=16 and yi=20.	(Constant term A)	
	SHIFT A (7) =	-35.59856934
	(Regression coefficient B)	
	SHIFT B (8) =	1.495939413
	(y when xi=16)	
	16 SHIFT $\hat{y}$ (-)	-13.38291067
	(x when yi=20)	
	20 SHIFT $\hat{x}$ (+)	47.14556728
	(x when yi=20)	
	SHIFT $\hat{x}$ (+)	175.5872105

10. Integration calculation

Integration calculation can be carried out by entering the integral calculus formula in the following format:

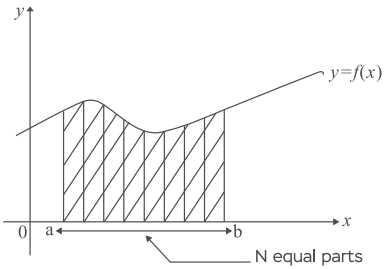
∫dx f(x) , a , b , n

where a is the starting point

b is the ending point

n is the value such that the number divisions = 2^n

Integration calculation is performed using Simpson's rule to determine function f(x). Because of this, partition of the integrated area is necessary; however, if the number of divisions is not specified, the unit automatically sets N according to the formula. To specify the number of divisions for $N=2^n$, n can be an integer from 1 to 9.



Input of function f(x) and integration calculation:

(1) Press SHIFT ∫dx to specify integration calculation.

(2) Input the formula for the function f(x), then input integral partitions [a, b].

Note: f(x) can use the variable X only. Anything other than X, i.e., A~F, Y, is treated as a constant, and its memory contents are applied.

(3) Next input n and finish by inputting a parenthesis. Input of n and parenthesis can be omitted. When input of n is omitted, N (where $N=2^n$) is automatically set.

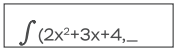
(4) Press = to execute calculation. Results are displayed in a few seconds or a number of minutes.

Examples of operation:

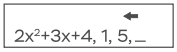
Example: Calculate the following: $\int_1^5(2x^2+3x+4)dx$

MODE EXE (Specify "COMP" mode)

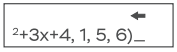
SHIFT ∫dx ($a^b/_c$) 2 Alpha X (() x^3 + 3
Alpha X + 4 SHIFT) (hyp)(f(x)input)



1 SHIFT , (hyp) 5 SHIFT)
(hyp)(a,b input)



6) (n input)



=

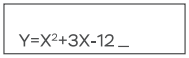


11. Formula memory function

Formula memory lets you input a single formula in the memory, and then input values for the formula variables to calculate results. Memory can hold a single formula, up to 79 steps long.

A) Store a formula in memory

Input the formula as the normal input. Now, try to input the formula "Y=X²+3X-12" into the memory.



Press SHIFT PROG to store the formula and exit from programming mode.



To execute the formula, press CALC.

CALC



Key in 7 =



You can press = again to recycle the formula execution or you can press AC to stop the formula execution.

AC



12. Complex number calculation

Press MODE ➡ HEX to enter the CMPLX mode for calculations that include complex numbers. In CMPLX mode, only variables A, B, C, and M can be used only. The others are used for storing the imaginary parts of values.

EXAMPLE	OPERATION	DISPLAY
	MODE ➡ = → "CMPLX"	
$(2+3i)+(4+5i)$	[(]2[+]3[i])[+][(]4[+]5[i])[=] [Shift][Re→Im](=)	6. 8. i
Find the absolute value of $(3+4i)$ Determine the argument of $(3+4i)$	[Shift][Abs](())[(]3[+]4[i])[=] [Shift][arg](()[(]3[+]4[i])[=]	5. 53.13010235

13. Previous calculation recall

Latest calculations will be saved in the last calculation memory and be able to recall using ↑ or ↓ key buttons. The maximum total size is 384 characters.

Note: Answer for these latest calculations will not be stored.

When the up-arrow is present on the right side of the LCD, it indicates that there are previous calculations available in the last calculation memory. You can press ↑ to retrieve and show the previous calculation on the screen. The answer will be calculated instantly and displayed as well. At the same time, the down-arrow will be ON to indicate that more recent calculations are stored in the last calculation memory.

Let the current display be



Press ↑ to read the previous calculation.



Then you can press ↓ to go back to the more recent calculation.



Chapter 3. Graphs

Graph functions are active only in COMP, SD, and REG modes. In this calculator, one can plot the graphs by defining the range of the graph window first then inputting the graph formula first in the "FUNCT" menu. Lastly, press DRAW to sketch the graph(s). The functions, such as "Trace," "Scroll," and "Zoom," can be operated on the active curve. Two function buffers are available for storing the two latest active graph formulae.

To open the "FUNCT" menu, you can press SHIFT FUNCT.

```
FUNCT?
Y1    Y2
```

If function "Y1" is the desired function, press =.
Otherwise, press either ← or → to select the function you want.
Say, F1 is selected. The third line will show"Y1 = " and the cursor stays on the leftmost position of the lower line.

```
Y1 =
_
```

You can enter the graph formula. Press = or SHIFT FUNCT upon completion and the unit will go back to the"FUNCT" menu. You can proceed to define function Y2 in the same way. Or you can press DRAW to plot the graph(s). Or, if you want to exit from the"FUNCT" menu, press SHIFT FUNCT again. These two function formulae will not be cleared unless you press DEL in the"FUNCT" menu or you switch between function graph mode and parametric graph mode.

