CASIO

CASIO COMPUTER CO., LTD.

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fx-7400G PLUS User's Guide

fx-7400G PLUS

User's Guide

E

CASIO

GUIDELINES LAID DOWN BY FCC RULES FOR USE OF THE UNIT IN THE U.S.A. (not applicable to other areas).

NOTICE

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC WARNING

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
Proper connectors must be used for connection to host computer and/or peripherals in order to meet FCC emission limits.

Connector SB-62	Power Graphic Unit to Power Graphic Unit
Connector FA-123	Power Graphic Unit to PC for IBM/Macintosh Machine

CE

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

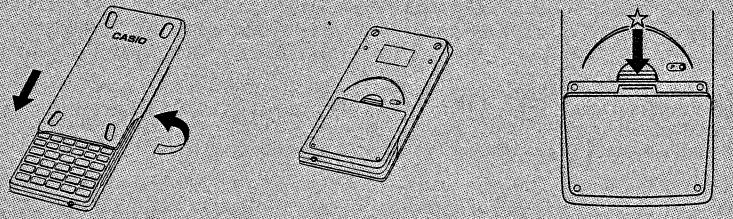
Important!
Please keep your manual and all information handy for future reference.

IBM is a registered trademark of International Business Machines Corporation.
Macintosh is a registered trademark of Apple Computer, Inc.

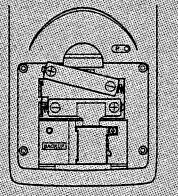
BEFORE USING THE CALCULATOR FOR THE FIRST TIME ONLY...

This calculator does not contain any main batteries when you purchase it. Be sure to perform the following procedure to load batteries, reset the calculator, and adjust the contrast before trying to use the calculator for the first time.

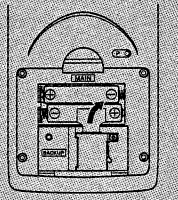
1. Making sure that you do not accidently press the [AC/ON] key, slide the case onto the calculator and then turn the calculator over. Remove the back cover from the unit by pulling with your finger at the point marked ☆.



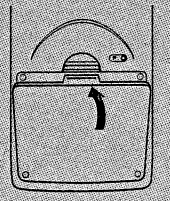
2. Load the two batteries that come with calculator.
   - Make sure that the positive (+) and negative (–) ends of the batteries are facing correctly.

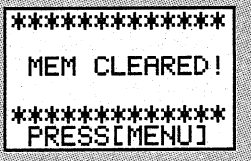


3. Remove the insulating sheet at the location marked "BACK UP" by pulling in the direction indicated by the arrow.



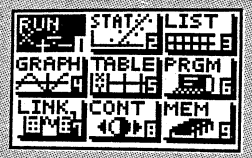
4. Replace the back cover and turn the calculator front side up, which should automatically turn on power and perform the memory reset operation.

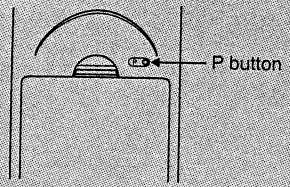




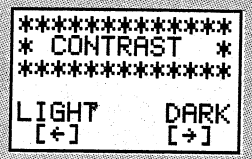
5. Press [MENU].

If the Main Menu shown to the right is not on the display, press the P button on the back of the calculator to perform memory reset.





6. Use the cursor keys (▲, ▼, ◀, ▶) to select the **CONT** icon and press [EXE] or simply press [8] to display the contrast adjustment screen.

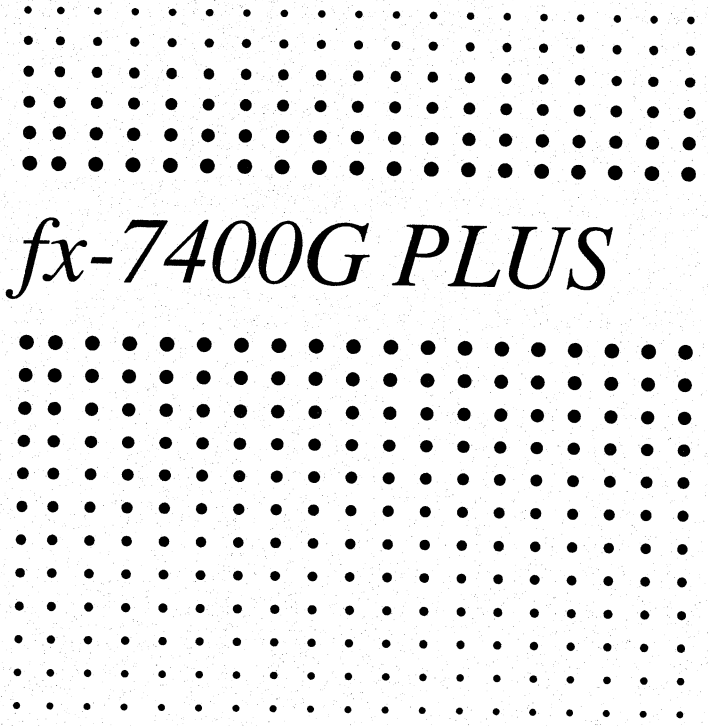


7. Press ◀ to make the figure on the screen lighter or ▶ to make them darker.

8. After getting the contrast the way you want it, press [MENU] to return to the main menu.

Handling Precautions

- Your calculator is made up of precision components. Never try to take it apart.
- Avoid dropping your calculator and subjecting it to strong impact.
- Do not store the calculator or leave it in areas exposed to high temperatures or humidity, or large amounts of dust. When exposed to low temperatures, the calculator may require more time to display results and may even fail to operate. Correct operation will resume once the calculator is brought back to normal temperature.
- The display will go blank and keys will not operate during calculations. When you are operating the keyboard, be sure to watch the display to make sure that all your key operations are being performed correctly.
- Replace both the main power supply and the memory back up batteries once every 2 years regardless of how much the calculator is used during that period. Never leave dead batteries in the battery compartment. They can leak and damage the unit.
- Keep batteries out of the reach of small children. If swallowed, consult with a physician immediately.
- Avoid using volatile liquids such as thinner or benzine to clean the unit. Wipe it with a soft, dry cloth, or with a cloth that has been dipped in a solution of water and a neutral detergent and wrung out.
- In no event will the manufacturer and its suppliers be liable to you or any other person for any damages, expenses, lost profits, lost savings or any other damages arising out of loss of data and/or formulas arising out of malfunction, repairs, or battery replacement. The user should prepare physical records of data to protect against such data loss.
- Never dispose of batteries, the liquid crystal panel, or other components by burning them.
- When the "Low battery!" message appears on the display, replace the main power supply batteries as soon as possible.
- Be sure that the power switch is set to OFF when replacing batteries.
- If the calculator is exposed to a strong electrostatic charge, its memory contents may be damaged or the keys may stop working. In such a case, perform the All Reset operation to clear the memory and restore normal key operation.
- Note that strong vibration or impact during program execution can cause execution to stop or can damage the calculator's memory contents.
- Using the calculator near a television or radio can cause interference with TV or radio reception.
- Before assuming malfunction of the unit, be sure to carefully reread this manual and ensure that the problem is not due to insufficient battery power, programming or operational errors.



Be sure to keep physical records of all important data!

The large memory capacity of the unit makes it possible to store large amounts of data. You should note, however, that low battery power or incorrect replacement of the batteries that power the unit can cause the data stored in memory to be corrupted or even lost entirely. Stored data can also be affected by strong electrostatic charge or strong impact.

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Chapter 1

Getting Acquainted
— Read This First!

The symbols in this manual indicate the following messages.

: Important notes

: Notes

: Reference pages

P.000

1. Using the Main Menu

The main menu appears on the display whenever you turn on the calculator. It contains a number of icons that let you select the mode (work area) for the type of operation you want to perform. You can also make the Main Menu appear at any time by pressing [MENU].

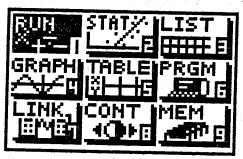
The following explains the meaning of each icon.

Icon	Meaning
RUN	Use this mode for arithmetic calculations and function calculations.
STAT	Use this mode to perform single-variable (standard deviation) and paired-variable (regression) statistical calculations, and to draw statistical graphs.
LIST	Use this mode for storing and editing numeric data.
GRAPH	Use this mode to store graph functions and to draw graphs using the functions.
TABLE	Use this mode to store functions, to generate a numeric table of different solutions as the values assigned to variables in a function change, and to draw graphs.
PRGM	Use this mode to store programs in the program area and to run programs.
LINK	Use this mode to transfer memory contents or back-up data to another unit.
CONT	Use this mode to adjust the contrast of the display.
MEM	Use this mode to check how much memory is used and remaining, to delete data from memory, and to initialize (reset) the calculator.

•To enter a mode

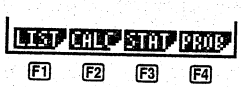
Example **To enter the RUN Mode from the Main Menu**

1. Press [MENU] to display the Main Menu.
2. Use ◀, ▶, ▲, and ▼ to move the highlighting to the **RUN** icon.
3. Press [EXE] to enter the RUN Mode.

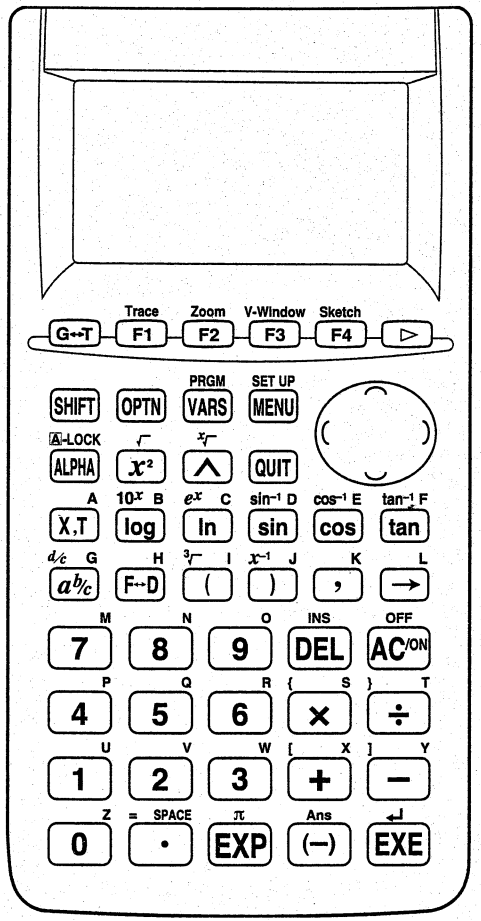


- You can also enter a mode without highlighting an icon in the Main Menu by inputting the number marked in the lower right corner of the icon.
- When you enter a mode, up to four function key menu items appear at the bottom of the display. Each menu item corresponds to the function key ([F1], [F2], [F3], [F4]) that is below the item. Some function menus have multiple pages. When this happens, you should press [▷] to advance to the next menu page.

Example Menus

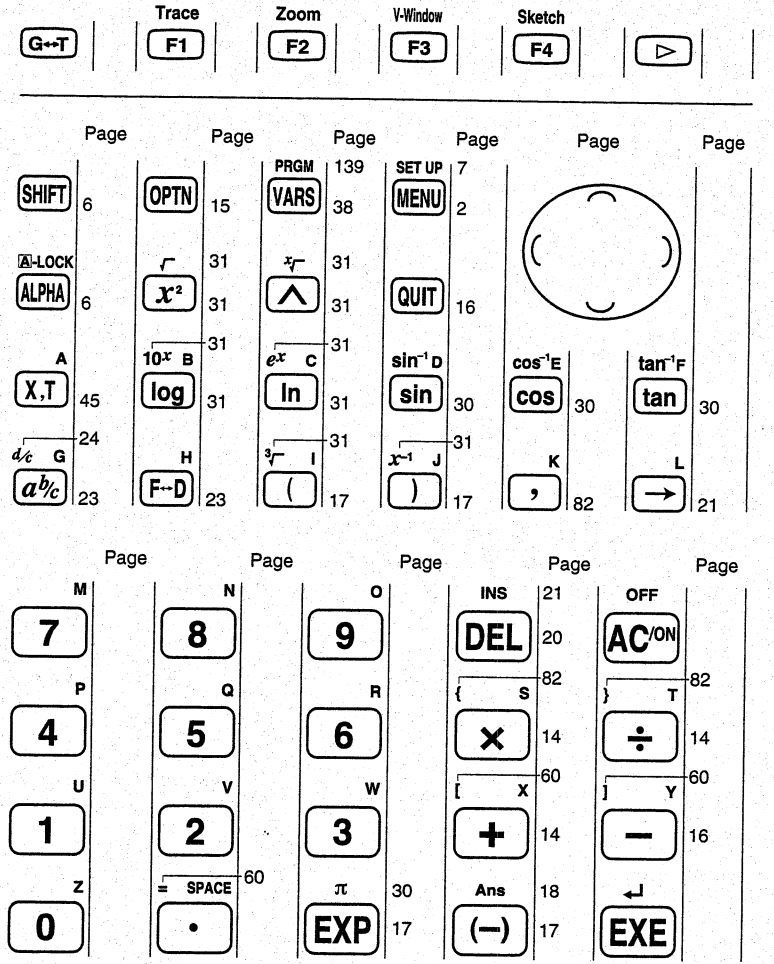


2. Key Table



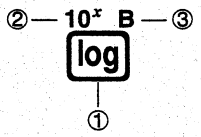
Alpha Lock

Normally, once you press [ALPHA] and then a key to input an alphabetic character, the keyboard reverts to its primary functions immediately. If you press [SHIFT] and then [ALPHA], the keyboard locks in alpha input until you press [ALPHA] again.



3. Key Markings

Many of the calculator's keys are used to perform more than one function. The functions marked on the keyboard are color coded to help you find the one you need quickly and easily.



	Function	Key Operation
①	log	[log]
②	10^x	[SHIFT] [log]
③	B	[ALPHA] [log]

The following describes the color coding used for key markings.

Color	Key Operation
Orange	Press [SHIFT] and then the key to perform the marked function.
Red	Press [ALPHA] and then the key to perform the marked function.

4. Selecting Modes

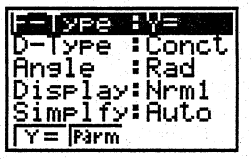
■ Using the Set Up Screen

The first thing that appears when you enter a mode is the mode's set up screen, which shows the current status of settings for the mode. The following procedure shows how to change a set up.

•To change a mode set up

1. Select the icon you want and press [EXE] enter a mode and display its initial screen. Here we will enter the RUN Mode.

2. Press [SHIFT] [SETUP] to display the mode's set up screen.
   - This set up screen is just one possible example. Actual set up screen contents will differ according to the mode you are in and that mode's current settings.

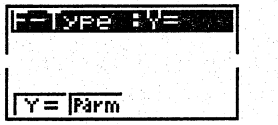


3. Use the ▲ and ▼ cursor keys to move the highlighting to the item whose setting you want to change.
4. Press the function key ([F1] to [F4]) that is marked with the setting you want to make.
5. After you are finished making any changes you want, press [QUIT] to return to the initial screen of the mode.

■ Set Up Screen Function Key Menus

This section details the settings you can make using the function keys in the set up display.

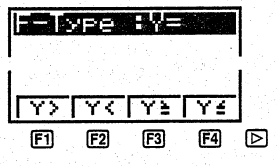
•Graph Function Type (F-Type)



[F1] (Y=) ..... Rectangular coordinate graphs

[F2] (Parm) ..... Parametric coordinate graphs

[▷]



[F1] (Y>) ..... $y > f(x)$ inequality graph

[F2] (Y<) ..... $y < f(x)$ inequality graph

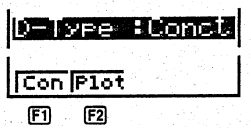
[F3] (Y≥) ..... $y \geqq f(x)$ inequality graph

[F4] (Y≤) ..... $y \leqq f(x)$ inequality graph

Press [▷] to return to the previous menu.

- The setting you make for F-Type determines the variable name that is input when you press [X,T].

•Graph Draw Type (D-Type)

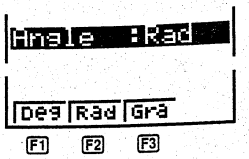


[F1] (Con) ..... Connection of points plotted on graph.

[F2] (Plot) ..... Plotting of points on graph without connection.

•Angle unit (Angle)

[F1] (Deg) ..... Specifies degrees as default.
[F2] (Rad) ..... Specifies radians as default.
[F3] (Gra) ..... Specifies grads as default.



•Statistical Graph View Window Setting (S-Wind)

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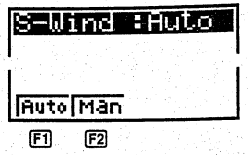
[F1] (Auto)..... Automatic setting of view window values for statistical graph drawing.

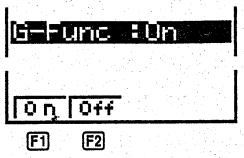
P.120

[F2] (Man)..... Manual setting of view window values for statistical graph drawing.



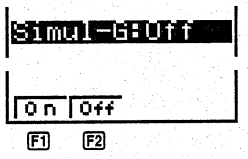
•Graph Function Display (G-Func)

[F1] (On) ..... Turns on display of function during graph drawing and trace.
[F2] (Off) ..... Turns off display of function during graph drawing and trace.



•Simultaneous Graph Mode (Simul-G)

[F1] (On) ..... Turns on simultaneous graphing of all functions in memory.
[F2] (Off) ..... Simultaneous graphing off (graphs drawn one-by-one).



•Table & Graph Generation Settings (Var)

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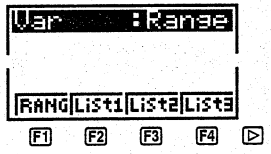
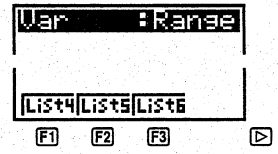
[F1] (RANG) .... Table generation and graph drawing using numeric table range.
[F2] (List1)
[F3] (List2) .... Table generation and graph drawing using list data.
[F4] (List3)



▷

[F1] (List4)
[F2] (List5) .... Table generation and graph drawing using list data.
[F3] (List6)



Press [▷] to return to the previous menu.

Other menus for set up (Display, Simplfy, Frac) are described in each applicable section of this manual as they come up.

Abbreviations

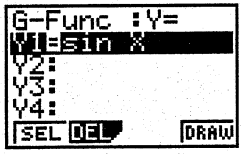
STAT ..... Statistics
PRGM ..... Program
CONT ..... Contrast
MEM ..... Memory

5. Display

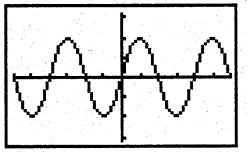
■ About the Display Screen

This calculator uses two types of display: a text display and a graphic display. The text display can show 13 columns and six lines of characters, with the bottom line used for the function key menu, while the graph display uses an area that measures 79 (W) × 47 (H) dots.

Text Display



Graph Display



■ About Menu Item Types

This calculator uses certain conventions to indicate the type of result you can expect when you press a function key.

• Next Menu

Example: LIST
Selecting LIST displays a menu of list functions.

• Command Input

Example: List
Selecting List inputs the "List" command.

• **Direct Command Execution**

Example: DRAW

Selecting DRAW executes the DRAW command.

■ Exponential Display

The calculator normally displays values up to 10 digits long. Values that exceed this limit are automatically converted to and displayed in exponential format. You can specify one of two different ranges for automatic changeover to exponential display.

Norm 1 ..... 10^{-2} (0.01) > |x|, |x| ≧ 10^{10}

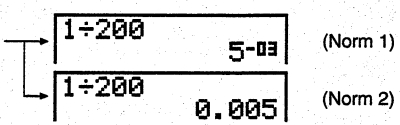
Norm 2 ..... 10^{-9} (0.000000001) > |x|, |x| ≧ 10^{10}

•To change the exponential display range

1. Press SHIFT SETUP to display the Set Up Screen.
2. Use ▲ and ▼ to move the highlighting to "Display".
3. Press F3 (Norm).

The exponential display range switches between Norm 1 and Norm 2 each time you perform the above operation. There is no display indicator to show you which exponential display range is currently in effect, but you can always check it by seeing what results the following calculation produces.

AC 1 ÷ 2 0 0 EXE



(Norm 1)

(Norm 2)

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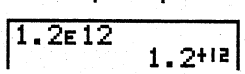
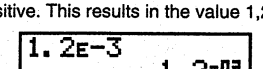
All of the examples in this manual show calculation results using Norm 1.

For full details about the "Display", see "Selecting Value Display Modes".

•How to interpret exponential format



1.2^{+12} indicates that the result is equivalent to 1.2×10^{12}. This means that you should move the decimal point in 1.2 twelve places to the right, because the exponent is positive. This results in the value 1,200,000,000,000.

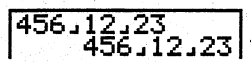


1.2^{-03} indicates that the result is equivalent to 1.2×10^{-3}. This means that you should move the decimal point in 1.2 three places to the left, because the exponent is negative. This results in the value 0.0012.

■ Special Display Formats

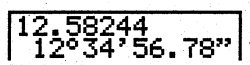
This calculator uses special display formats to indicate fractions, and sexagesimal values.

•Fractions



..... Indicates: 456 $\frac{12}{23}$

•Sexagesimal Values



..... Indicates: 12° 34' 56.78"

• In addition to the above, this calculator also uses other indicators or symbols, which are described in each applicable section of this manual as they come up.

■ Calculation Execution Screen

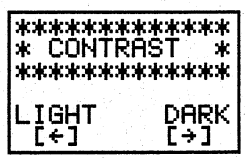
Whenever the calculator is busy drawing a graph or executing a long, complex calculation or program, a black box (■) flashes in the upper right corner of the display. This black box tells you that the calculator is performing an internal operation.

6. Contrast Adjustment

Adjust the contrast whenever objects on the display appear dim or difficult to see.

•To display the contrast adjustment screen

Highlight the **CONT** icon in the Main Menu and then press EXE.



Press ◀ to make the figures on the screen lighter or ▶ to make them darker.

After getting the contrast the way you want it, press MENU to return to the main menu.

7. When you keep having problems...

If you keep having problems when you are trying to perform operations, try the following before assuming that there is something wrong with the calculator.

■ Get the Calculator Back to its Original Mode Settings

1. In the Main Menu, select the **RUN** icon and press [EXE].
2. Press [SHIFT] [SETUP] to display the Set Up Screen.
3. Highlight "Angle" and press [F2] (Rad).
4. Highlight "Display" and press [F3] (Norm) to select the exponential display range (Norm 1 or Norm 2) that you want to use.
5. Now enter the correct mode and perform your calculation again, monitoring the results on the display.

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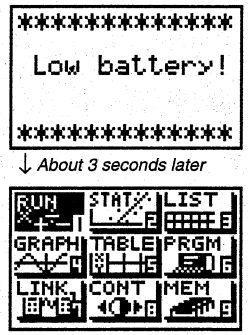
■ Low Battery Message

The low battery message appears while the main battery power is below a certain level whenever you press [AC/ON] to turn power on or [MENU] to display the Main Menu.

[AC/ON] or [MENU]



If you continue using the calculator without replacing batteries, power will automatically turn off to protect memory contents. Once this happens, you will not be able to turn power back on, and there is the danger that memory contents will be corrupted or lost entirely.

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Chapter 2

Basic Calculations

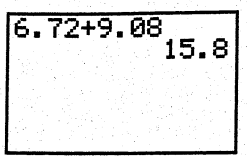
In the RUN Mode you can perform arithmetic calculations (addition, subtraction, multiplication, division) as well as calculations involving scientific functions.

1. **Addition and Subtraction**
2. **Multiplication**
3. **Division**
4. **Quotient and Remainder Division**
5. **Mixed Calculations**
6. **Other Useful Calculation Features**
7. **Using Variables**
8. **Fraction Calculations**
9. **Selecting Value Display Modes**
10. **Scientific Function Calculations**

1. Addition and Subtraction

Example 6.72 + 9.08

[6] [.] [7] [2] [+] [9] [.] [0] [8] [EXE]



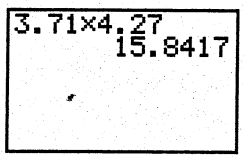
You can input the operation just as it is written. This capability is called "true algebraic logic."

Be sure to press [AC] to clear the display before starting a new calculation.

2. Multiplication

Example 3.71 × 4.27

[AC] [3] [.] [7] [1] [×]
[4] [.] [2] [7] [EXE]

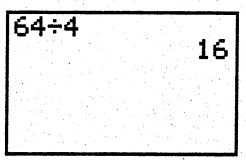


• The range of this calculator is $-9.99999999 \times 10^{99}$ to $+9.99999999 \times 10^{99}$.

3. Division

Example 64 ÷ 4

[AC] [6] [4] [÷] [4] [EXE]



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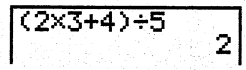
Parentheses also come in handy when performing division. For full details on using parentheses, see "Parentheses Calculation Priority Sequence".

•To use parentheses in a calculation

Example 1 $\frac{2 \times 3 + 4}{5}$

You should input this calculation as: (2 × 3 + 4) ÷ 5

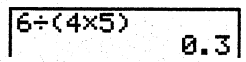
[AC] [(] [2] [×] [3] [+] [4] [)] [÷] [5] [EXE]



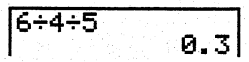
Example 2 $\frac{6}{4 \times 5}$

You can input this calculation as: 6 ÷ (4 × 5) or 6 ÷ 4 ÷ 5.

[AC] [6] [÷] [(] [4] [×] [5] [)] [EXE]



[AC] [6] [÷] [4] [÷] [5] [EXE]



4. Quotient and Remainder Division

This calculator can produce either the quotient or the quotient and remainder of division operations involving two integers. Use [OPTN] to display the Option Menu for the function key menu you need to perform quotient and remainder division.

Operation

Use the RUN Mode for quotient and remainder division.

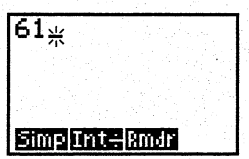
Quotient Division ..... <integer> [OPTN] [F2] (CALC) [F2] (Int÷) <integer> [EXE]

Reminder Division .... <integer> [OPTN] [F2] (CALC) [F3] (Rmdr) <integer> [EXE]

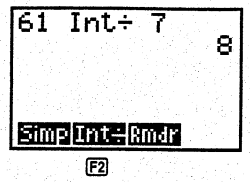
•To perform quotient division

Example **To display the quotient produced by 61 ÷ 7**

[AC] [6] [1] [OPTN] [F2] (CALC)



[F2](Int÷)[7][EXE]



- Remember that you can use only integers in quotient division operations. You cannot use expressions such as $\sqrt{2}$ or sin60 because their results have a decimal part.

•To perform remainder division

Example **To display the remainder produced by 857 ÷ 48**

[8][5][7][F3](Rmdr)[4][8][EXE]

Press [QUIT] to clear the Option Menu after you finish your remainder and quotient calculations.

- Remember that you can use only integers in remainder division operations. You cannot use expressions such as $\sqrt{2}$ or sin60 because their results have a decimal part.
- Quotient and remainder division can also be used with lists to divide a multiple integers by each other in a single operation.

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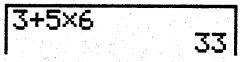
5. Mixed Calculations

(1) Mixed Arithmetic Calculation Priority Sequence

For mixed arithmetic calculations, the calculator automatically performs multiplication and division before addition and subtraction.

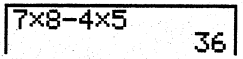
Example 1 $3 + 5 \times 6$

[AC][3][+][5][×][6][EXE]



Example 2 $7 \times 8 - 4 \times 5$

[AC][7][×][8][−][4][×][5][EXE]

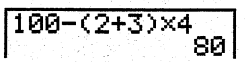


(2) Parentheses Calculation Priority Sequence

Expressions enclosed inside parentheses are always given priority in a calculation.

Example 1 $100 - (2 + 3) \times 4$

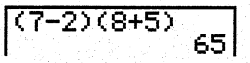
[AC][1][0][0][−][(][2][+][3][)]
[×][4][EXE]



Example 2 $(7 - 2) \times (8 + 5)$

- A multiplication sign immediately in front of an open parenthesis can be omitted.

[AC][(][7][−][2][)][(][8][+][5][)]
[EXE]



- Any closing parentheses at the end of a calculation can be omitted, no matter how many there are.

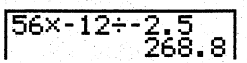
Parentheses are always closed in the operation examples presented in this manual.

(3) Negative Values

Use the [(−)] key to input negative values.

Example $56 \times (-12) \div (-2.5)$

[AC][5][6][×][(−)][1][2][÷]
[(−)][2][.][5][EXE]

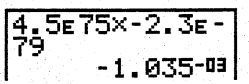


(4) Exponential Expressions

Use the [EXP] key to input exponents.

Example $(4.5 \times 10^{75}) \times (-2.3 \times 10^{-79})$

[AC][4][.][5][EXP][7][5][×][(−)][2][.][3]
[EXP][(−)][7][9][EXE]



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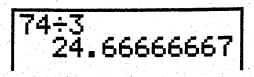
The above shows what would appear when the exponential display range is set to Norm 1. It stands for -1.035×10^{-3}, which is –0.001035.

(5) Rounding

Example 74 ÷ 3

[AC] [7] [4] [÷] [3] [EXE]



The actual result of the above calculation is 24.66666666... (and so on to infinity), which the calculator rounds off. The calculator's internal capacity is 15 digits for the values it uses for calculations, which avoids precision problems with consecutive operations that use the result of the previous operation.

6. Other Useful Calculation Features

(1) Answer Memory (Ans)

Calculation results are automatically stored in the Answer Memory, which means you can recall the results of the last calculation you performed at any time.

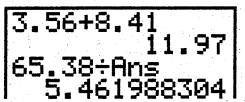
•To recall Answer Memory contents

Press [SHIFT] and then [Ans] (which is the shifted function of the [(-)] key).

This operation is represented as [SHIFT] [Ans] throughout this manual.

Example To perform 3.56 + 8.41 and then divide 65.38 by the result

[AC] [3] [·] [5] [6] [+] [8] [·] [4] [1] [EXE]
[6] [5] [·] [3] [8] [÷] [SHIFT] [Ans] [EXE]



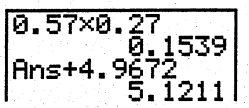
(2) Consecutive Calculations

If the result of the last calculation is the first term of the next calculation, you can use the result as it is on the display without recalling Answer Memory contents.

•To perform a consecutive calculation

Example To perform 0.57 × 0.27, and then add 4.9672 to the results

[AC] [0] [·] [5] [7] [×] [0] [·] [2] [7] [EXE]
[+] [4] [·] [9] [6] [7] [2] [EXE]



(3) Replay

While the result of a calculation is on the display, you can use [◀] and [▶] to move the cursor to any position within the expression used to produce the result. This means you can back up and correct mistakes without having to input the entire calculation. You can also recall past calculations you have already cleared by pressing [AC].

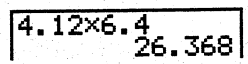
Operation

The first press of [▶] displays the cursor at the beginning of the expression, while [◀] displays the cursor at the end. Once the cursor is displayed, use [▶] to move it right and [◀] to move it left.

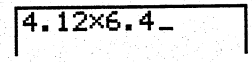
•To use Replay to change an expression

Example To calculate 4.12 × 6.4 and then change the calculation to 4.12 × 7.1

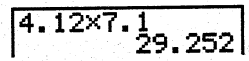
[AC] [4] [·] [1] [2] [×] [6] [·] [4] [EXE]



[◀]



[◀] [◀] [◀] [7] [·] [1] [EXE]



Multi-Replay

Pressing [AC] and then [▲] or [▼] sequentially recalls and displays past calculations.

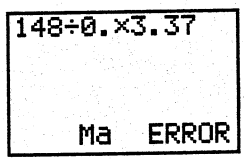
(4) Error Recovery

Whenever an error message appears on the display, press [◀] or [▶] to re-display the expression with the cursor located just past the part of the expression that caused the error. You can then move the cursor and make necessary corrections before executing the calculation again.

•To correct an expression that causes an error

Example To recover from the error generated by performing 148 ÷ 0. × 3.37 instead of 148 ÷ 0.3 × 3.37

[AC] [1] [4] [8] [÷] [0] [·]
[×] [3] [·] [3] [7] [EXE]



◀ (You could also press ▶.)

148÷0.x3.37

SHIFT INS 3

148÷0.3X3.37

(See below for details on making corrections.)

EXE

148÷0.3×3.37
1662.533333

(5) Making Corrections

Use the ◀ and ▶ keys to move the cursor to the position you want to change, and then perform one of the operations described below. After you edit the calculation, you can execute it by pressing EXE, or use ▶ to move to the end of the calculation and input more.

•To change a step

Example To change cos60 to sin60

cos 6 0

cos 60_

◀◀◀

cos 60

sin

sin 60

•To delete a step

Example To change 369 × × 2 to 369 × 2

3 6 9 × × 2

369××2_

◀◀ DEL

369×2

•To insert a step

Example To change 2.36² to sin2.36²

2 • 3 6 x^2

2.36²_

◀◀◀◀◀

2.36²

SHIFT INS

2.36²

sin

sin 2.36²

- When you press SHIFT INS a space is indicated by the symbol "□". The next function or value you input is inserted at the location of "□". To abort the insert operation without inputting anything, move the cursor, press SHIFT INS again, or press ◀, ▶ or EXE.

7. Using Variables

A total of 26 variables, named A through Z, are available for assignment of numeric values. Variable contents are retained even when you turn the calculator off. Note that when you assign a value to a variable, the calculator assigns its 15-digit internal value.

•To assign a value to a variable

Operation

<value or expression> → ALPHA <variable name: A to Z>

Example 1 To assign 1024 to variable A

AC 1 0 2 4 → ALPHA A EXE

1024→A
1024

Example 2 To display the contents of variable A

AC ALPHA A EXE

A
1024

Example 3 To clear the contents of variable A

To clear a variable, simply assign 0 to it.

AC 0 → ALPHA A EXE

0→A
0

•To assign the same value to more than one variable

Operation

<value or expression>⟹ ALPHA <start variable name> ALPHA F3 (~) ALPHA <end variable name> EXE

Example To assign the result of $\sqrt{2}$ to variables A, B, C, D, and E

AC SHIFT √ 2 ⟹ ALPHA A ALPHA F3 (~)
ALPHA E EXE

```
√2→A~E
  1.414213562
```

•To clear the contents of all variables

In the Main Menu, select the **MEM** icon and press EXE.

```
Memory
 Memory Usage
 Reset

Select:[↑][↓]
Set   :[EXE]
```

Select Memory Usage.

EXE

```
Memory Usage
Program:    0
Stat   :    0
List   :    0
```

Press ▼ to scroll the display until "Alpha" is highlighted.