Say, you are now in the "FUNCT" menu, and you are going to delete function Y2.

```
FUNCT?
Y1    Y2
```

Press → to select "Y2" then press DEL once. You will be asked if you are sure you want to delete Y2 by the following message.

```
Y2
DELETE?
```


Press = to delete function Y2. The lower display will show "-------" as an indication. A second later, the unit will be back to "FUNCT" menu.

1. Built-in function graph

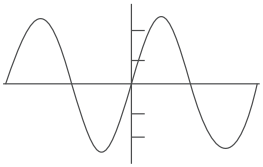
This unit contains a total of 21 built-in graphs, making it possible to produce the graphs of basic functions. These graphs are sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, $\sqrt{}$, x^2, log, ln, 10^x, e^x, x^{-1}, $\sqrt[3]{}$ and x^3.

When a built-in graph is executed, the ranges are automatically set to their optimum values, and any graph previously on the display is cleared.

Note: The built-in graphs can only be drawn in COMP mode when function graph has been selected in the main menu.

Example 1: Sin curve
Go back to COMP mode first. Follow the steps below.

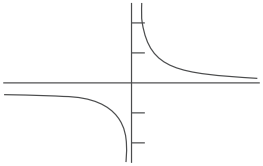
SHIFT FUNCT	(Open "FUNCT" menu.)
=	(Select the function"Y1")
sin =	(Let Y1=sin)
DRAW	(Sketch the graph.)



Note: The variable "x" is missing after the function key "sin" to indicate it is a built-in graph function.

Example 2: y = 1/x graph
Go back to COMP mode first. Follow the steps below.

SHIFT FUNCT	(Open "FUNCT" menu.)
=	(Select the function "Y1")
SHIFT x^{-1} =	(Let Y1 = -1)
DRAW	(Sketch the graph.)

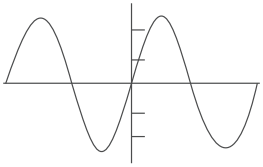


Note: Same as above, the variable "x" is missing before the inverse function.

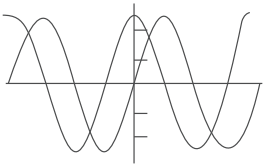
A) Overdrawing built-in function graphs

Two or more different built-in functions can be drawn together on the same display. Since the range for the first graph is automatically set, all subsequent graphs on the same display are produced according to the range of the first graph (provided that all subsequent graphs are user-defined graphs). The first graph is produced by using the previously mentioned operation. Subsequent graphs are produced using the variable "x" in the operation.

Say the function Y1 is defined as "Y1 = sin" for plotting the built-in sin curve.



Then overdraw the graph "y = cos x" on the graph above.
To do so, the function Y2 should be defined as "Y2 = cosx" (variable "x" has to be entered in this case since "y = cos x" is not a built-in function).



2. User-generated graphs

User-generated graphs can be divided into function graphing and parametric graphing. In function graphing, the user should input a formula in the format of
y = f(x) while in parametric graphing, both x = f(t) and y = f(t) should be defined.

A) Specifying range parameters

Unlike built-in functions, the ranges of user-generated graphs are not set automatically, so graphs produced outside the display range do not appear on the display. Range parameters are used to define the size of the graph window. The parameters consist of the following:

Xmin: The minimum value of the x-axis
Xmax: The maximum value of the x-axis
Xscl: Scale of the x-axis (distance between hash marks)
Ymin: The minimum value of the y-axis
Ymax: The maximum value of the v-axis
Yscl: Scale of the y-axis (distance between hash marks)
T_{min}: The minimum value of parameter "t" for parametric graphs
T_{max}: The maximum value of parameter "t" for parametric graphs
Pitch: The pitch value for parametric graphs

How to set the range parameters

To set the range parameters, press the RANGE key (except in the BASE-N and CMPLX mode). The range parameter setting screen appears on the display. Enter the value you want to specify for the displayed parameter, and then press =.
For example, change the range parameters on the left to those on the right as follows:

Xmin:	0 → -5	Ymin:	-10 → -5	T_{min}:	0
Xmax:	5 → 5	Ymax:	10 → 15	T_{max}:	10
Xscl:	4 → 2	Yscl:	4 → 4	Pitch:	0.1

RANGE

```
Xmin?
                -5.
```

Specify -5 for Xmin

(-) 5

```
Xmin?
-5_
```

Press = to confirm and move to Xmax.

=

```
Xmax?
                 5.
```

Simply press [=] since there is no change for Xmax.

Xscl?
2.

Specify 2 for Xscl.

[2] [=]

Ymin?
-5.

Specify -5 for Ymin.

[-] [5] [=]

Ymax?
15.

Specify 15 for Ymax.

[1] [5] [=]

Yscl?
4.

No change for T_{min}, just press [=].

T_{min}?
10.

Specify 10 for T_{max}.

[1] [0] [=]

T_{max}?
0.1

Press [=] to confirm and move to "Pitch"

Pitch?
0.1

Specify 0.1 for pitch by pressing [0] [•] [1] [=]. Meanwhile, the unit well recycle back to "Xmin".

Xmin?
-5.

To leave "RANGE" setting, press [RANGE] again.
Besides range values, you can also input range parameters as expressions, such as 2π, and these expressions are automatically converted to the values.

Note 1: If you enter a value that is outside the allowable range, or if you try to perform some other illegal operations, an error message appears on the display. When this happens, press [←] or [→] to locate the error in the calculation and to make the necessary corrections.

Note 2: Inputting 0 for Xscl or Yscl doesn't set any scales.

Note 3: Inputting a maximum value that is less than the minimum value will reverse the respective axes.

Note 4: If the maximum and minimum values of an axis are equal, an error will be generated.

Note 5: When a range setting is used that does not allow the display of the axes, the scale for the y-axis is indicated on either the left or right edge of the display, while that for the x-axis is indicated on either the top or bottom edge.

Note 6: When the range values are changed or reset, the graph display is cleared and only the newly set axes are displayed.

Note 7: If the range is set too wide or narrow, the graph produced may not fit on the display.

How to check the range parameters

If you want to check all the range parameters, you can press [RANGE] to switch to parameter setting screen. Then press [=] to scroll through the range parameter settings without changing them.

[RANGE]

Xmin?
-5.

[=]

Xmax?
5.

[=]

Xscl?
2.

[=]

Ymin?
-5.

[=]

Ymax?
15.

[=]

Yscl?
4.

[=]

T_{min}?
10.

[=]

T_{max}?
10.

[=]

Pitch?
0.1

Lastly, press [RANGE] again to return to the display that was shown before entering the range display.

How to reset the range parameters

Range values are reset to their initial values by pressing SHIFT Mcl (AC) or SHIFT Scl (AC) during range display.

The initial values are as follows:

Xmin:	-4.6	Ymin:	-3.0	T_{min}:	0
Xmax:	4.6	Ymax:	3.0	T_{max}:	2π
Xscl:	1	Yscl:	1	Pitch:	2π/45

B) Generation of function graphs

After specifying the range parameters as described above, user-generated graphs can be drawn simply by defining the functions (formula) in "FUNCT" menu as described above. For example, the graph for $y = 2x^2+3x-4$ is to be drawn. Firstly, set the ranges to the values shown below.

Xmin:	-5	Ymin:	-10
Xmax:	5	Ymax:	10
Xscl:	2	Yscl:	4

Then open the "FUNC" menu, select "Y1" and define the function formula of "Y1".

```
Y1=
_
```

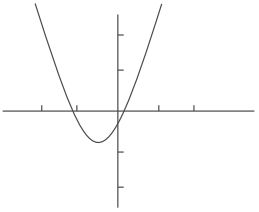
Enter the formula by keying in 2 X.T X² + 3 X.T - 4

```
Y1=                ←
2X²+3X-4
```

Press = to go back "FUNC" menu.

```
FUNCT?
Y1   Y2
```

Draw the graph by pressing DRAW . The graph will be displayed as below.



C) Generation of parametric graphs

When parametric graph has been selected in "MODE" menu, you can draw parametric graphs. To do so, press MODE MODE and select "PARAM". Similar to function graphs, specify the range parameters first to define the graph window. Then you can input the formula in "FUNCT" menu.
Press SHIFT FUNCT to open the "FUNCT" menu. "PARAM?" is displayed instead of "FUNCT" to indicate the parametric function is to be defined.

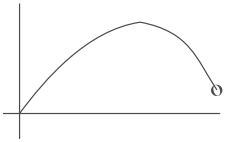
```
PARAM?
X(t)   Y(t)
```

Example: Graph the parametric graphs of x(t) = 30T cos25 and y(t) =30T sin 25 - 9.8T²/2.
Ensure your calculator is in PARAM mode.
Press SHIFT FUNCT and press = for X(t).
Now, enter in 3 0 X.T cos 2 5 = .
Now for Y(t), enter in 3 0 X.T sin 2 5 - 9 . 8 X.T X2 ab/c 2 =

To set the proper range, press Range and enter the following values:

Xmin:	-10	Xmax:	100	Xscl:	50
Ymin:	-5	Ymax:	15	Yscl:	10
T_{min}:	0	T_{max}:	10	Pitch:	0.6

Press Range to confirm the values.
Finally, press DRAW and you will now see the parametric graph.



Note: If either x(t) only or y(t) only has been defined, no curve will be plotted, as the key button DRAW has been pressed. Only the x-y coordinates will be shown.

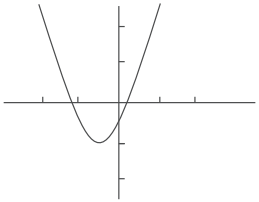
D) Graphs overdraw

Two or more graphs can be overdrawn, which makes it easy to determine intersection points and solutions that satisfy all the equations.