▼▼▼▼▼▼▼

```
Memory Usage
V-Win  :    0
Table  :    0
Alpha  :   50
DEL
```

F1

F1 (DEL)

```
YES        NO
```

F1 F4

Press F1 (YES) to clear all variables or F4 (NO) to abort the clear operation without clearing anything.

8. Fraction Calculations

(1) Fraction Display and Input

Example 1 Display of $\frac{3}{4}$

```
3⌟4
```

Example 2 Display of $3\frac{1}{4}$

```
3⌟1⌟4
```

Mixed fractions (such as 3 1/4) are input and displayed as:
integer⌟numerator⌟denominator.

Improper fractions (15/7) and proper fractions (such as 1/4) are input and displayed as: numerator⌟denominator.

Use the a b/c key to input each part of a fraction.

•To input a fraction

Operation

Proper Fraction or Improper Fraction Input: <numerator value> a b/c <denominator value>

Mixed Fraction Input: <integer value> a b/c <numerator value> a b/c <denominator value>

Example To input $3\frac{1}{4}$

Press 3 a b/c 1 a b/c 4.

> Note that the maximum size of a fractional value is 10 digits, counting the integer, numerator, and denominator digits and separator symbols. Any value longer than 10 digits is automatically converted to its equivalent decimal value.

(2) Performing Fraction Calculations

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

AC 2 a b/c 5 + 3 a b/c 1 a b/c 4 EXE

```
2⌟5+3⌟1⌟4
          3⌟13⌟20
```

•To convert between fraction and decimal values

Operation

Fraction to Decimal Conversion: F↔D

Decimal to Fraction Conversion: F↔D

Example **To convert the result of the previous example to a decimal and then back to a fraction**

F↔D

```
2.5+3.1.4
              3.65
```

F↔D

```
2.5+3.1.4
            3.13.20
```

•To convert between proper and improper fractions

Operation

Mixed Fraction to Improper Fraction Conversion: SHIFT d/c

Improper Fraction to Mixed Fraction Conversion: SHIFT d/c

Example **To convert the result of the previous example to an improper fraction and then back to a proper fraction**

SHIFT d/c

```
2.5+3.1.4
             73.20
```

SHIFT d/c

```
2.5+3.1.4
            3.13.20
```

- The calculator automatically reduces the results of fraction calculations. You can use the procedure described under "Changing the Fraction Simplification Mode" below to specify manual fraction simplification.

•To perform a mixed decimal and fraction calculation

Example $5.2 \times \frac{1}{5}$

AC 5 · 2 × 1 a b/c 5 EXE

```
5.2×1.5
              1.04
```

- The result of a calculation that mixes fractions and decimal values is always a decimal value.

•To use parentheses in a fraction calculation

Example $\dfrac{1}{\frac{1}{3}+\frac{1}{4}}+\frac{2}{7}$

AC 1 a b/c (1 a b/c 3 + 1 a b/c 4) + 2 a b/c 7 EXE

```
1.(1.3+1.4)+2
.7
                2
```


(3) Changing the Fraction Simplification Mode

The initial default of the calculator is automatic simplification of fractions produced by fraction calculations. You can use the following operation to change the fraction simplification mode to manual.

•To change the fraction simplification mode

Example **To change the fraction simplification mode to manual**

SHIFT SETUP

(Displays the Set Up Screen.)

```
F-Type :Y=
D-Type :Conct
Angle  :Rad
Display:Nrm1
Simplfy:Auto
Y= Parm
```

▼▼▼▼ F2 (Man)

```
F-Type :Y=
D-Type :Conct
Angle  :Rad
Display:Nrm1
Simplfy:Man
Auto Man
```

F2

When the fraction simplification is set to manual, you have to use the Option Menu to simplify fractions. You can let the calculator select the divisor to use for simplification or you can specify a divisor.

•To simplify using the calculator's divisor

Operation

Perform calculations after selecting the **RUN** icon in the Main Menu to enter the RUN Mode.

To display the simplification menu: OPTN F2 (CALC)

To select automatic simplification: F1 (Simp) EXE

To specify the divisor for simplification*: F1 (Simp) <Divisor> EXE

* You can specify only a positive integer as the divisor.

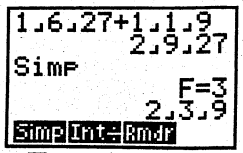
Example **To perform the calculation** $1\frac{6}{27}+1\frac{1}{9}$ **and reduce the result**

AC 1 a b/c 6 a b/c 2 7 + 1 a b/c 1 a b/c 9 EXE

```
1.6.27+1.1.9
             2.9.27
```

(The result that appears when using manual simplification is the least common multiple of the fractions used in the calculation.)

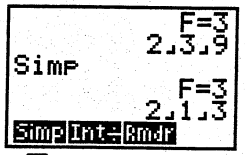
OPTN F2 (CALC) F1 (Simp) EXE



- F = 3 indicates that 3 is the divisor.
- The calculator automatically selects the smallest possible divisor for simplification.

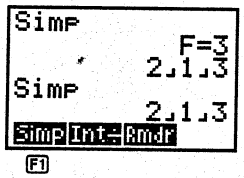
Repeat the above operation to simplify again.

F1 (Simp) EXE



Try once again.

F1 (Simp) EXE

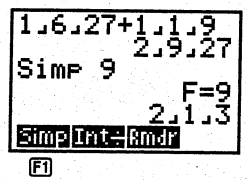


This display indicates that further simplification is impossible.

•To simplify using your own divisor

Example **To perform the above calculation and then specify 9 as the divisor to use for simplification**

F1 (Simp) 9 EXE



- If the value you specify is invalid as a divisor for simplification, the calculator automatically uses the lowest possible divisor.

9. Selecting Value Display Modes

You can make specifications for three value display modes.

Fix Mode

This mode lets you specify the number of decimal places to be displayed.

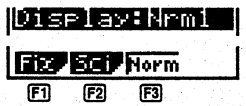
Sci Mode

This mode lets you specify the number of significant digits to be displayed.

Norm 1/Norm 2 Mode

This mode determines at what point the display changes over to exponential display format.

Display the Set Up Screen and use the ▲ and ▼ keys to highlight "Display".

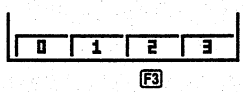


• To specify the number of decimal places (Fix)

1. While the set-up screen is on the display, press F1 (Fix).
2. Press the function key that corresponds to the number of decimal places you want to set (0 to 9).
   - Press ▷ to display the next menu of numbers.

Example **To specify two decimal places**

F1 (Fix)



F3 (2)

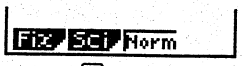
Press the function key that corresponds to the number of decimal places you want to specify.

- Displayed values are rounded off to the number of decimal places you specify.
- A number of decimal place specification remains in effect until you change the Norm Mode setting.

• To specify the number of significant digits (Sci)

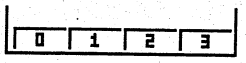
1. While the set-up screen is on the display, press F2 (Sci).
2. Press the function key that corresponds to the number of significant digits you want to set (0 to 9).
   • Press ▷ to display the next menu of numbers.

Example **To specify three significant digits**



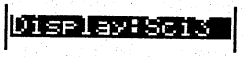
F2

F2 (Sci)



F4

F4 (3)



Press the function key that corresponds to the number of significant digits you want to specify.

- Displayed values are rounded off to the number of significant digits you specify.
- Specifying 0 makes the number of significant digits 10.
- A number of significant digit specification remains in effect until you change the Norm Mode setting.

• To specify the exponential display range (Norm 1/Norm 2)

Press F3 (Norm) to switch between Norm 1 and Norm 2.

Norm 1: 10^{-2} (0.01)>|x|, |x| ≧10^{10}

Norm 2: 10^{-9} (0.000000001)>|x|, |x| ≧10^{10}

10. Scientific Function Calculations

Use the **RUN Mode** to perform calculations that involve trigonometric functions and other types of scientific functions.

(1) Trigonometric Functions

Before performing a calculations that involves trigonometric functions, you should first specify the default angle unit as degrees (°), radians (r), or grads (g).

■ Setting the Default Angle Unit

The default angle unit for input values can be set using the set up screen. If you set degrees (°) for example, inputting a value of 90 is automatically assumed to be 90° The following shows the relationship between degrees, radians, and grads.

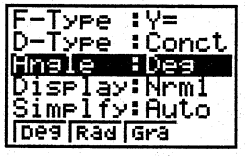
90° = π/2 radians = 100 grads

•To set the default angle unit

Example **To change the angle unit from radians to degrees**

SHIFT SETUP

▼▼ F1 (Deg)



F1

- Once you change the angle unit setting, it remains in effect until you change it again using the set up screen. You also should check the set up screen to find out what the current angle unit setting is.

■ Converting Between Angle Units

You can use the following procedure to input a value using an angle unit that is not the current default angle unit. Then when you press EXE, the value will be converted to the default angle unit.

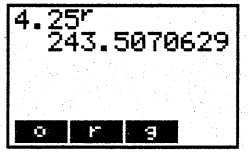
•To convert between angle units

Example **To convert 4.25 radians to degrees while degrees are set as the default angle unit**

AC 4 · 2 5 OPTN ▷

F2

F2 (ANGL) F2 (r) EXE



F2

P.29

■ Trigonometric Function Calculations

Always make sure that the default angle unit is set to the required default before performing trigonometric function calculations.

•To perform trigonometric function calculations

Example 1 sin (63° 52' 41")

Default angle unit: Degrees

[SHIFT] [SETUP] [▼] [▼] [F1](Deg) [QUIT]

[sin] [6] [3] [OPTN] [▷] [F2](ANGL) [▷] [F1](° ' ") [5] [2] [F1](° ' ") [4] [1] [F1](° ' ") [EXE]

Result: 0.897859012

Example 2 $\sec\left(\frac{\pi}{3}\text{ rad}\right) = \frac{1}{\cos\left(\frac{\pi}{3}\text{rad}\right)}$

Default angle unit: Radians

[SHIFT] [SETUP] [▼] [▼] [F2](Rad) [QUIT]

[1] [÷] [cos] [(] [SHIFT] [π] [÷] [3] [)] [EXE]

Result: 2

Example 3 tan(–35grad)

Default angle unit: Grads

[SHIFT] [SETUP] [▼] [▼] [F3](Gra) [QUIT]

[tan] [(–)] [3] [5] [EXE]

Result: –0.6128007881

(2) Logarithmic and Exponential Function Calculations

- A base 10 logarithm (common logarithm) is normally written as $\log_{10}$ or log.
- A base e ($\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n = 2.71828...$) logarithm (natural logarithm) is normally written as $\log_e$ or ln.

Note that certain publications use "log" to refer to base e logarithms, so you must take care to watch for what type of notation is being used in the publications you are working with. This calculator and manual use "log" to mean base 10 and "ln" for base e.

•To perform logarithmic/exponential function calculations

Example 1 log1.23

[log] [1] [.] [2] [3] [EXE]

Result: 0.0899051114

Example 2 ln90

[ln] [9] [0] [EXE]

Result: 4.49980967

Example 3 To calculate the anti-logarithm of common logarithm 1.23 ($10^{1.23}$)

[SHIFT] [10^x] [1] [.] [2] [3] [EXE]

Result: 16.98243652

Example 4 To calculate the anti-logarithm of natural logarithm 4.5 ($e^{4.5}$)

[SHIFT] [e^x] [4] [.] [5] [EXE]

Result: 90.0171313

Example 5 $(-3)^4 = (-3)\times(-3)\times(-3)\times(-3)$

[(] [(–)] [3] [)] [^] [4] [EXE]

Result: 81

Example 6 $\sqrt[7]{123}$

[7] [SHIFT] [$\sqrt{\ }$] [1] [2] [3] [EXE]

Result: 1.988647795

(3) Other Functions

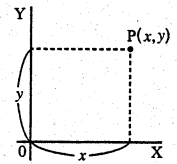
Example	Operation	Display
$\sqrt{2}+\sqrt{5}=3.65028154$	[SHIFT] [$\sqrt{\ }$] [2] [+] [SHIFT] [$\sqrt{\ }$] [5] [EXE]	3.65028154
$(-3)^2=(-3)\times(-3)=9$	[(] [(–)] [3] [)] [x^2] [EXE]	9
$-3^2=-(3\times3)=-9$	[(–)] [3] [x^2] [EXE]	–9
$\frac{1}{\frac{1}{3}-\frac{1}{4}}=12$	[(] [3] [SHIFT] [x^{-1}] [–] [4] [SHIFT] [x^{-1}] [)] [SHIFT] [x^{-1}] [EXE]	12
8! (= 1×2×3×....×8) = 40320	[8] [OPTN] [F4](PROB) [F1](x!) [EXE]	40320
$\sqrt[3]{36\times42\times49}=42$	[SHIFT] [$\sqrt[3]{\ }$] [(] [36] [×] [42] [×] [49] [)] [EXE]	42
Random number generation (pseudo random number between 0 and 1.)	[OPTN] [F4](PROB) [F4](Ran#) [EXE]	(Ex.) 0.4810497011

Example	Operation	Display
What is the absolute value of the common logarithm of $\frac{3}{4}$?		
$\left\| \log \frac{3}{4} \right\| = 0.1249387366$	OPTN ▷ F1(NUM) F1(Abs) log (3 ÷ 4) EXE	0.1249387366
What is the integer part of $\frac{7800}{96}$?	OPTN ▷ F1(NUM) F2(Int) (7800 ÷ 96) EXE	81
What is the decimal part of $\frac{7800}{96}$?	OPTN ▷ F1(NUM) F3(Frac) (7800 ÷ 96) EXE	0.25
200 ÷ 6 =	200 ÷ 6 EXE	33.33333333
× 3 =	× 3 EXE	100
Round the value used for internal calculations to 11 digits*	200 ÷ 6 EXE OPTN ▷ F1(NUM) F4(Rnd) EXE × 3 EXE	33.33333333 33.33333333 99.99999999
What is the nearest integer not exceeding – 3.5?	OPTN ▷ F1(NUM) ▷ F1(Intg) (–) 3.5 EXE	– 4

* When a Fix (number of decimal places) or Sci (number of significant digits) is in effect, Rnd rounds the value used for internal calculations in accordance with the current Fix or Sci specification. In effect, this makes the internal value match the displayed value.

(4) Coordinate Conversion

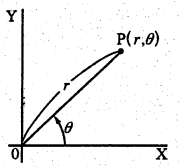
- **Rectangular Coordinates**



Pol

Rec

- **Polar Coordinates**



- With polar coordinates, θ can be calculated and displayed within a range of $-180° < \theta \leqq 180°$ (radians and grads have same range).

Example **To calculate r and $\theta°$ when $x = 14$ and $y = 20.7$**

Operation	Display
SHIFT SETUP ▼ ▼ F1(Deg) QUIT OPTN ▷ F2(ANGL) ▷ ▷ F1(Pol) (14 , 20.7) EXE	Ans 1 [24.989] → 24.98979792 (r) 2 [55.928] → 55.92839019 (θ)

Example **To calculate x and y when $r = 25$ and $\theta = 56°$**

Operation	Display
SHIFT SETUP ▼ ▼ F1(Deg) QUIT OPTN ▷ F2(ANGL) ▷ ▷ F2(Rec) (25 , 56) EXE	Ans 1 [13.979] → 13.97982259 (x) 2 [20.725] → 20.72593931 (y)

(5) Permutation and Combination

- **Permutation** $_nP_r = \frac{n!}{(n-r)!}$
- **Combination** $_nC_r = \frac{n!}{r!\,(n-r)!}$

Example **To calculate the possible number of different arrangements using 4 items selected from among 10 items**

Formula	Operation	Display
$_{10}P_4 = 5040$	10 OPTN F4(PROB) F2($_nP_r$) 4 EXE	5040

Example **To calculate the possible number of different combinations of 4 items that can be selected from among 10 items**

Formula	Operation	Display
$_{10}C_4 = 210$	10 OPTN F4(PROB) F3($_nC_r$) 4 EXE	210

(6) Other Things to Remember

■ Multiplication Sign

You can leave out the multiplication sign in any of the following cases.

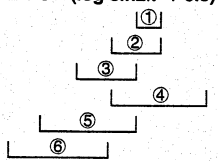
- In front of the following scientific functions:
  sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, log, ln, 10^x, e^x, $\sqrt{\ }$, $\sqrt[3]{\ }$, Pol(x, y), Rec(r, θ), d/dx, Seq, Min, Max, Mean, Median, List, Dim, Sum
  Examples: 2 sin30, 10log1.2, 2 $\sqrt{3}$, etc.
- In front of constants, variable names, Ans memory contents.
  Examples: 2π, 2AB, 3Ans, 6X, etc.
- In front of an open parenthesis.
  Examples: 3(5 + 6), (A + 1)(B –1)

■ Calculation Priority Sequence

The calculation priority sequence is the order that the calculator performs operations. Note the following rules about calculation priority sequence.

- Expressions contained in parentheses are performed first.
- When two or more expressions have the same priority, they are executed from right to left.

Example **2 + 3 × (log sin2π² + 6.8) = 22.07101691 (angle unit = Rad)**



The following is a complete list of operations in the sequence they are performed.

1. Coordinate transformation: (Pol (*x*, *y*), Rec (*r*, *θ*); differential calculations: *d*/*dx*(; List: Fill, Seq, Min, Max, Mean, Median, SortA, SortD
2. Type A functions (value input followed by function): x^2, x^{-1}, *x*!
   sexagesimal input: ° ' "
3. Powers: ^ (x^y); roots: $\sqrt[x]{\ }$
4. Fraction input: $a\,b/c$
5. Multiplication operations where the multiplication sign before π or a variable is omitted: 2π; 5A; 3sin*x*; etc.
6. Type B functions (function followed by value input):
   $\sqrt{\ }$, $\sqrt[3]{\ }$, log, ln, e^x, 10^x, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, (–), Dim, Sum
7. Multiplication operations where the multiplication sign before a scientific function is omitted: $2\sqrt{3}$; Alog2; etc.
8. Permutation: *n*P*r*; combination: *n*C*r*
9. Multiplication; division; integer division; remainder division
10. Addition; subtraction
11. Relational operators: =, ≠, >, <, ≥, ≤

■ Using Multistatements

Multistatements are formed by connecting a number of individual statements for sequential execution. You can use multistatements in manual calculations and in programmed calculations. There are two different ways that you can use to connect statements to form multistatements.

• Colon (:)

Statements that are connected with colons are executed from left to right, without stopping.

• Display Result Command (◢)

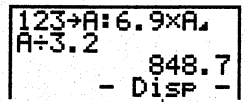
When execution reaches the end of a statement followed by a display result command, execution stops and the result up to that point appears on the display. You can resume execution by pressing the [EXE] key.

•To use multistatements

Example **6.9 × 123 = 848.7**

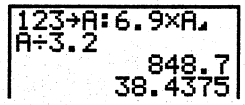
123 ÷ 3.2 = 38.4375

[AC] [1] [2] [3] [→] [ALPHA] [A]
[SHIFT] [PRGM] [▷] [▷] [F3](:)
[6] [·] [9] [×] [ALPHA] [A] [SHIFT] [PRGM] [▷] [F2](◢)
[ALPHA] [A] [÷] [3] [·] [2] [EXE]



Intermediate result at point where "◢" is used.

[EXE]



- Note that the final result of a multistatement is always displayed, regardless of whether it ends with a display result command.
- You cannot construct a multistatement in which one statement directly uses the result of the previous statement.

Example **123 × 456: × 5**

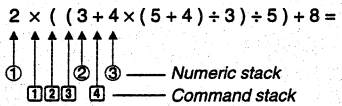
Invalid

■ Stacks

When the calculator performs a calculation, it temporarily stores certain information in memory areas called a "stacks" where it can later recall the information when it is necessary.

There are actually two stacks: a 10-level numeric stack and a 26-level command stack. The following example shows how data is stored in the stacks.

2 × ((3 + 4 × (5 + 4) ÷ 3) ÷ 5) + 8 =



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A calculation can become so complex that it requires too much stack memory and cause a stack error (Stk ERROR) when you try to execute it. If this happens, try simplifying your calculation or breaking it down into separate parts. See "How to Calculate Memory Usage" for details on how much memory is taken up by various commands.

■ Errors

An error message appears on the display and calculation stops whenever the calculator detects some problem. Press [AC] to clear the error message.

The following is a list of all the error messages and what they mean.

Ma ERROR - (Mathematical Error)

- A value outside the range of $\pm 9.99999999 \times 10^{99}$ was generated during a calculation, or an attempt was made to store such a value in memory.
- An attempt was made to input a value that exceeds the range of the scientific function being used.
- An attempt was made to perform an illegal statistical operation.

Stk ERROR - (Stack Error)

- The calculation being performed caused the capacity of one of the stacks to be exceeded.

Syn ERROR - (Syntax Error)

- An attempt to use an illegal syntax.

Arg ERROR - (Argument Error)

- An attempt to use an illegal argument with a scientific function.

Dim ERROR - (Dimension Error)

- An attempt to perform an operation with two or more lists when the dimensions of the lists do not match.

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In addition to the above, there are also a Mem ERROR and Go ERROR. See "Error Message Table" for details.

■ How to Calculate Memory Usage

Some key operations take up one byte of memory each, while others take up two bytes.

1-byte operations: 1, 2, 3, ..., sin, cos, tan, log, ln, $\sqrt{\ }$, π, etc.

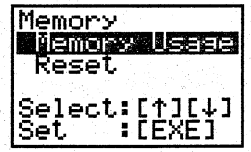
2-byte operations: d/dx(, Xmin, If, For, Return, DrawGraph, SortA(, Sum, etc.

■ Memory Status (MEM)

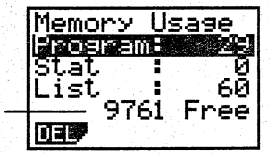
You can check how much memory is used for storage for each type of data. You can also see how many bytes of memory are still available for storage.

•To check the memory status

1. In the Main Menu, select the **MEM** icon and press [EXE].



2. Press [EXE] again to display the memory status screen.



Number of bytes still free

3. Use ▲ and ▼ to move the highlighting and view the amount of memory (in bytes) used for storage of each type of data.

The following table shows all of the data types that appear on the memory status screen.

Data type	Meaning
Program	Program data
Stat	Statistical calculations and graphs
List	List data
Y=	Graph functions
Draw	Graph drawing conditions (View Window, enlargement/reduction factor, graph screen)
V-Win	View Window memory data
Table	Table & Graph data
Alpha	Alpha memory data

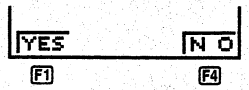
■ Clearing Memory Contents

•To clear all data within a specific data type

1. In the memory status screen, use ▼ and ▲ to move the highlighting to the data type whose data you want to clear.

2. Press [F1] (DEL).

[F1](DEL)



3. Press [F1] (YES) to clear the data or [F4] (NO) to abort the operation without clearing anything.

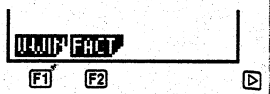
■ Variable Data (VARS) Menu

You can use the variable data menu to recall the data listed below.

- View Window values
- Enlargement/reduction factor
- Single-variable/paired-variable statistical data
- Graph functions
- Table & Graph table range and table contents

To recall variable data, press [VARS] to display the variable data menu.

[VARS]



[F1] (V-WIN) .... View Window values
[F2] (FACT) ..... x and y-axis enlargement/reduction factor

[▷]

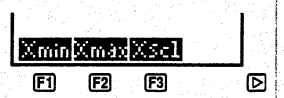
[F1] (STAT) ..... Single/paired-variable statistical data
[F2] (GRPH) .... Graph functions stored in the GRAPH Mode
[F3] (TABL) ..... Table & Graph function table range and table contents

Press [▷] to return to the previous menu.

•To recall View Window values

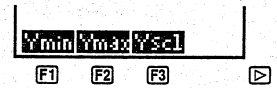
Pressing [F1] (V-WIN) while the variable data menu is on the screen displays a View Window value menu.

[F1] (V-WIN)



[F1] (Xmin) ..... x-axis minimum
[F2] (Xmax) ..... x-axis maximum
[F3] (Xscl) ..... x-axis scale

[▷]



[F1] (Ymin) ..... y-axis minimum
[F2] (Ymax) ..... y-axis maximum
[F3] (Yscl) ..... y-axis scale

[▷]

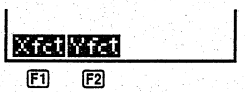
[F1] (Tmin) ..... Minimum of T
[F2] (Tmax) ..... Maximum of T
[F3] (Tpth) ..... Pitch of T

Press [▷] to return to the previous menu.

•To recall enlargement and reduction factors

Pressing [F2] (FACT) while the variable data menu is on the screen displays an enlargement/reduction factor menu.

[F2](FACT)



[F1] (Xfct) ..... x-axis enlargement/reduction factor
[F2] (Yfct) ..... y-axis enlargement/reduction factor

•To recall single/paired-variable statistical data

Pressing [▷] and then [F1] (STAT) while the variable data menu is on the screen displays a statistical data menu.

[▷][F1](STAT)

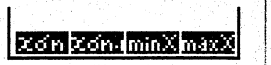
[F1] (X) ..... Single/paired-variable x-data menu
[F2] (Y) ..... Paired-variable y-data menu
[F3] (GRPH) .... Statistical graph data menu
[F4] (PTS) ..... Summary point data menu

The following menu appears whenever you press F1 (X), while the statistical data menu is on the display.

F1 (X)

F1 (*n*) ..... Number of data
F2 ($\bar{x}$) ..... Mean of *x* data
F3 (Σx) ..... Sum of *x* data
F4 (Σx^2) ..... *x* data sum of squares

▷



F1 ($x\sigma_n$) ..... *x* data population standard deviation
F2 ($x\sigma_{n-1}$) ..... *x* data sample standard deviation
F3 (minX) ..... *x* data minimum value
F4 (maxX) ..... *x* data maximum value

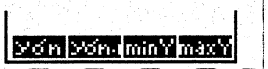
Press ▷ to return to the previous menu.

The following menu appears whenever you press F2 (Y) while the statistical data menu is on the display.

F2 (Y)

F1 ($\bar{y}$) ..... Mean of *y* data
F2 (Σy) ..... Sum of *y* data
F3 (Σy^2) ..... *y* data sum of squares
F4 (Σxy) ..... *x* data and *y* data sum of products

▷



F1 ($y\sigma_n$) ..... *y* data population standard deviation
F2 ($y\sigma_{n-1}$) ..... *y* data sample standard deviation
F3 (minY) ..... *y* data minimum value
F4 (maxY) ..... *y* data maximum value

Press ▷ to return to the previous menu.

The following menu appears whenever you press F3 (GRPH) while the statistical data menu is on the display.

F3 (GRPH)

F1 (*a*)-F3 (*c*) ... Statistical graph regression coefficient and multinomial coefficients
F4 (*r*) ..... Statistical graph correlation coefficient

▷

F1 (Q1) ..... First quartile
F2 (Med) ..... Median of input data
F3 (Q3) ..... Third quartile
F4 (Mod) ..... Mode of input data

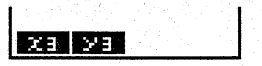
Press ▷ to return to the previous menu.

The following menu appears whenever you press F4 (PTS) while the statistical data menu is on the display.

F4 (PTS)

F1 (*x*1)-F4 (*y*2) ..... Coordinates of summary points

▷



F1 (*x*3)-F2 (*y*3) ..... Coordinates of summary points

Press ▷ to return to the previous menu.

•To recall graph functions

Pressing ▷ and then F2 (GRPH) while the variable data menu is on the screen displays a graph function menu.

▷ F2 (GRPH)

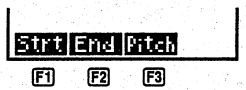
Input a storage area number and then press one of the following function keys to recall the corresponding graph function stored in that storage area.

[F1] (Y) ..... Rectangular coordinate or inequality function
[F2] (Xt) ..... Parametric graph function Xt
[F3] (Yt) ..... Parametric graph function Yt

•To recall Table & Graph table range and table content data

Pressing [▷] and then [F3] (TABL) while the variable data menu is on the screen displays a Table & Graph data menu.

[▷] [F3] (TABL)



[F1] (Strt) ..... Table range start value (**F Start** command)
[F2] (End) ..... Table range end value (**F End** command)
[F3] (Pitch) ..... Table value increment (**F Pitch** command)

Chapter 3

3

Differential Calculations

- To perform differential calculations, first display the Option Menu, and then input the values shown in the formula below.

[OPTN] [F2](CALC)[▷]
[F1](*d*/*dx*) *f*(*x*)[,] *a*[,] Δ*x*[)]

Δ*x*: Increase/decrease of *x*
a: Point for which you want to determine the derivative

$$d/dx\,(f(x), a, \Delta x) \Rightarrow \frac{d}{dx} f(a)$$

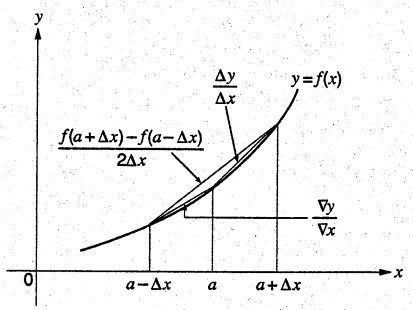
The differentiation for this type of calculation is defined as:

$$f'(a) = \lim_{\Delta x \to 0} \frac{f(a+\Delta x) - f(a)}{\Delta x}$$

In this definition, *infinitesimal* is replaced by a *sufficiently small* Δ*x*, with the value in the neighborhood of $f'(a)$ calculated as:

$$f'(a) \fallingdotseq \frac{f(a+\Delta x) - f(a)}{\Delta x}$$

In order to provide the best precision possible, this unit employs central difference to perform differential calculations. The following illustrates central difference.



The slopes of point a and point $a + \Delta x$, and of point a and point $a - \Delta x$ in function $y = f(x)$ are as follows:

$$\frac{f(a+\Delta x) - f(a)}{\Delta x} = \frac{\Delta y}{\Delta x}, \quad \frac{f(a) - f(a-\Delta x)}{\Delta x} = \frac{\nabla y}{\nabla x}$$

In the above, $\Delta y/\Delta x$ is called the forward difference, while $\nabla y/\nabla x$ is the backward difference. To calculate derivatives, the unit takes the average between the value of $\Delta y/\Delta x$ and $\nabla y/\nabla x$, thereby providing higher precision for derivatives.

This average, which is called the *central difference*, is expressed as:

$$f'(a) = \frac{1}{2}\left(\frac{f(a+\Delta x) - f(a)}{\Delta x} + \frac{f(a) - f(a-\Delta x)}{\Delta x}\right)$$
$$= \frac{f(a+\Delta x) - f(a-\Delta x)}{2\Delta x}$$

•To perform a differential calculation

Example **To determine the derivative at point $x = 3$ for the function $y = x^3 + 4x^2 + x - 6$, when the increase/decrease of x is defined as $\Delta x = 1\text{E} - 5$**

Input the function $f(x)$.

[AC] [OPTN] [F2](CALC)[▷] [F1](*d*/*dx*)
[X,T] [^] [3] [+] [4] [X,T] [x²]
[+] [X,T] [−] [6] [,]

```
d/dx(X^3+4X²+
X-6,_
```

Input point $x = a$ for which you want to determine the derivative.

[3] [,]

```
d/dx(X^3+4X²+
X-6,3,_
```

Input Δ*x*, which is the increase/decrease of *x*.

[1] [EXP] [(−)] [5] [)]

```
d/dx(X^3+4X²+
X-6,3,1E-5)_
```

[EXE]

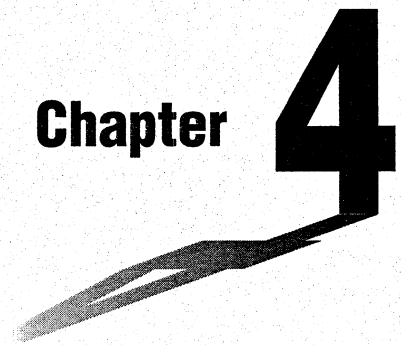
```
d/dx(X^3+4X²+
X-6,3,1E-5)
                52
```

- In the function $f(x)$, only X can be used as a variable in expressions. Other variables (A through Z) are treated as constants, and the value currently assigned to that variable is applied during the calculation.
- Input of Δ*x* and the closing parenthesis can be omitted. If you omit Δ*x*, the calculator automatically uses a value for Δ*x* that is appropriate for the value of $x = a$, which you specified as the point for which you wanted to determine the derivative.
- Discontinuous points or sections with drastic fluctuation can adversely affect precision or even cause an error.
- Note that you cannot use differential calculation inside of a differential calculation term.

- Pressing AC during calculation of a differential (while the cursor is not shown on the display) interrupts the calculation.
- Always perform trigonometric differentials using radians (Rad Mode) as the angle unit.

Chapter 4

4



Graphing

A collection of versatile graphing tools plus a large 79 × 47-dot display makes it easy to draw a variety of function graphs quickly and easily. This calculator is capable of drawing the following types of graphs.

- Rectangular coordinate (Y =) graphs
- Parametric graphs
- Inequality graphs

- A selection of graph commands also makes it possible to incorporate graphing into programs.

1. **Before Trying to Draw a Graph**
2. **View Window (V-Window) Settings**
3. **Graph Function Operations**
4. **Drawing Graphs Manually**
5. **Other Graphing Functions**

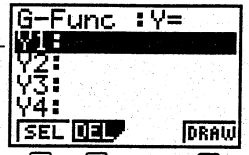
1. Before Trying to Draw a Graph

■ Entering the Graph Mode

On the Main Menu, select the **GRAPH** icon and enter the GRAPH Mode. When you do, the Graph Function (G-Func) menu appears on the display. You can use this menu to store, edit, and recall functions and to draw their graphs.

Memory area

Use ▲ and ▼ to change selection.



F1 (SEL) ..... Draw/non-draw status

F2 (DEL) ..... Graph delete

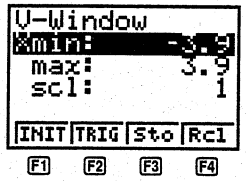
F4 (DRAW) .... Draws graph

2. View Window (V-Window) Settings

Use the View Window to specify the range of the *x*-and *y*-axes, and to set the spacing between the increments on each axis. You should always set the View Window parameters you want to use before drawing a graph. Press SHIFT F3 to display the View Window.

1. Press SHIFT F3 to display the View Window.

SHIFT F3 (V-Window)



F1 (INIT) ..... View Window initial settings

F2 (TRIG) ..... View Window initial settings using specified angle unit

F3 (Sto) ..... Store View Window settings to View Window memory.

F4 (Rcl) ..... Recall View Window settings from View Window memory.

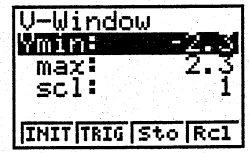
Xmin ..... Minimum *x*-axis value

Xmax ..... Maximum *x*-axis value

Xscl ..... Spacing of *x*-axis increments

2. Input a value for a parameter and press EXE. The calculator automatically selects the next parameter for input.

- You can also select a parameter using the ▼ and ▲ keys. .