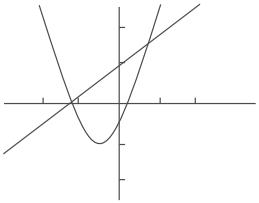
For example, let's find the intersection points of the graph $y= 2x^2+3x-4$ and $y = 2x+3$.

First, press SHIFT Cls = to clear the graph screen in preparation for the first graph. Then enter the formula for the first graph in the "FUNCT" menu.

$Y1 = 2x^2 + 3x - 4$
Press DRAW to plot Y1.



Next, overdraw the graph for $y=2x+3$ by defining $Y2=2X+3$ as well.
Press DRAW and the graphs are overdrawn as shown on the right.



In this way, it can be easily seen that there are two intersections for the two function graphs. The approximate coordinates for these two intersections can be found using the "ZOOM" function or the "Trace" function described in the following sections.

3.Zoom function

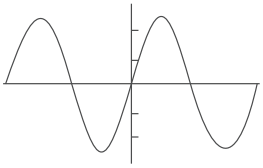
This function lets you enlarge or reduce the x and y coordinates. If you use the Trace or Plot function to locate the pointer at a specific point on the graph, the enlargement /reduction is performed using the pointer location as the center point.

How to enlarge a graph

Example: Enlarge the graph for y = sin x by a factor of 1.5 on the x-axis, and 20 on the y-axis.
First, set the range parameters as below by pressing RANGE and entering the following values:

Xmin:	-360	Xmax:	360	Xscl:	180
Ymin:	-1.6	Ymax:	1.6	Yscl:	1

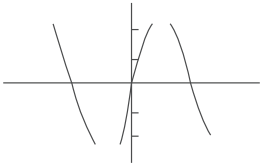
Once you have specified the range parameters, press RANGE again to confirm these values.
After specifying the range parameters, graph y = sin x. To graph this, press SHIFT Factor . Press = to confirm function Y1 or Y2. For this example, we will use Y1. After pressing = for Y1, enter sin x, by pressing sin X, T . Once you enter sin x, press = . Press DRAW to draw the function Y1 or sin x. You will see a graph of sin x.



Now, to zoom in the graph, press SHIFT Factor for the factor specification screen (the current zoom factor is 2). Enter 1.5 for "Xfact?" and press = to move forward to the Y-factor screen. Enter 2 for "Yfact". Press = to cycle back to "Xfact" to confirm everything is correct.
Press SHIFT Factor to exit.
Press SHIFT G <-> T to return to the graph screen.
Press SHIFT Zoomxf to enlarge the graph according to the factors specified.
When you view the range parameters again, you will find that the window size becomes:

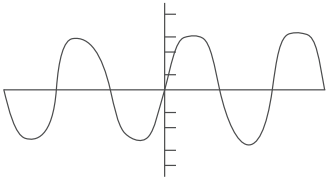
Xmin:	-240	Xmax:	240	Xscl:	180
Ymin:	-0.8	Ymax:	0.8	Yscl:	1

If you press SHIFT Zoomxf, the graph is enlarged once more by the factors you specified. To return the graph to its original size, press SHIFT Zoom Org.



How to reduce a graph

Follow the same procedure as described above for enlarging a graph. After specifying the factor, press SHIFT Zoom ×1/f (Draw) instead. The graph will be reduced, as below.



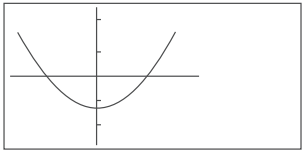
You can take a look at the range parameters, which become:

Xmin: -540,	Xmax: 540,	Xscl: 180
Ymin: -3.2,	Ymax: 3.2,	Yscl: 1

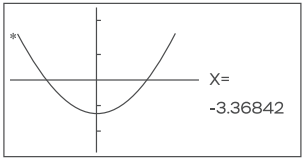
If you press SHIFT Zoom ×1/f again, the graph is reduced once more by the factors specified. To return the graph to its original size, press SHIFT Zoom Org.

4. Trace function

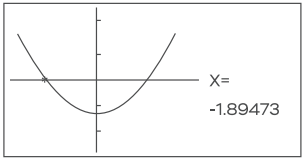
This function lets you move a pointer around a graph and display the x and y coordinates of the current pointer location. The coordinates can be displayed with the use of seven digits or eleven digits. When two active graphs are overdrawn, you can press ↑ or ↓ to switch between the graphs. Each time you toggle between the curves, the tracing will restart from the leftmost position.
For example, graph $y = x^2 - 3$ on the screen.



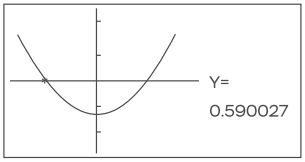
Activate the Trace function by pressing TRACE. A blinking pointer will be located on the left of the curve and the corresponding x coordinate will be shown.



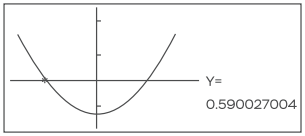
You can use the buttons ← or → to move the pointer along the graph. Each press moves the cursor one point. Holding down either key moves the pointer at high speed. The corresponding coordinate reading shown on the lower right part of the screen will be updated all the way.
Press → consecutively.



Besides the x coordinate, you can also read the y coordinate of the blinking pointer by pressing SHIFT X↔Y, which will toggle the reading of x coordinate and y coordinate.

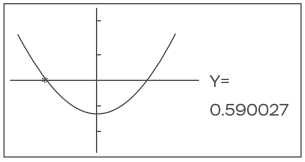


As you trace along the curve, either x coordinate or y coordinate will be shown in 7-digit mantissa plus a 2-digit exponent. If you want to get the exact value, you can press VALUE to read the value, which will be displayed in 11-digit mantissa plus a 2-digit exponent, as below.

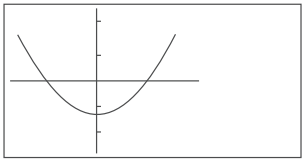


To switch back to 7-digit mantissa, you can press VALUE again.

VALUE



To exit the Trace function, press TRACE again. The blinking pointer will disappear.

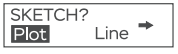


5. Sketch operations

You can select and perform the following functions by Sketch operations.

Plot --- Plot a point on the graph
Line --- Draw a line segment between two points
Tangent --- Draw a line segment tangent to a function
Horizontal --- Draw a horizontal line
Vertical --- Draw a vertical line

To display the Sketch menu, press SHIFT SKETCH . Functions "Plot" and "Line" are displayed.



Press → consecutively to select the desired function.

→



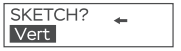
→



→



Press → further to move to the end or SKETCH menu.



Press → lets you go back to the previous item.



Once you have chosen the desired function, press = for confirmation and exit from SKETCH menu.

A) Plot function

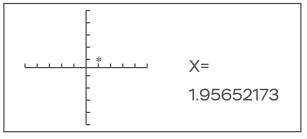
The plot function is used to mark a point on the screen of a graph display. The point can be moved left, right, up, and down using the cursor keys, and the coordinates for the graph displayed can be read.
Select Plot function in the SKETCH menu. The command "Plot" will be shown on the display, as below.



You have to specify the x and y coordinates after the command "Plot."
Example: Plot a point at x = 2 and y = 2 on the axes created by the following range values.

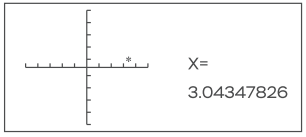
Xmin: = -5	Xmax: = 5	Xscl: = 1
Ymin: = -10	Ymax: = 10	Yscl: = 2

Press SHIFT SKETCH = 2 SHIFT . 2 =

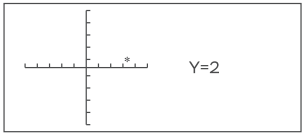


The blinking pointer is positioned at the specified coordinates. Due to limitations caused by the resolution of the display, the actual position of the pointer can only be approximate. The pointer can be moved left, right, up, and down using the cursor keys. The current position of the pointer is always shown at the bottom of the display.

→ → → → →

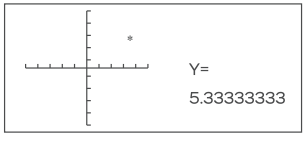


To find the y-coordinate values, press SHIFT X↔Y



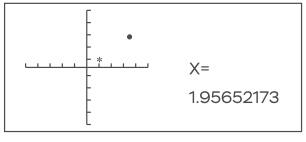
As you move the blinking pointer upwards or downwards, the y-coordinate will be updated simultaneously.

↑ ↑ ↑ ↑ ↑



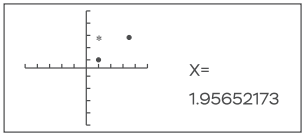
When the pointer is at the location you want, press = to plot a point. At this time, the pointer returns to the original point you specified ((2,2) in this example).

=



Now, you can input a new coordinate value to create a new blinking pointer without clearing the present pointer. The present pointer will become a fixed point, as shown below.

SHIFT SKETCH = 2
, 6 . 5 =



If x-y coordinates are not specified for the Plot function (i.e., SHIFT SKETCH = =), the blinking pointer appears at the center of the screen.

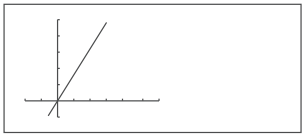
B) Line function

The Line function makes it possible to generate a line to connect with a plotted graph as a visual aid.

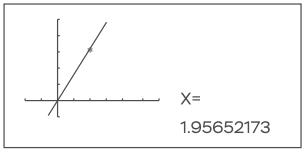
Example: Draw perpendiculars from the point (2, 0) on the x axis to its intersection with the graph for Y = 3X. Then draw a line from the point of intersection to the y axis.
Press RANGE to set the range values:

Xmin: = -2	Xmax: = 5	Xscl: = 1
Ymin: = -2	Ymax: = 10	Yscl: = 1
Tmin: = 0	Tmax: = 360	Pitch: = 8

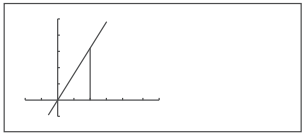
Press RANGE again to confirm the values.
Next, press SHIFT FUNCT. Press = to confirm Y1. Set Y1 =3X by pressing 3 X. T and press = again. Continue by pressing DRAW. You will now see the graph of Y = 3X.