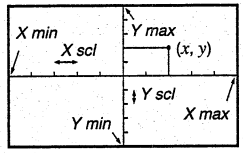


Ymin ..... Minimum *y*-axis value

Ymax ..... Maximum *y*-axis value

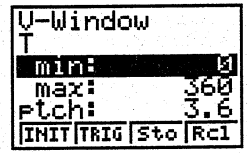
Yscl ..... Spacing of *y*-axis increments

The following illustration shows the meaning of each of these parameters.



3. Input a value for a parameter and press EXE. The calculator automatically selects the next parameter for input.

- There are actually nine View Window parameters. The remaining three parameters appear on the display when you move the highlighting down past the Y scale parameter by inputting values and pressing ▼.

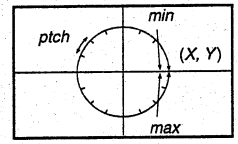


Tmin ..... T minimum values

Tmax ..... T maximum values

Tptch ..... T pitch

The following illustration shows the meaning of each of these parameters.



4. To exit the View Window, press [QUIT].
   • Pressing [EXE] without inputting any value also exits the View Window.

• The following is the input range for View Window parameters.
  –9.99E+97 to 9.999E+97
• You can input parameter values up to 7 digits long. Values greater than 10^6 or less than 10^{-1}, are automatically converted to a 4-digit mantissa (including negative sign) plus a 2-digit exponent.
• The only keys that enabled while the View Window is on the display are: [0] to [9], [·], [EXP], [(–)], [▲], [▼], [◀], [▶], [+], [–], [×], [÷], [(], [)], [SHIFT] [π], [QUIT]. You can use [(–)] or [–] to input negative values.
• The existing value remains unchanged if you input a value outside the allowable range or in the case of illegal input (negative sign only without a value).
• Inputting a View Window range so the min value is greater than the max value, causes the axis to be inverted.
• You can input expressions (such as 2π) as View Window parameters.
• When the View Window setting does not allow 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.
• When View Window values are changed, the graph display is cleared and the newly set axes only are displayed.
• View Window setting may cause irregular scale spacing.
• Setting maximum and minimum values that create too wide of a View Window range can result in a graph made up of disconnected lines (because portions of the graph run off the screen), or in graphs that are inaccurate.
• The point of deflection sometimes exceeds the capabilities of the display with graphs that change drastically as they approach the point of deflection.
• Setting maximum and minimum values that create to narrow of a View Window range can result in an error (Ma ERROR).

■ Initializing and Standardizing the View Window

•To initialize the View Window

a. Press [SHIFT] [F3] (V-Window) [F1] (INIT) to initialize the View Window to the following settings.

Xmin	= –3.9	Ymin	= –2.3
Xmax	= 3.9	Ymax	= 2.3
Xscl	= 1	Yscl	= 1

b. Press [SHIFT] [F3] (V-Window) [F2] (TRIG) to initialize the View Window to the following settings.

Deg Mode

Xmin	= –360	Ymin	= –1.6
Xmax	= 360	Ymax	= 1.6
Xscl	= 90	Yscl	= 0.5

Rad Mode

Xmin	= –6.28318
Xmax	= 6.28318
Xscl	= 1.57079

Gra Mode

Xmin	= –400
Xmax	= 400
Xscl	= 100

• The settings for Ymin, Ymax, Ypitch, Tmin, Tmax, and Tpitch remain unchanged when you press [F2] (TRIG).

■ View Window Memory

You can store a set of View Window settings in View Window memory for recall when you need them.

•To save View Window settings

While the View Window setting screen is on the display, press [F3] (Sto) to save the current settings.

• Whenever you save View Window settings, any settings previously stored in memory are replaced.

•To recall View Window settings

While the View Window setting screen is on the display, press [F4] (Rcl) to recall the View Window settings stored in memory.

• Whenever you recall View Window settings, the settings on the View Window are replaced by the recalled settings.

• You can change View Window settings in a program using the following syntax.
  View Window [Xmin value], [Xmax value], [Xscl value],
  [Ymin value], [Ymax value], [Yscl value],
  [Tmin value], [Tmax value], [Tptch value]

3. Graph Function Operations

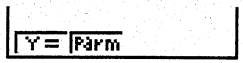
You can store up to 10 functions in memory. Functions in memory can be edited, recalled, and graphed. The types of functions that can be stored in memory are: rectangular coordinate functions, parametric functions, and inequalities.

■ Specifying the Graph Type

Before you can store a graph function in memory, you must first specify its graph type.

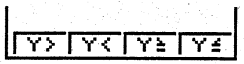
1. While the Graph Function Menu is on the display, press [▷] to display a Graph Type Menu.

[▷]



[F1] (Y =) ..... Rectangular coordinate graph
[F2] (Parm) ..... Parametric graph

[▷]



[F1] (Y >) ..... $Y > f(x)$ inequality
[F2] (Y <) ..... $Y < f(x)$ inequality
[F3] (Y ≥) ..... $Y \geq f(x)$ inequality
[F4] (Y ≤) ..... $Y \leq f(x)$ inequality

Press [▷] to return to the previous menu

2. Press the function key that corresponds to the graph type you want to specify.

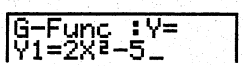
■ Storing Graph Functions

•To store a rectangular coordinate function (Y =)

Example **To store the following expression in memory area Y1:**

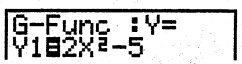
$y = 2x^2 - 5$

[▷] [F1] (Y =)
(Specifies rectangular coordinate expression.)



[2] [X,T] [x^2] [−] [5]
(Inputs expression.)

[EXE]
(Stores expression.)



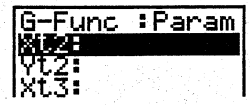
- You will not be able to store the expression in an area that already contains a parametric function. Select another area to store your expression or delete the existing parametric function first. This also applies when storing inequalities.

•To store a parametric function

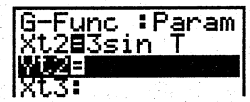
Example **To store the following functions in memory areas Xt2 and Yt2:**

$x = 3 \sin T$
$y = 3 \cos T$

[▷] [F2] (Parm)
(Specifies parametric expression.)



[3] [sin] [X,T] [EXE]
(Inputs and stores x expression.)



[3] [cos] [X,T] [EXE]
(Inputs and stores y expression.)

- You will not be able to store the expression in an area that already contains a rectangular coordinate expression or inequality. Select another area to store your expression or delete the existing expression first.

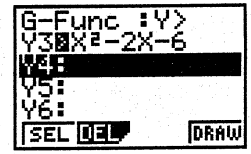
•To store an inequality

Example **To store the following inequality in memory area Y3:**

$y > x^2 - 2x - 6$

[▷] [▷] [F1] (Y>)
(Specifies an inequality.)
[X,T] [x^2] [−] [2] [X,T] [−] [6]
(Inputs expression.)

[EXE]
(Stores expression.)



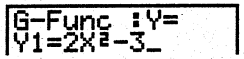
■ Editing Functions in Memory

•To edit a function in memory

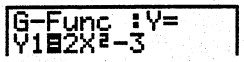
Example **To change the expression in memory area Y1 from $y = 2x^2 - 5$ to $y = 2x^2 - 3$**

▶
(Displays cursor.)

▶▶▶▶3
(Changes contents.)

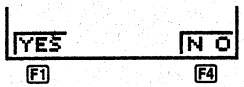


EXE
(Stores new graph function.)



•To delete a function

1. While the Graph Function Menu is on the display, press ▲ or ▼ to display the cursor and move the highlighting to the area that contains the function you want to delete.
2. Press F2 (DEL).



3. Press F1 (YES) to delete the function for F4 (NO) to abort the procedure without deleting anything.

■ Drawing a Graph

Before actually drawing a graph, you should first make the draw/non-draw status.

•To specify the draw/non-draw status of a graph

You can specify which functions out of those stored in memory should be used for a draw operation.

- Graphs for which there is no draw/non-draw status specification are not drawn.

Example **To select the following functions for drawing:**

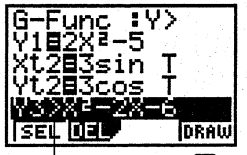
Y1 : $y = 2x^2 - 5$
Xt2: $x = 3 \sin T$
Yt2: $y = 3 \cos T$

Use the following View Window parameters.

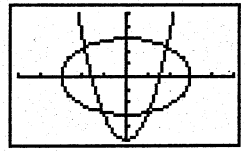
Xmin	= –5	Ymin	= –5
Xmax	= 5	Ymax	= 5
Xscl	= 1	Yscl	= 1

▼▼▼
(Select a memory area that contains a function for which you want to specify non-draw.)

F1 (SEL)
(Specify non-draw.)



F4 (DRAW) or EXE
(Draws graphs.)



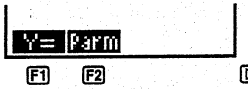
- Pressing G↔T or AC returns to the Graph Function Menu.

- A parametric graph will appear coarse if the settings you make in the View Window cause the pitch value to be too large, relative to the differential between the min and max settings. If the settings you make cause the pitch value to be too small relative to the differential between the min and max settings, on the other hand, the graph will take a very long time to draw.

4. Drawing Graphs Manually

After you select the **RUN** icon in the Main Menu and enter the RUN Mode, you can draw graphs manually. First press SHIFT F4 (SKTCH) F2 (GRPH) to recall the Graph Command Menu, and then input the graph function.

SHIFT F4 (SKTCH) F2 (GRPH)



F1 (Y =) ..... Rectangular coordinate graph
F2 (Parm) ..... Parametric graph

▷

F1 F2 F3 F4 ▷

F1 (Y >) ..... Y > $f(x)$ inequality
F2 (Y <) ..... Y < $f(x)$ inequality
F3 (Y ≥) ..... Y ≥ $f(x)$ inequality
F4 (Y ≤) ..... Y ≤ $f(x)$ inequality

Press ▷ to return to the previous menu.

•To graph using rectangular coordinates (Y =)

You can graph functions that can be expressed in the format $y = f(x)$.

Example **To graph $y = 2x^2 + 3x - 4$**

Use the following View Window parameters.

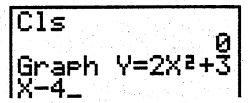
Xmin	**= –5**	**Ymin**	**= –10**
Xmax	**= 5**	**Ymax**	**= 10**
Xscl	**= 2**	**Yscl**	**= 5**

1. In the set-up screen, specify the appropriate graph type for F-Type.

   SHIFT SETUP F1 (Y =) QUIT

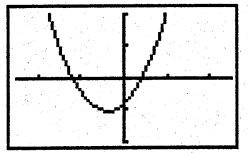
2. Input the rectangular coordinate (Y =) expression.

   AC SHIFT F4 (SKTCH) F1 (Cls) EXE
   F2 (GRPH) F1 (Y =)
   2 X,T x^2 + 3 X,T − 4



3. Press EXE to draw the graph.

   EXE



- You can draw graphs of the following built-in scientific functions.

• $\sin x$	• $\cos x$	• $\tan x$	• $\sin^{-1} x$	• $\cos^{-1} x$
• $\tan^{-1} x$	• $\sqrt{x}$	• x^2	• $\log x$	• $\ln x$
• 10^x	• e^x	• x^{-1}	• $\sqrt[3]{x}$	

View Window settings are made automatically for built-in graphs.

•To graph parametric functions

You can graph parametric functions that can be expressed in the following format.

(X, Y) = (f(T), g(T))

Example **To graph the following parametric functions:**

$x = 7\cos T - 2\cos 3T$
$y = 7\sin T - 2\sin 3T$

Use the following View Window parameters.

Xmin	**= –20**	**Ymin**	**= –12**
Xmax	**= 20**	**Ymax**	**= 12**
Xscl	**= 5**	**Yscl**	**= 5**
Tmin	**= 0**	**Tmax**	**= 2π**
Tptch	**= π÷36**		

1. In the set-up screen, specify the appropriate graph type for F-Type.

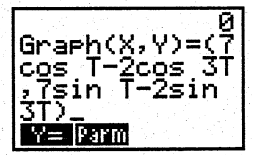
   SHIFT SETUP F2 (Parm)

2. Set the default angle unit to radians (Rad).

   ▼ ▼ F2 (Rad) QUIT

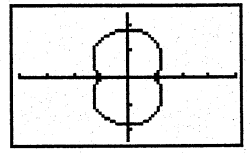
3. Input the parametric functions.

   AC SHIFT F4 (SKTCH) F1 (Cls) EXE
   F2 (GRPH) F2 (Parm)
   7 cos X,T − 2 cos 3 X,T ,
   7 sin X,T − 2 sin 3 X,T)



4. Press EXE to draw the graph.

   EXE



•To graph inequalities

You can graph inequalities that can be expressed in the following four formats.

- $y > f(x)$
- $y < f(x)$
- $y \geq f(x)$
- $y \leq f(x)$

Example **To graph the inequality $y > x^2 - 2x - 6$**

Use the following View Window parameters.

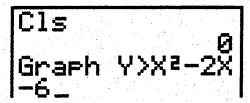
Xmin	= –6	Ymin	= –10
Xmax	= 6	Ymax	= 10
Xscl	= 1	Yscl	= 5

1. In the set-up screen, specify the appropriate graph type for F-Type.

   [SHIFT] [SETUP] [▷] [F1] (Y>) [QUIT]

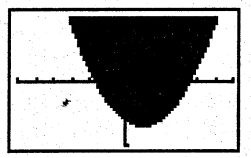
2. Input the inequality.

   [AC] [SHIFT] [F4] (SKTCH) [F1] (Cls) [EXE]
   [F2] (GRPH) [▷] [F1] (Y>)
   [X,T] [x^2] [−] [2] [X,T] [−] [6]



3. Press [EXE] to draw the graph.

   [EXE]



5. Other Graphing Functions

The functions described in this section tell you how to read the x- and y-coordinates at a given point, and how to zoom in and zoom out on a graph.

- These functions can be used with rectangular coordinate, parametric, and inequality graphs only.

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■ Connect Type and Plot Type Graphs (D-Type)

You can use the D-Type setting of the set-up screen to specify one of two graph types.

- Connect type (Conct)

  Points are plotted and connected by lines to create a curve.
- Plot

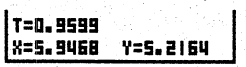
  Points are plotted without being connected.

■ Trace

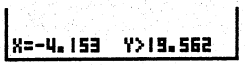
With trace, you can move a flashing pointer along a graph with the [▲], [▼], [◀], and [▶] cursor keys and obtain readouts of coordinates at each point. The following shows the different types of coordinate readouts produced by trace.

- Rectangular Coordinate Graph

- Parametric Function Graph



- Inequality Graph



•To use trace to read coordinates

Example **To determine the points of intersection for graphs produced by the following functions:**

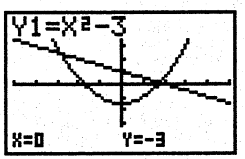
Y1: $y = x^2 - 3$
Y2: $y = -x + 2$

Use the following View Window parameters.

Xmin	= –5	Ymin	= –10
Xmax	= 5	Ymax	= 10
Xscl	= 1	Yscl	= 2

1. After drawing the graphs, press [F1] (TRCE) to display the pointer in the center of the graph.

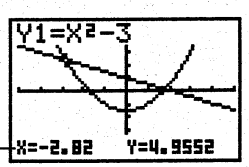
   [F1] (TRCE)



- The pointer may not be visible on the graph when you press [F1] (TRCE).

2. Use [◀] to move the pointer to the first intersection.

   [◀] ~ [◀]

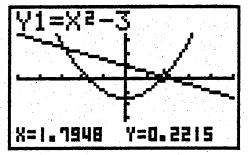


x/y coordinate values

- Pressing ◀ and ▶ moves the pointer along the graph. Holding down either key moves the pointer at high speed.

3. Use ▲ and ▼ to move the pointer between the two graphs.
4. Use ▶ to move the pointer to the other intersection.

▶ ~ ▶



- To quit the trace operation, press F1 (TRCE) again.

•Scrolling

When the graph you are tracing runs off the display along either the x- or y-axis, pressing the ▶ or ◀ cursor key causes the screen to scroll in the corresponding direction eight dots.

- You can scroll only rectangular coordinate and inequality graphs while tracing. You cannot scroll parametric function graphs.

- Trace can be used only immediately after a graph is drawn. It cannot be used after changing the settings of a graph.
- You cannot incorporate trace into a program.
- You can use trace on a graph that was drawn as the result of an output command (◢), which is indicated by the "-Disp-" indicator on the screen.

■ Scroll

You can scroll a graph along its x- or y-axis. Each time you press ▲, ▼, ◀, or ▶, the graph scrolls 12 dots in the corresponding direction.

■ Overwrite

Using the following syntax to input a graph causes multiple versions of the graph to be drawn using the specified values. All versions of the graph appear on the display at the same time.

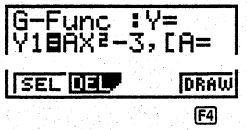
<function with one variable> , SHIFT [<variable name> SHIFT =
<value> , <value> , ... <value> SHIFT] EXE

Example **To graph $y = Ax^2 - 3$, substituting 3, 1, and –1 for the value of A**

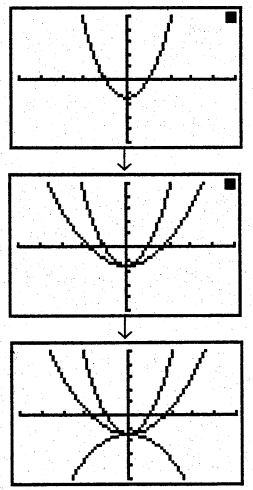
Use the following View Window parameters.