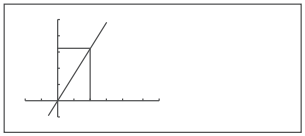
To find the point (2,0), press SHIFT SKETCH and select Plot. Enter 2, 0. Press = =.
Press the UP arrow ↑ 15 times until the blinking cursor is touching Y = 3X.



Press SHIFT SKETCH , select "Line," and press = = .
You will now see a straight line from (2,0) that intersects with the graph of Y = 3X.

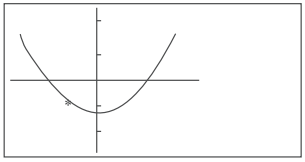


Next, to draw a perpendicular line from the same point on the graph to the y axis.
Press SHIFT SKETCH and select Plot. Enter X.Y and then press = = .
Press ← 13 times until the blinking cursor is touching Y=3X.
Press SHIFT SKETCH and select Line. Press = = , and you will now see the perpendicular line.

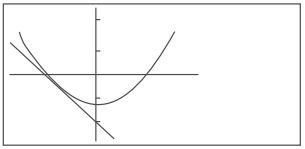


C) Drawing a tangent line

For this example, we will graph X^2-3 and draw a line tangent to the graph at x = -1.
Press MODE MODE and select FUNCT and press = . Press SHIFT FUNCT to graph Y1 = X^2-3. Use the X. T button on the calculator to enter X. Once you finish inputting the equation, press = to confirm. Then, press DRAW .
Press Trace → → → → → → → to get the cursor where the graph meets x = -1.

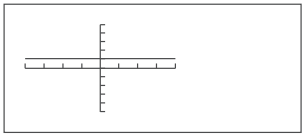


Press SHIFT SKETCH and select Tangent and press = .
You will now see a tangent line to X2 -3 at x = -1.



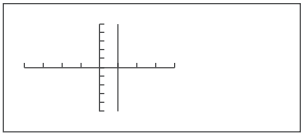
D) Draw a horizontal line

Example: Draw a horizontal line at coordinates (0, 2).
Press SHIFT SKETCH , select Plot, and press = .
Enter 0,2 and press = . The graph will now show the cursor on coordinates (0,2). Press SHIFT SKETCH and press the right arrow → until you see HORIZ. Press = .
You will now see a horizontal line drawn at coordinates(0,2).



E) Drawing a vertical line

Example: Draw a vertical line at coordinates (2,0).
Press SHIFT SKETCH , select Plot, and press = .
Enter 2,0 and press = . The graph will now show the cursor on coordinates (2,0).
Press SHIFT SKETCH and press the right arrow → until you see VERT. Press = .
You will now see a vertical line drawn at coordinates (2,0).



6. Graph scroll function

After you have drawn a graph, you can scroll it on the display by using the cursor keys ←, →, ↑, ↓. Every time you press the cursor keys, the display window will be shifted accordingly in the corresponding direction. As you press RANGE to check the range values, you will find that Xmin, Xmax, Ymin, and/or Ymax have been changed.

7. Single-variable statistical graphs

In SD mode, single-variable statistical graphs can be drawn. Either bar graphs or normal distribution curves can be produced.

For drawing the bar graphs, the x coordinate represents the data range and the y coordinate stands for the number of items (frequency) of each data. The number of bars ranges between 1 and 20, which is defaulted at 10 upon power-up reset. If you want to change the number of bars, you can press RANGE to view the range parameters as described previously. The bar number selection is appended to the end of the parameter list. Hence, as you press = consecutively, you can view the parameters in the order of Xmin, Xmax, Xscl, Ymin, Ymax, Yscl, Tmin, Tmax, Pitch, Bar, and cycle back to Xmin. As you come to the bar selection screen, the display shows as below.

```
SD
Bar
1~20?
                10.
```

If you want to change the bar number, enter an integer in the range of 1 to 20. Then press = to update the value. If you have entered a value out of this range, or the input value is not an integer, an error will occur.

Example: Use the following data to draw a ranked graph.

Rank No.	1	2	3	4	5	6	7	8	9	10	11
Rank	0	10	20	30	40	50	60	70	80	90	100
Frequency	1	3	2	2	3	5	6	8	15	9	2

Step 1: Set the range values as below.

Xmin: = 0 Xmax: = 110 Xscl: = 10
Ymin: = 0 Ymax: = 20 Yscl: = 2

Step 2: Clear the statistical memory by pressing SHIFT Scl (AC/ON) =.

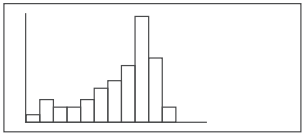
Step 3: Input the data.

0 DT (M+)
10 DT (M+) DT (M+) DT (M+)
20 DT (M+) DT (M+)
30 DT (M+) DT (M+)
40 DT (M+) DT (M+) DT (M+)
50 SHIFT ; (X. T) 5 SHIFT DT (M+)
60 SHIFT ; (X. T) 6 SHIFT DT (M+)
70 SHIFT ; (X. T) 8 SHIFT DT (M+)
80 SHIFT ; (X. T) 15 SHIFT DT (M+)
90 SHIFT ; (X. T) 9 SHIFT DT (M+)
100 DT (M+) SHIFT DT (M+)

Step 4: Press DRAW to draw the graph. You will be asked to select either bar chart or distribution curve by the screen display, as shown below.

```
SD
DRAW?
Bar   Line
```

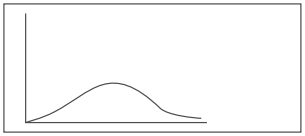
Press either ← or → to select the type of graphs. Then press = to start the drawing. Let's say bar chart has been chosen.



If a normal distribution graph is to be drawn, select "Line" above and press =.

Please note that the range values may be quite different from the previous data since the y axis value is relatively small when compared with the bar graph. Let's say the range values are changed to those shown below.

Xmin: = 0 Xmax: = 110 Xscl: = 10
Ymin: = 0 Ymax: = 0.05 Yscl: = 0.01



The formula used for normal distribution curves is:

$$y=\frac{1}{\sigma\sqrt{(2\pi)}}e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

Where σ is the population standard deviation, $x\sigma n$ m is the mean.

8. Paired-variable statistical graphs

Paired-variable graphs are drawn in REG mode. When data is input in LIN mode, points will be displayed immediately and data is input to the statistical memory.

Example: Perform linear regression on the following data and draw a regression line graph.

xi	-9 -5 -3 1 4 7
yi	-2 -1 2 3 5 8

Step 1: Speeify the range values below.

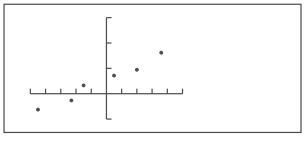
Xmin: = -10 Xmax: = 10 Xscl: = 2
Ymin: = -5 Ymax: = 15 Yscl: = 5

Step 2: Press SHIFT Scl (AC) = to clear the statistical memories.

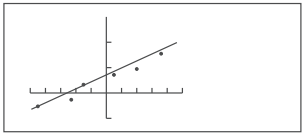
Step 3: Input the data.

(-) 9 SHIFT , (hyp) (-) 2 DT (M+)
(-) 5 SHIFT , (hyp) (-) 1 DT (M+)
(-) 3 SHIFT , (hyp) 2 DT (M+)
1 SHIFT , (hyp) 3 DT (M+)
4 SHIFT , (hyp) 5 DT (M+)
7 SHIFT , (hyp) 8 DT (M+)

For each data input, the point is displayed immediately on the screen. If the data value exceeds the window size, the corresponding data point will not appear on the display, but the data will be stored into the statistical memory.



Step 4: As all the data have been input, press DRAW to draw the regression line.



Note: When data input is outside the preset range values, the point will not appear.
To read the coefficients of the regression lines, A, B, or C, you can press SHIFT A, or SHIFT B, or SHIFT C respectively.

9. Graph learning

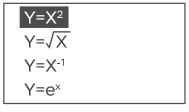
Two functions, i.e., Shift and Change, help students to grasp the relationship between an equation and its graph. (They only work in COMP mode.) Press SHIFT GRAPH (LRN) to start the learning function. The display will show, as below.



If "Shift" is the function you want, press = and you can proceed to the "Shift" function.

A) Shift

Shift the graph's location without changing its shape; the change is immediately reflected in the equation on the lower right of the display.
At entering "Shift" menu, you can ask to select a built-in function for shifting.

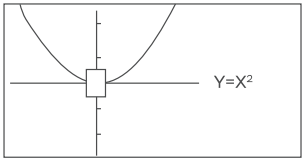


Those functions available are:

$y=x^2$
$y=\sqrt{x}$
$y=x^{-1}$
$y=e^x$
$y=\ln x$
$y=x^3$

$y=sin\ x$
$y=tan\ x$
$x^2+y^2=4$

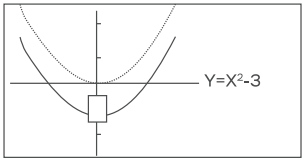
After you have found the desired function, press [=] to start the "Shift" function.
The function will be plotted on the graph with the ranges set to the optimum values. Let's say you have selected the function Y = X^2.



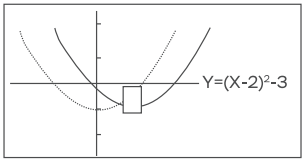
A flashing block appear on the lotus of the curve to indicate that you can press the key buttons [↑], [↓], [←] or [→] to shift the graph in the step of Yscl or Xscl along the y axis or x axis respectively.

Let Xscl = 2 and Yscl = 3.

When you have moved the graph downwards for one step, the equation will become as below.

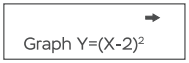


As you move the graph further to the right for one step, the equation will change to "y = $(x-2)^2-3$."



If the new equation is too long to be shown on the lower right LCD, you can press [G↔T] to switch to text display.