Xmin	= –5	Ymin	= –10
Xmax	= 5	Ymax	= 10
Xscl	= 1	Yscl	= 2

▷ F1 (Y =)
(Specifies graph type.)
ALPHA A X,T x² − 3 ,
SHIFT [ALPHA A SHIFT = 3 ,
1 , (↔) 1 SHIFT] EXE
(Stores expression.)



F4 (DRAW) or EXE
(Draws graph.)



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- The function that is input using the above syntax can have only one variable.
- You cannot use X, Y or T as the variable name.
- You cannot assign a variable to the variable in the function.
- When the set-up screen's Simul-G item is set to "**On**," the graphs for all the variables are drawn simultaneously.

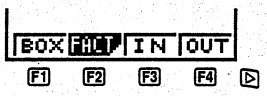
■ Zoom

The zoom feature lets you enlarge and reduce a graph on the display.

•Before using zoom

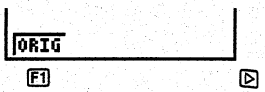
Immediately after drawing a graph, press [SHIFT] [F2] (ZOOM) to display the Zoom Menu.

[SHIFT] [F2] (ZOOM)



[F1] (BOX) ..... Graph enlargement using box zoom
[F2] (FACT) ..... Displays screen for specification of zoom factors
[F3] (IN) ..... Enlarges graph using zoom factors
[F4] (OUT) ..... Reduces graph using zoom factors

[▷]



[F1] (ORIG) ..... Original size

Press [▷] to return to the previous menu

•To use box zoom

With box zoom, you draw a box on the display to specify a portion of the graph, and then enlarge the contents of the box.

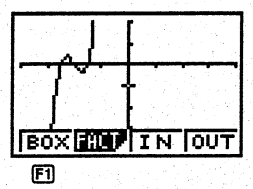
Example **To use box zoom to enlarge a portion of the graph $y = (x + 5)(x + 4)(x + 3)$**

Use the following View Window parameters.

Xmin	**= −8**	**Ymin**	**= −4**
Xmax	**= 8**	**Ymax**	**= 2**
Xscl	**= 2**	**Yscl**	**= 1**

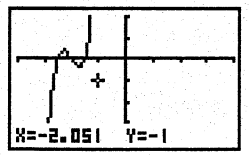
1. After graphing the function, press [SHIFT] [F2] (ZOOM).

[SHIFT] [F2] (ZOOM)



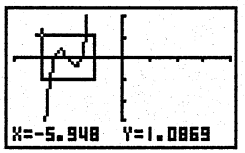
2. Press [F1] (BOX), and then use the cursor keys (◀, ▶, ▲, ▼) to move the pointer to the location of one of the corners of the box you want to draw on the screen. Press [EXE] to specify the location of the corner.

[F1] (BOX)
◀ ~ ◀ [EXE]



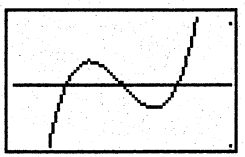
3. Use the cursor keys to move the pointer to the location of the corner that is diagonally across from the first corner.

▲ ~ ▲ ◀ ~ ◀



4. Press [EXE] to specify the location of the second corner. When you do, the part of the graph inside the box is immediately enlarged so it fills the entire screen.

[EXE]



• To return to the original graph, press [F2] (ZOOM) [▷] [F1] (ORIG).

• Nothing happens if you try to locate the second corner at the same location or directly above the first corner.
• You can use box zoom for any type of graph.

•To use factor zoom

With factor zoom, you can zoom in or zoom out on the display, with the current pointer location being at the center of the new display.

• Use the cursor keys (◀, ▶, ▲, ▼) to move the pointer around the display.

Example **Graph the two functions below, and enlarge them five times in order to determine whether or not they are tangential:**

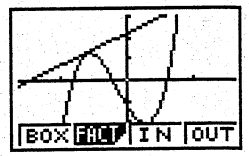
Y1: $y = (x + 4)(x + 1)(x - 3)$
Y2: $y = 3x + 22$

Use the following View Window parameters.

Xmin	= –8	Ymin	= –30
Xmax	= 8	Ymax	= 30
Xscl	= 5	Yscl	= 10

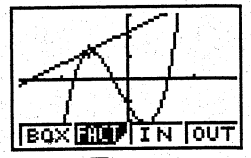
1. After graphing the functions, press [SHIFT] [F2] (ZOOM), and the pointer appears on the screen.

[SHIFT] [F2] (ZOOM)



2. Use the cursor keys (◀, ▶, ▲, ▼) to move the pointer to the location that you want to be the center of the new display.

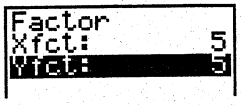
◀ ~ ◀ ▲ ~ ▲



[F2]

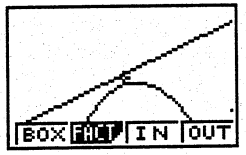
3. Press [F2] (FACT) to display the factor specification screen, and input the factor for the x- and y-axes.

[F2] (FACT)
[5] [EXE] [5] [EXE]



4. Press [QUIT] to return to the graphs, and then press [F3] (IN) to enlarge them.

[QUIT] [F3] (IN)



This enlarged screen makes it clear that the graphs of the two expressions are not tangential.

- Note that the above procedure can also be used to reduce the size of a graph (zoom out). In step 4, press [F4] (OUT).

- The above procedure automatically converts the x-range and y-range View Window values to 1/5 of their original settings.
- You can repeat the factor zoom procedure more than once to further enlarge or reduce the graph.

•To initialize the zoom factor

Press [SHIFT] [F2] (ZOOM) [F2] (FACT) [F1] (INIT) to initialize the zoom factor to the following settings.

Xfct = 2 Yfct = 2

- You can use the following syntax to incorporate a factor zoom operation into a program.

  Factor <X factor>, <Y factor>
- You can use factor zoom for any type of graph.

■ Sketch Function

The sketch function lets you draw lines and graphs on an existing graph.

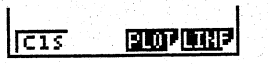
- Note that Sketch function operation in the **STAT, GRAPH** or **TABLE Mode** is different from Sketch function operation in the **RUN** or **PRGM Mode**.

•Before using the Sketch Function

Press [SHIFT] [F4] (SKTCH) to display the sketch menu.

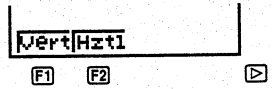
In the STAT, GRAPH or TABLE Mode

[SHIFT] [F4] (SKTCH)



[F1] (Cls) ..... Clears drawn line and point
[F3] (PLOT) ..... Displays plot menu
[F4] (LINE) ..... Displays line menu

▷

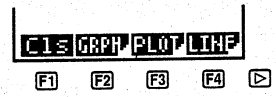


[F1] (Vert) ..... Vertical line
[F2] (Hztl) ..... Horizontal line

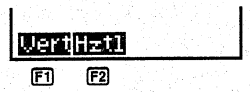
Press ▷ to return to the previous menu

In the RUN or PRGM Mode

[SHIFT] [F4] (SKTCH)



▷



- Other menu items are identical to those in the STAT, GRAPH, TABLE Mode menu.

The Sketch function lets you draw lines and plot points on a graph that is already on the screen.

All the examples in this section that show operations in the STAT, GRAPH or TABLE Mode are based on the assumption that the following function has already been graphed in the **GRAPH Mode**.

Memory Area Y1: $y = x(x + 2)(x - 2)$

The following are the View Window parameters used when drawing the graph.

Xmin	= −5	Ymin	= −5
Xmax	= 5	Ymax	= 5
Xscl	= 1	Yscl	= 1

•To plot points

In the STAT, GRAPH or TABLE Mode

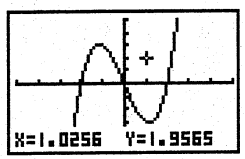
Example **To plot a point on the graph of $y = x(x + 2)(x - 2)$**

1. After graphing the function, display the sketch menu and perform the following operation to cause the pointer to appear on the graph screen.

   SHIFT F4 (SKTCH) F3 (PLOT) F1 (Plot)

2. Use the cursor keys (▲, ▼, ◀, ▶) to move the pointer the locations of the points you want to plot and press EXE to plot.
   - You can plot as many points as you want.

   ▶ ~ ▶▲ ~ ▲
   EXE



- The current x- and y-coordinate values are assigned respectively to variables X and Y.

In the RUN or PRGM Mode

The following is the syntax for plotting points in these modes.

Plot <x-coordinate>, <y-coordinate>

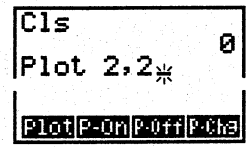
Example **To plot a point at (2, 2)**

Use the following View Window parameters.

Xmin	**= −5**	**Ymin**	**= −10**
Xmax	**= 5**	**Ymax**	**= 10**
Xscl	**= 1**	**Yscl**	**= 2**

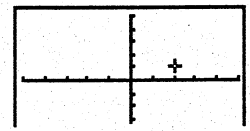
1. After entering the RUN Mode, display the sketch menu and perform the following operation.

   SHIFT F4 (SKTCH) F1 (Cls) EXE
   F3 (PLOT) F1 (Plot) 2 , 2



2. Press EXE.

   EXE EXE



- You can use the cursor keys (▲, ▼, ◀, ▶) to move the pointer around the screen.

- If you do not specify coordinates, the pointer is located in the center of the graph screen when it appears on the display.
- If the coordinates you specify are outside the range of the View Window parameters, the pointer will not be on the graph screen when it appears on the display.
- The current x- and y-coordinate values are assigned respectively to variables X and Y.

•To turn plot points on and off in the STAT, GRAPH and TABLE Modes

• To turn a plot point on

1. After drawing a graph, display the sketch menu and then perform the following operation to make the pointer appear at the center of the screen.

   [SHIFT] [F4] (SKTCH) [F3] (PLOT) [F2] (P-On)

2. Use the cursor keys (▲, ▼, ◀, ▶) to move the pointer to the location where you want to plot a point and then press [EXE].

• To turn a plot point off

Perform the same procedure as described under "To turn a plot point on" above, except press [F3] (P-Off) in place of [F2] (P-On).

• To change the on/off status of a plot point

Perform the same procedure as described under "To turn a plot point on" above, except press [F4] (P-Chg) in place of [F2] (P-On).

•To turn plot points on and off in the RUN or PRGM Mode

The following are the syntax for turning plot points on and off in these modes.

• To turn a plot point on

PlotOn <*x*-coordinate>, <*y*-coordinate>

• To turn a plot point off

PlotOff <*x*-coordinate>, <*y*-coordinate>

• To change the on/off status of a plot point

PlotChg <*x*-coordinate>, <*y*-coordinate>

•To draw a line between two plotted points

In the STAT, GRAPH or TABLE Mode

Example **To draw a line between the two points of inflection on the graph of $y = x(x + 2)(x - 2)$**

Use the same View Window parameters as in the example on page 66.

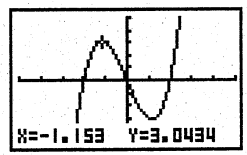
1. After graphing the function, display the sketch menu and perform the following operation to cause the pointer to appear on the graph screen.

   [SHIFT] [F4] (SKTCH) [F3] (PLOT) [F1] (Plot)

2. Use the cursor keys (▲, ▼, ◀, ▶) to move the pointer to one of the points of inflection and press [EXE] to plot it.

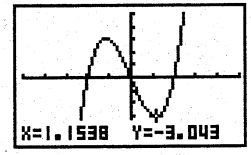
   ◀ ~ ◀▲ ~ ▲

   [EXE]



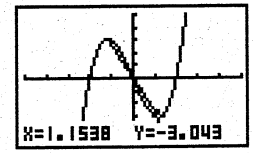
3. Use the cursor keys to move the pointer to the other point of inflection.

   ▶ ~ ▶▼ ~ ▼



4. Display the sketch menu and perform the following operation to draw a line between the two points.

   [SHIFT] [F4] (SKTCH) [F4] (LINE) [F1] (Line)



•To draw a line in the STAT, GRAPH and TABLE Modes

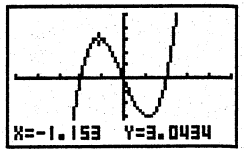
Example **To draw a line between two points of inflection on the graph of $y = x(x + 2)(x - 2)$**

1. After graphing the function, display the sketch menu and perform the following operation to cause the pointer to appear on the graph screen.

   SHIFT F4 (SKTCH) F4 (LINE) F2 (F-Lin)

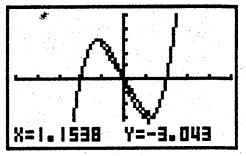
2. Use the cursor keys (▲, ▼, ◀, ▶) to move the pointer to one of the points of inflection and press EXE.

   ◀ ~ ◀ ▲ ~ ▲
   EXE



3. Use the cursor keys to move the pointer to the other point of inflection and press EXE to draw the line.

   ▶ ~ ▶ ▼ ~ ▼
   EXE



•To draw a line in the RUN or PRGM Mode

The following is the syntax for drawing lines in these modes.

F-Line <x-coordinate 1>, <y-coordinate 1>, <x-coordinate 2>, <y-coordinate 2>

In the RUN or PRGM Mode

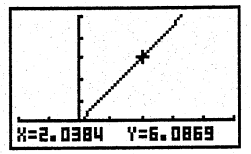
Example **To draw a line perpendicular to the x-axis from point $(x, y) = (2, 6)$ on the graph $y = 3x$**

Use the following View Window parameters:

Xmin	= −2	Ymin	= −2
Xmax	= 5	Ymax	= 10
Xscl	= 1	Yscl	= 2

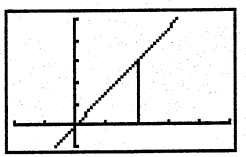
1. After drawing the graph, use the procedure under "To plot points" to move the pointer to $(x, y) = (2, 0)$, then use the cursor key (▲) to move the pointer on the graph $y = 3x$.

   SHIFT F4 (SKTCH) F3 (PLOT) F1 (Plot)
   2 , 0 EXE EXE ▲ ~ ▲



2. Display the sketch menu and perform the following operation to draw a straight line between the two points.

   G⇔T
   SHIFT F4 (SKTCH) F4 (LINE) F1 (Line) EXE



- The above draws a straight line between the current pointer location and the previous pointer location.

•To draw vertical and horizontal lines

The procedures presented here draw vertical and horizontal lines that pass through a specific coordinate.

In the STAT, GRAPH or TABLE Mode

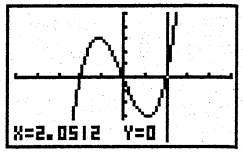
Example **To draw a vertical line on the graph of $y = x(x + 2)(x - 2)$**

1. After graphing the function, display the sketch menu and perform the following operation to display the pointer and draw a vertical line through its current location.

   SHIFT F4 (SKTCH) ▷ F1 (Vert)

2. Use the ◀ and ▶ cursor keys to move the line left and right, and press EXE to draw the line at the current location.

▶ ~ ▶ EXE



• To draw a horizontal line, simply press F2 (Hztl) in place of F1 (Vert), and use the ▲ and ▼ cursor keys to move the horizontal line on the display.

In the RUN or PRGM Mode

The following is the syntax for drawing vertical and horizontal lines in these modes.

• To draw a vertical line

Vertical <*x*-coordinate>

• To draw a horizontal line

Horizontal <*y*-coordinate>

•To clear drawn lines and points

The following operation clears all drawn lines and points from the screen.

In the STAT, GRAPH or TABLE Mode

Lines and points drawn using sketch menu functions are temporary. Display the sketch menu and press F1 (Cls) to clear drawn lines and points, leaving only the original graph.

In the RUN or PRGM Mode

The following is the syntax for clearing drawn lines and points, as well as the graph itself.

Cls

Chapter 5

5

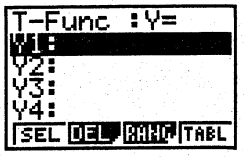
Table & Graph

The Table & Graph menu makes it possible to generate numeric tables from functions stored in memory. You can also use multiple functions to generate tables. Since Table & Graph uses the same list of functions that the GRAPH Mode uses for graphing, there is no need to input the same functions in different modes.

- You can specify the range and increment of values assigned to variables for table value generation.
- You can assign list values to variables.
- In addition to graphing of stored functions, you can also plot table values generated by Table & Graph itself.
- Table values can be assigned to a list.

1. **Storing a Function**
2. **Deleting a Function**
3. **Assigning Values to a Variable**
4. **Generating a Numeric Table**
5. **Editing a Table**
6. **Graphing a Function**
7. **Assigning Numeric Table Contents to a List**

To enter the Table Mode, press [MENU] to display the Main Menu, use the cursor keys to select the **TABLE** icon, and then press [EXE].



This is the initial Table Mode screen. To generate a table, you must first specify the variable range.

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The menu at the bottom of the display looks like the one shown here when the Var item of the set-up screen is set to a list name (indicating that variable values should be obtained from a list).

1. Storing a Function

Example **To store the function $y = 3x^2 - 2$ in memory area Y1**

Use ▲ and ▼ to move the highlighting in the TABLE Mode function list to the memory area where you want to store the function. Next, input the function and press [EXE] to store it.

2. Deleting a Function

Use ▲ and ▼ to move the highlighting to the memory area that contains the function you want to delete.

Press [F2] (DEL).

Press [F1] (YES) to delete the selected function or [F4] (NO) to abort the delete operation without deleting anything.

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The procedures for storing and deleting functions are identical to those used in the GRAPH Mode.

3. Assigning Values to a Variable

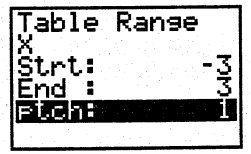
You can use either one of two methods to assign values to a variable: automatic assignment within a specified range, and assignment of values from a list. The standard default method is automatic assignment within a specified range.

•To assign values automatically within a specified range

Example **To assign values from –3 to 3, in increments of 1 (seven values total)**

[F3](RANG)

[←] 3 [EXE] 3 [EXE] 1 [EXE]



Strt: ..... Variable x start value

End: ..... Variable x end value

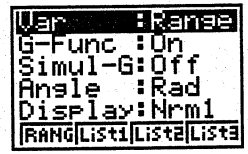
ptch: ..... Variable x value change

To interrupt automatic assignment of variables and return to the function storage screen, press [QUIT].

•To assign values from a list

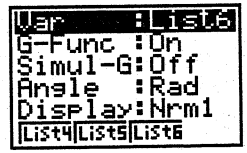
Press [SHIFT] [SETUP] to display the set-up screen.

[SHIFT] [SETUP]



If necessary, you can press [▷] to display a menu of other lists (4, 5, 6). The following shows the operation required to select List 6.

[▷] [F3](List6)



[F3]

After making the set-up screen setting you want, press [QUIT] to return to the Function List. Note that the [RANG] item does not appear in the function key menu at the bottom of the screen when a list is selected for assignment of variable values.

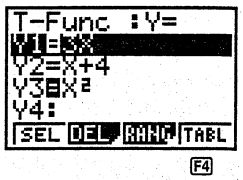
4. Generating a Numeric Table

Before actually generating a numeric table, you must first select the functions you want to use.

Use the ▲ and ▼ cursor keys to move the highlighting to the function you want to use and then press [F1] (SEL) to select it.

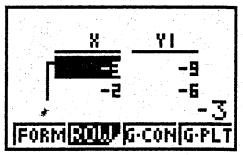
The "=" symbols of selected functions are highlighted on the display. You can select more than one function for table generation.

In this display, Y1 and Y3 are selected.



[F4]

Press [F4] (TABL) or [EXE] to generate a numeric table.



- In this example, values are assigned automatically.

This display shows the generated numeric table. Though this example display shows only the values for function Y1, values for function Y3 were also generated.

Each cell can hold up to six digits (negative sign takes up one digit).

You can move the cursor around the table using the cursor (▲, ▼, ◀, ▶) keys.

The following points apply to cursor position and movement.

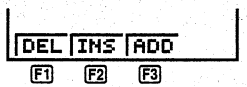
- The value contained in the currently selected cell appears at the bottom of the display, with all current display attributes (number of decimal place, number of significant digit, and exponential display range settings) applied.
- Moving the cursor off the screen causes the table to scroll when there are cells off the top, bottom, left, or right .
- When the cursor is located in any function value cell (Y1, Y2, etc.), the function is shown at the top of the display.
- If you change a value in column X, the corresponding function value is automatically updated using the new value for X.

To return to the Function List, press [F1] (FORM).

5. Editing a Table

You can use the editing screen to add lines to or delete lines from an existing table. Press [F2] (ROW) to display the Table Editing Menu.

[F2](ROW)



[F1] (DEL) ..... Deletes line where cursor is located.

[F2] (INS) ..... Inserts new line where cursor is located.

[F3] (ADD) ..... Insert new line below line where cursor is located.

6. Graphing a Function

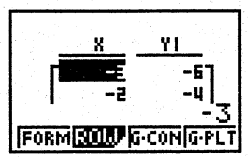
You can use the two following function keys to produce a graph using the numeric table currently on the screen.

[F3] (G-CON) ... Graph with connected plot points

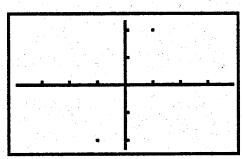
[F4] (G-PLT) ..... Graph with plotted points (unconnected)

- Note that you can also produce a G-PLT ([F4]) graph by pressing [EXE] while a numeric table is on the screen.

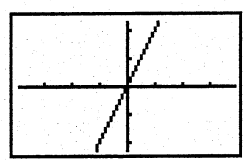
Example **To graph the function Y1 = 2X, whose table of numeric values is currently on the screen**



[F4](G-PLT)



[F3](G-CON)



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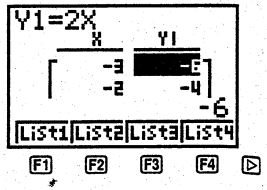
Graphing a table whose values were generated using more than one function causes the graphs of all the functions to be drawn at the same time. You can set *x*- and *y*-axis parameters using the View Window.

Press [G↔T] or [AC] to return to the numeric table screen from a graph. Pressing [G↔T] again goes back to the graph. You can use [G↔T] to switch between the graph and its table as long as you do not clear the graph.

7. Assigning Numeric Table Contents to a List

You can assign a column of values from a table into a list. Simply use [◀] and [▶] to move the cursor into the column whose values you want to copy. The cursor can be in any row of the column. The copy operation is performed by pressing [OPTN] to display the Option Menu, and then pressing [F2] (LMEM).

[OPTN] [F1] (LIST) [F2] (LMEM)



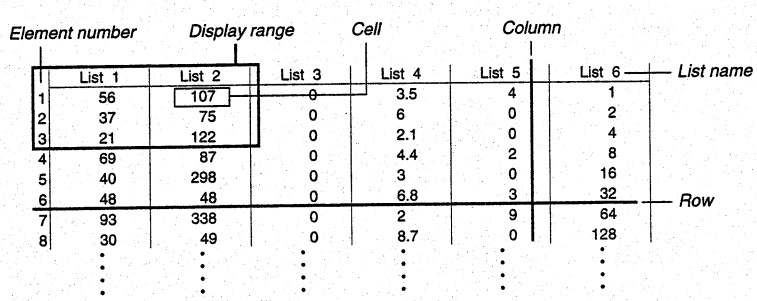
Use the first function menu to copy the column's values to List 1 ([F1]) to List 4 ([F4]). To copy to List 5 or List 6, press [▷] and then [F1] (List 5) or [F2] (List 6).

Chapter 6

List Function

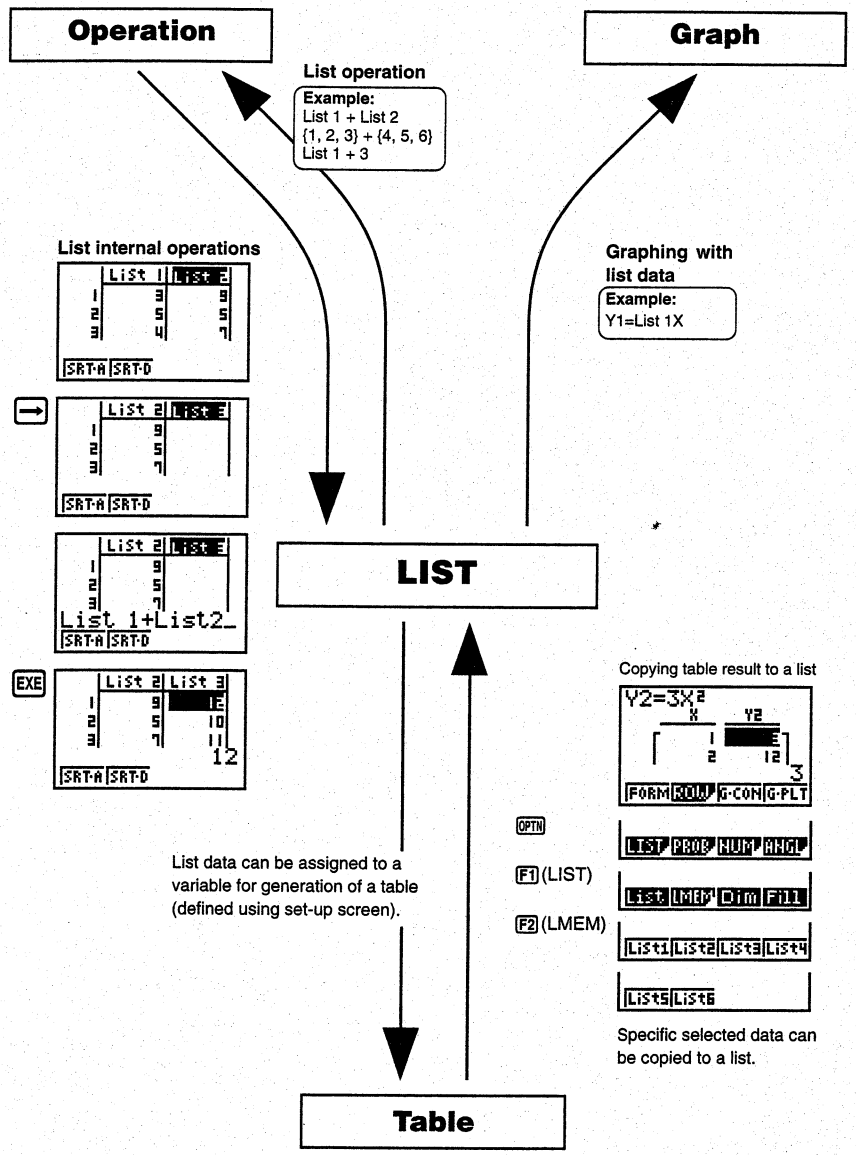
6

A list is a kind of container that you can use to store multiple data items. This calculator lets you have up to six lists in memory, and their contents can be used in arithmetic calculations, statistical calculations and for graphing.



1. **List Operations**
2. **Editing and Rearranging Lists**
3. **Manipulating List Data**
4. **Arithmetic Calculations Using Lists**

■ List Data Linking



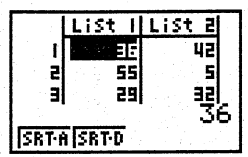
1. List Operations

Select the **LIST** icon in the Main Menu and enter the LIST Mode to input data into a list and to manipulate list data.

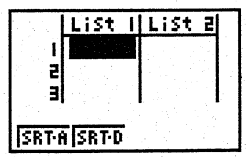
•To input values one-by-one

Use ◀ and ▶ to move between lists, and ▲ and ▼ to move between cells inside of a list.

The screen automatically scrolls when the cursor is located at the edge of the screen.

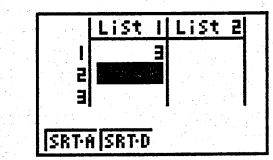


For our example, we will start by locating the cursor in Cell 1 of List 1.



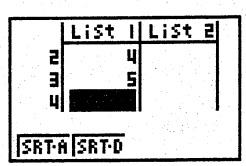
1. Input a value and press EXE to store it in the list.

   3 EXE



2. The cursor automatically moves down to the next cell for input.
   Let's continue our example by inputting the values 4 and 5.

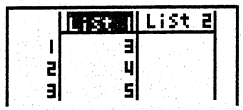
   4 EXE 5 EXE



•To batch input a series of values

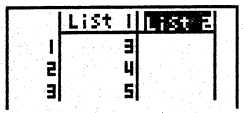
1. Use ▲ to move the cursor to the list name.

▲▲▲▲



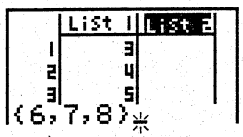
2. Use ◀ or ▶ to move the cursor to another list.

▶



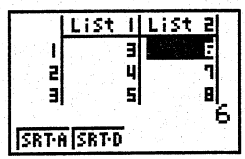
3. Press SHIFT {, and then input the values you want, pressing , between each one. Press SHIFT } after inputting the final value.

SHIFT { 6 , 7 , 8 SHIFT }



4. Press EXE to store all of the values in your list.

EXE



• Remember that a comma separates values, so you should not input a comma after the final value of the set you are inputting.

Right: {34, 53, 78}
Wrong: {34, 53, 78,}

2. Editing and Rearranging Lists

■ Editing List Values

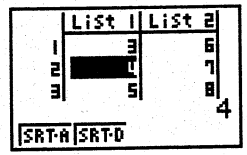
•To change a cell value

Use ◀ or ▶ to move the cursor to the cell whose value you want to change. Input the new value and press EXE to replace the old data with the new one.

•To delete a cell

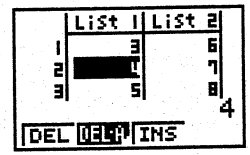
1. Use ◀, ▶, ▲, or ▼ to move the cursor to the cell you want to delete.

▼◀



2. Press ▷ to display the Cell Operation Menu.

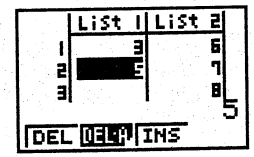
▷



F1

3. Press F1 (DEL) to delete the selected cell and cause everything below it to be shifted up.

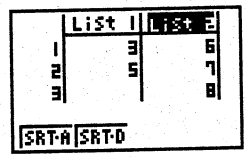
F1(DEL)



• Note that the above cell delete operation does not affect cells in other lists. If the data in the list whose cell you delete is somehow related to the data in neighboring lists, deleting a cell can cause related values to become misaligned.

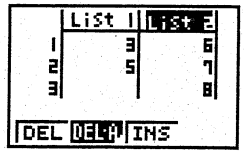
•To delete all cells in a list

1. Use ◀, ▶, ▲ or ▼ to move the cursor to the name of the list whose cells you want to delete.



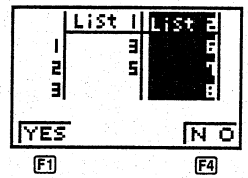
2. Press [▷] to display the Cell Operation Menu (if it is not already displayed).

[▷]



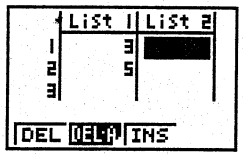
3. Press [F2] (DEL-A). The function menu changes to confirm whether you really want to delete all the cells in the list.

[F2](DEL-A)



4. Press [F1] (YES) to delete all the cells in the selected list or [F4] (NO) to abort the delete operation without deleting anything.

[F1](YES)



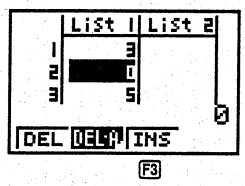
•To insert a new cell

Use [◀], [▶], [▲], or [▼] to move the cursor to the location where you want to insert the new cell. In this example, we will reinsert a cell containing the value 4, which we deleted above.

1. Press [▷] to display the Cell Operation Menu (if it is not already displayed).

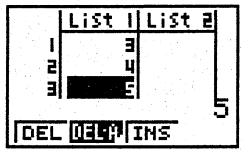
2. Press [F3] (INS) to insert a new cell, which contains a value of 0, causing everything below it to be shifted down.

[F3](INS)



3. Input the value you want into the new cell (4 in our example) and press [EXE].

[4][EXE]



• Note that the above cell insert operation does not affect cells in other lists. If the data in the list where you insert a cell is somehow related to the data in neighboring lists, inserting a cell can cause related values to become misaligned.

■ Sorting List Values

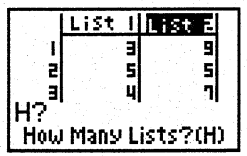
You can sort lists into either ascending order or descending order. The current cursor location does not matter in the following procedures.

•To sort a single list

Ascending order

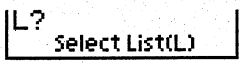
1. While the lists are on the screen, press [▷] to display the Operation Menu and then press [F1] (SRT-A).

[▷][F1](SRT-A)



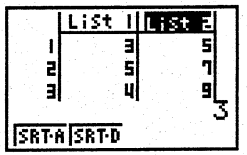
2. The prompt "How Many Lists? (H)" appears to ask how many lists you want to sort. Here we will input 1 to indicate we want to sort only one list.

[1][EXE]



3. In response to the "Select List (L)" prompt, input the number of the list you want to sort. Here we will input 2 to specify sorting of List 2.

[2][EXE]



The values in List 2 are sorted into ascending order.

Descending order

Use the same procedure as that for the ascending order sort. The only difference is that you should press [F2] (SRT-D) in place of [F1] (SRT-A).

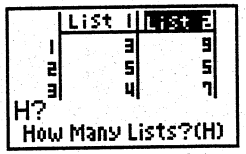
•To sort multiple lists

You can link multiple lists together for a sort so that all of their cells are rearranged in accordance with the sorting of a base list. The base list is sorted into either ascending order or descending order, while the cells of the linked lists are arranged so that the relative relationship of all the rows is maintained.

Ascending order

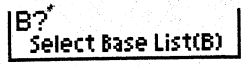
1. While the lists are on the screen, press [F1] (SRT-A).

[F1](SRT-A)



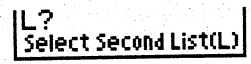
2. The prompt "How Many Lists? (H)" appears to ask how many lists you want to sort. Here we will sort one base list linked to one other list, so we should input 2.

[2] [EXE]



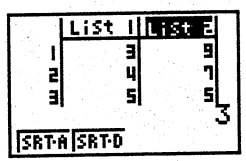
3. In response to the "Select Base List (B)" prompt, input the number of the list you want to sort into ascending order. Here we will specify List 1.

[1] [EXE]



4. In response to the "Select Second List (L)" prompt, input the number of the list you want to link to the base list. Here we will specify List 2.

[2] [EXE]



The values in List 1 are sorted into ascending order, and the cells of List 2 are also rearranged to keep the same relationship with the List 1 cells.

Descending order

Use the same procedure as that for the ascending order sort. The only difference is that you should press [F2] (SRT-D) in place of [F1] (SRT-A).