[SHIFT] [G↔T]



You can use the key buttons [←] or [→] to read the whole equation. To go back to the graph display, press [G↔T] again.

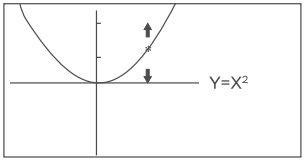
B) Change

"Change" function is used to change the shape of the graph; the change is immediately reflected in the equation on the right side of the display.
Select "Change" in the graph learning menu. Then press [=] to proceed to the selection of the desired function.

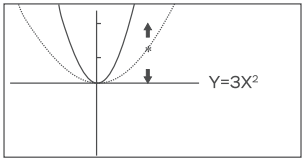
Those functions available are:

$y=x^2$
$y=\sqrt{x}$
$y=|x|$
$y=e^x$
$y=x^3$
$y=sin\ x$
$y=x$
$x^2+y^2=4$

As you have selected the function, press [=] to start the "Change" function. Let the function be Y = X^2. The graph will be as below.



A flashing cursor will be located on the lotus of the curve. You can change the shape of the graph by pressing either [↑] or [↓] buttons as indicated. Let's say the graph is moved to the lotus of "Y = $3X^2$".



Same as "Shift" function, you can press G↔T to switch to text display to read the whole equation. For the function $x^2 + y^2 = r^2$, as you press ↑ or ↓ to change the shape of the circle, the lotus of the circle should move radially.

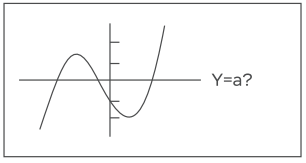
10. Graph solving

Graph Solving functions let you plot the graph on the display and find the corresponding x value for a specified y value. Press GRAPH SOLVE once and the display will be as below.

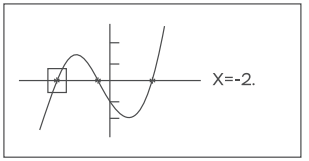
```
Solve
Graph Y=_
```

You are asked to input the desired function.
Let the function be y = 0.25(x+2)(2x+1)(2x-5).

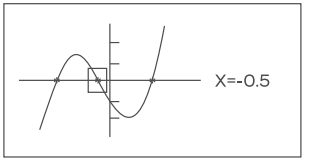
As you press = to complete the entry, the graph will be plotted; meanwhile, the message "Y = a?" will be shown up on the lower right portion of the display.



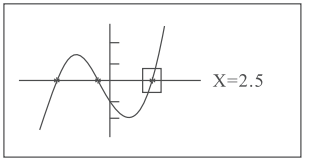
(It is assumed that the graph is plotted on the window with the optimum range).
After you have defined the value of a the horizontal line, Y = a will be overdrawn on the original graph; the intersection points are the roots of the equation
0.25(x+2)(2x+1)(2x-5) - a = 0.
Let a be zero in this example. Hence the equation 0.25(x+2)(2x+1)(2x-5) = 0 is going to be solved. If roots have been found, flashing cursor(s) will be located at the corresponding position(s).



To read other roots, you can press either ← or → to move the block to the next root at the left or at the right of the current root.
Let's say you have pressed the button →. The display will become as below.



Press → further to read the third root.



If you press → further, the graph will scroll to the right further for one window. No matter whether root or (roots) is present or not, the graph will stay on the display. Similarly, you can go to the left to search for roots by pressing ← or press → to move the graph to the right one window further.

Note: The accuracy of the roots is affected by the solution of the scales.

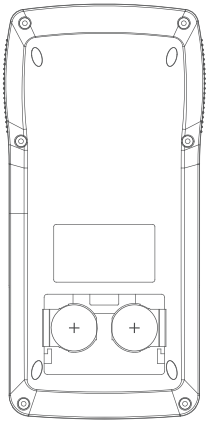
Chapter 4. Replacing the Battery

1. Replacing the battery

1. Remove the battery cover.
2. Auto power off.
3. Wipe off the sides of the new battery with a dry, soft cloth. Load it into the unit with the positive ⊕ side facing up (so you can see it).
4. Replace the battery cover.
5. Press AC to turn the power on.

2. Auto power off

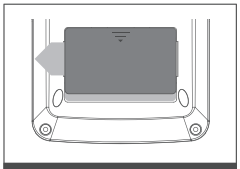
Calculator power automatically turns off if you do not perform any operation for about six minutes. When this happens, press ON to turn the power back on.



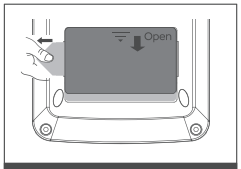
Battery CR2032 x 2

Reset button: If the calculator malfunctions or shuts down when used, please first double-check if the batteries are working properly. If the issue persists, please press the ON at the front of the calculator.

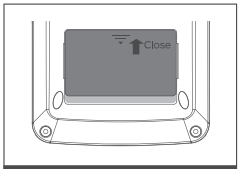
3. How to remove the battery-insulating tab:



The original condition when you receive the product.



Open the battery case and then gently pull the tab out.



Put back the battery case.