3. Manipulating List Data

List data can be used in arithmetic and function calculations. There is also a collection of powerful list data manipulation functions that let you do the following.

- Count the number values (Dim)
- Replace all cell values with the same value (Fill)
- Generate a sequence of numbers (Seq)
- Find the minimum value in a list (Min)
- Find the maximum value in a list (Max)
- Find which of two lists contains the smallest value (Min)
- Find which of two lists contains the greatest value (Max)
- Calculate the mean of list values (Mean)
- Calculate the mean of values of specified frequency (Mean)
- Calculate the median of values in a list (Med)
- Calculate the median of values of specifies frequency (Med)
- Calculate the sum of values in a list (Sum)

You can use list data manipulation functions in the **RUN**, **STAT**, **LIST**, **TABLE**, or **PRGM Mode**.

■ Accessing the List Data Manipulation Function Menu

All of the following examples are performed after entering the **RUN Mode**.

Press [OPTN] and then [F1] (LIST). This menu has three pages and you can advance to the next page by pressing [▷].

Note that all closing parentheses at the end of the following operations can be omitted.

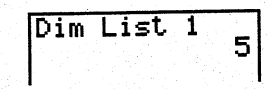
•To count the number of values (Dim)

[OPTN] [F1](LIST) [F3](Dim) [F1](List) <list number 1-6> [EXE]

- The number of cells that contain data in a list is called its "dimension."

Example **To enter the RUN Mode and count the number of values in List 1 (36, 16, 58, 46, 56)**

[AC] [OPTN] [F1](LIST) [F3](Dim)
[F1](List) [1] [EXE]

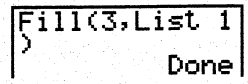


•To replace all cell values with the same value (Fill)

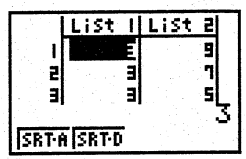
OPTN F1 (LIST) F4 (Fill) <value> ▸ F1 (List) <list number 1-6>) EXE

Example **To replace all values in List 1 (36, 16, 58, 46, 56) with 3**

AC OPTN F1 (LIST) F4 (Fill)
3 ▸ F1 (List) 1) EXE



The following shows the new contents of List 1.



•To generate a sequence of numbers (Seq)

OPTN F1 (LIST) ▷ F1 (Seq) <expression> ▸ <variable name> ▸ <start value> ▸ <end value> ▸ <pitch>) EXE

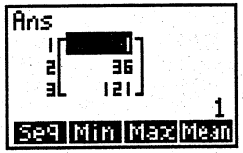
- The result of this operation is also stored in Ans Memory.

Example **To input the number sequence 1^2, 6^2, 11^2 into a list**

Use the following settings.
Variable: x
Starting value: 1
Ending value: 11
Pitch: 5

AC OPTN F1 (LIST) ▷ F1 (Seq)
X,T x² ▸ X,T ▸ 1 ▸ 1 1 ▸ 5)

EXE



Specifying an ending value of 12, 13, 14, or 15 produces the same result as shown above, because all of them are less than the value produced by the next increment (16).

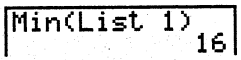
The resulting sequence is input into Ans Memory.

•To find the minimum value in a list (Min)

OPTN F1 (LIST) ▷ F2 (Min) ▷ ▷ F1 (List) <list number 1-6>) EXE

Example **To find the minimum value in List 1 (36, 16, 58, 46, 56)**

AC OPTN F1 (LIST) ▷ F2 (Min)
▷ ▷ F1 (List) 1) EXE



•To find the maximum value in a list (Max)

Use the same procedure as when finding the minimum value, except press F3 (Max) in place of F2 (Min).

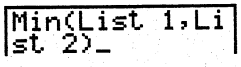
•To find which of two lists contains the smallest value (Min)

OPTN F1 (LIST) ▷ F2 (Min) ▷ ▷ F1 (List) <list number 1-6> ▸
F1 (List) <list number 1-6>) EXE

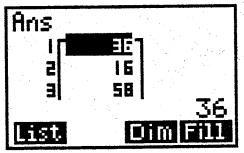
- The two lists must contain the same number of values. If they don't, an error (Dim ERROR) occurs.
- The result of this operation is also stored in Ans Memory.

Example **To find whether List 1 (75, 16, 98, 46, 56) or List 2 (36, 89, 58, 72, 67) contains the smallest value**

AC OPTN F1 (LIST) ▷ F2 (Min)
▷ ▷ F1 (List) 1 ▸
F1 (List) 2)



EXE



•To find which of two lists contains the greatest value (Max)

Use the same procedure as that for the smallest value, except press F3 (Max) in place of F2 (Min).

- The two lists must contain the same number of values. If they don't, an error (Dim ERROR) occurs.

•To calculate the mean of list values (Mean)

OPTN F1 (LIST) ▷ F4 (Mean) ▷ ▷ F1 (List) <list number 1-6>) EXE

Example **To calculate the mean of values in List 1 (36, 16, 58, 46, 56)**

AC OPTN F1 (LIST) ▷ F4 (Mean)
▷ ▷ F1 (List) 1) EXE

```
Mean(List 1)
              42.4
```

•To calculate the mean of values of specified frequency (Mean)

This procedure uses two lists: one that contains values and one that contains the number of occurrences of each value. The frequency of the data in Cell 1 of the first list is indicated by the value in Cell 1 of the second list, etc.

- The two lists must contain the same number of values. If they don't, an error (Dim ERROR) occurs.

OPTN F1 (LIST) ▷ F4 (Mean) ▷ ▷ F1 (List) <list number 1-6(data)>
, F1 (List) <list number 1-6 (frequency)>) EXE

Example **To calculate the mean of values in List 1 (36, 16, 58, 46, 56), whose frequency is indicated by List 2 (75, 89, 98, 72, 67)**

AC OPTN F1 (LIST) ▷ F4 (Mean)
▷ ▷ F1 (List) 1 , F1 (List) 2) EXE

```
Mean(List 1,L
ist 2)
  42.07481297
```

•To calculate the median of values in a list (Med)

OPTN F1 (LIST) ▷ ▷ F1 (Med) ▷ F1 (List) <list number 1-6>) EXE

Example **To calculate the median of values in List 1 (36, 16, 58, 46, 56)**

AC OPTN F1 (LIST) ▷ ▷ F1 (Med)
▷ F1 (List) 1) EXE

```
Median(List 1
)
              46
```

•To calculate the median of values of specified frequency (Med)

This procedure uses two lists: one that contains values and one that contains the number of occurrences of each value. The frequency of the data in Cell 1 of the first list is indicated by the value in Cell 1 of the second list, etc.

- The two lists must contain the same number of values. If they don't, an error (Dim ERROR) occurs.

OPTN F1 (LIST) ▷ ▷ F1 (Med) ▷ F1 (List) <list number 1-6 (data)>
, F1 (List) <list number 1-6 (frequency)>) EXE

Example **To calculate the median of values in List 1 (36, 16, 58, 46, 56), whose frequency is indicated by List 2 (75, 89, 98, 72, 67)**

AC OPTN F1 (LIST) ▷ ▷ F1 (Med)
▷ F1 (List) 1 , F1 (List) 2) EXE

```
Median(List 1
,List 2)
              46
```


•To calculate the sum of values in a list (Sum)

OPTN F1 (LIST) ▷ ▷ F2 (Sum) ▷ F1 (List) <list number 1-6> EXE

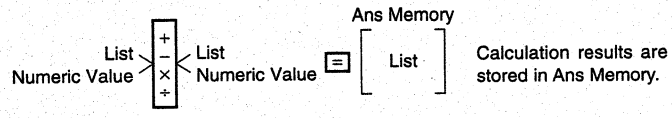
Example **To calculate the sum of values in List 1 (36, 16, 58, 46, 56)**

AC OPTN F1 (LIST) ▷ ▷ F2 (Sum)
▷ F1 (List) 1 EXE

```
Sum List 1
              212
```

4. Arithmetic Calculations Using Lists

You can perform arithmetic calculations using two lists or one list and a numeric value.



■ Error Messages

- A calculation involving two lists performs the operation between corresponding cells. Because of this, a Dim ERROR occurs if the two lists do not have the same number of values (which means they have different "dimensions").
- An Ma ERROR occurs whenever an operation involving any two cells generates a mathematical error.

■ Inputting a List into a Calculation

There are two methods you can use to input a list into a calculation.

•To input a specific list by name

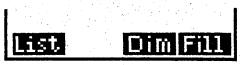
Example **To input List 6**

1. Press OPTN to display the first Operation Menu.
   - This is the function key menu that appears in the **RUN** or **PRGM Mode** when you press OPTN.

OPTN

2. Press [F1] (LIST) to display the List Data Manipulation Menu.

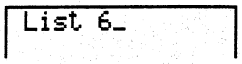
   [F1](LIST)



3. Press [F1] (List) to display the "List" command and input the number of the list you want to specify.

   [F1](List)[6]

   (Input List 6.)



•To directly input a list of values

You can also directly input a list of values using [{], [}], and [,].

Example **To multiply List 3** $\begin{bmatrix} 41 \\ 65 \\ 22 \end{bmatrix}$ **by the list** $\begin{bmatrix} 6 \\ 0 \\ 4 \end{bmatrix}$

[OPTN][F1](LIST)[F1](List)[3][×][SHIFT][{][6][,][0][,][4][SHIFT][}][EXE]

The resulting list $\begin{bmatrix} 246 \\ 0 \\ 88 \end{bmatrix}$ is stored in Ans Memory.

•To assign the contents of one list to another list

Use [→] to assign the contents of one list to another list.

Example 1 **To assign the contents of List 3 to List 1**

[OPTN][F1](LIST)[F1](List)[3][→][F1](List)[1][EXE]

In place of [F1] (List) [3] operation in the above procedure, you could input [SHIFT][{][4][1][,][6][5][,][2][2][SHIFT][}].

Example 2 **To assign the list in Ans Memory to List 1**

[OPTN][F1](LIST)[F1](List)[SHIFT][Ans][→][F1](List)[1][EXE]

•To input a single list cell value into a calculation

You can extract the value in a specific cell of a list and use it in a calculation. Specify the cell number by enclosing it between square brackets using the [[] and []] keys.

Example **To calculate the sine of the value stored in Cell 3 of List 2**

[sin][OPTN][F1](LIST)[F1](List)[2][SHIFT][[][3][SHIFT][]][EXE]

•To input a value into a specific cell

You can input a value into a specific cell inside a list. When you do, the value that was previously stored in the cell is replaced with the new value you input.

Example **To input the value 25 into cell 2 of List 3**

[2][5][→][OPTN][F1](LIST)[F1](List)[3][SHIFT][{][2][SHIFT][}][EXE]

■ Recalling List Contents

Example **To recall the contents of List 1**

[OPTN][F1](LIST)[F1](List)[1][EXE]

- The above operation displays the contents of the list you specify and also stores them in Ans Memory. You can then use the Ans Memory contents in a calculation.

•To use list contents in Ans Memory in a calculation

Example **To multiply the list contents in Ans Memory by 36**

[OPTN][F1](LIST)[F1](List)[SHIFT][Ans][×][3][6][EXE]

- The operation [OPTN] [F1] (LIST) [F1] (List) [SHIFT] [Ans] recalls Ans Memory contents.
- This operation replaces current Ans Memory contents with the result of the above calculation.

■ Graphing a Function Using a List

When using the graphing functions of this calculator, you can input a function such as Y1 = List1 X. If List 1 contains the values 1, 2, 3, this function will produces three graphs: Y = X, Y = 2X, Y = 3X.

There are certain limitations on using lists with graphing functions.

■ Inputting Scientific Calculations into a List

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You can use the numeric table generation functions in the Table Mode to input values that result from certain scientific function calculations into a list. To do this, first generate a table and then use the list copy function to copy the values from the table to the list.

■ Performing Scientific Function Calculations Using a List

Lists can be used just as numeric values are in scientific function calculations. When the calculation produces a list as a result, the list is stored in Ans Memory.

Example 1 **To use List 3** $\begin{bmatrix} 41 \\ 65 \\ 22 \end{bmatrix}$ **to perform sin (List 3)**

Use radians as the angle unit

[sin] [OPTN] [F1](LIST)[F1](List)[3] [EXE]

The resulting list $\begin{bmatrix} -0.158 \\ 0.8268 \\ -8E{-}3 \end{bmatrix}$ is stored in Ans Memory.

In place of the [F1] (List) [3] operation in the above procedure, you could input [SHIFT] [(] [4] [1] [,] [6] [5] [,] [2] [2] [SHIFT] [)].

Example 2 **To use List 1** $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ **and List 2** $\begin{bmatrix} 4 \\ 5 \\ 6 \end{bmatrix}$ **to perform List 1$^{\text{List 2}}$**

[OPTN] [F1](LIST)[F1](List)[1] [^] [F1](List)[2] [EXE]

This creates a list with the results of 1^4, 2^5, 3^6.

The resulting list $\begin{bmatrix} 1 \\ 32 \\ 729 \end{bmatrix}$ is stored in Ans Memory.

Chapter 7

Statistical Graphs and Calculations

7

This chapter describes how to input statistical data into lists, and how to calculate the mean, maximum and other statistical values. It also tells you how to perform regression calculations.

1. **Before Performing Statistical Calculations**
2. **Statistical Calculation Examples**
3. **Calculating and Graphing Single-Variable Statistical Data**
4. **Calculating and Graphing Paired-Variable Statistical Data**
5. **Manual Graphing**
6. **Performing Statistical Calculations**

Important!

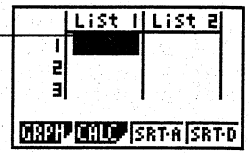
- This chapter contains a number of graph screen shots. In each case, new data values were input in order to highlight the particular characteristics of the graph being drawn. Note that when you try to draw a similar graph, the unit uses data values that you have input using the List function. Because of this, the graphs that appears on the screen when you perform a graphing operation will probably differ somewhat from those shown in this manual.

1. Before Performing Statistical Calculations

In the Main Menu, select the **STAT** icon to enter the STAT Mode and display the statistical data lists.

Use the statistical data lists to input data and to perform statistical calculations.

Use ▲, ▼, ◀ and ▶ to move the highlighting around the lists.



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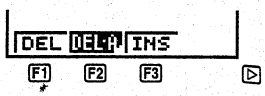
F1 (GRPH) .... Graph menu
F2 (CALC) ..... Statistical calculation menu
F3 (SRT•A) .... Ascending sort
F4 (SRT•D) .... Descending sort

▷



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F1 (DEL) ..... Single data item delete
F2 (DEL•A) .... Delete all data
F3 (INS) ..... Insert data item

Press ▷ to return to the previous menu.

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- The procedures you should use for data editing are identical to those you use with the list function. For details, see "Chapter 6 List Function".

2. Statistical Calculation Examples

Once you input data, you can use it to produce a graph and check for tendencies. You can also use a variety of different regression calculations to analyze the data.

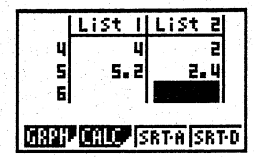
Example **To input the following two data groups and perform statistical calculations**

0.5, 1.2, 2.4, 4.0, 5.2
–2.1, 0.3, 1.5, 2.0, 2.4

■ Inputting Data into Lists

Input the two groups of data into List 1 and List 2.

0 • 5 EXE 1 • 2 EXE
2 • 4 EXE 4 EXE 5 • 2 EXE
▶
↩ 2 • 1 EXE 0 • 3 EXE
1 • 5 EXE 2 EXE 2 • 4 EXE



Once data is input, you can use it for graphing and statistical calculations.

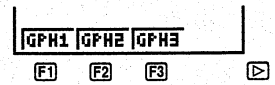
- Input values can be up to 10 digits long (9-digit mantissa and 2-digit exponent when using exponential format). Values in statistical data table cells are shown only up to six digits.
- You can use the ▲, ▼, ◀ and ▶ keys to move the highlighting to any cell in the lists for data input.

■ Plotting Data

Example **To specify Graph 1 as non-draw (OFF) and Graph 3 as draw (ON) and use Graph 3 to plot the data you input into statistical data List 1 and List 2 above**

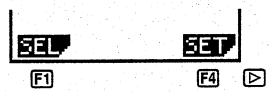
While the statistical data list is on the display, press F1 (GRPH) to display the graph menu.

F1 (GRPH)



F1 (GPH1) ..... Graph 1 draw
F2 (GPH2) ..... Graph 2 draw
F3 (GPH3) ..... Graph 3 draw

▷



F1 (SEL) ..... Graph (GPH1, GPH2, GPH3) selection
F4 (SET) ..... Graph settings (graph type, list assignments)

Press ▷ to return to the previous menu.

- You can specify the graph draw/non-draw status, the graph type, and other general settings for each of the graphs in the graph menu (GPH1, GPH2, GPH3).
- You can press any function key (F1, F2, F3) to draw a graph regardless of the current location of the highlighting in the statistical data list.
- The initial default graph type setting for all the graphs (Graph 1 through Graph 3) is scatter diagram, but you can change to one of a number of other graph types.

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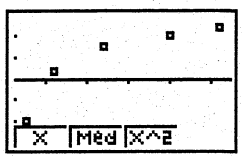
■ Plotting a Scatter Diagram

It is often difficult to spot the relationship between two sets of data (such as height and shoe size) by simply looking at the numbers. Such relationships often become clear however, when we plot the data on a graph, using one set as x-values and the other set as y-values.

•To plot a scatter diagram

Example **To plot the data we input in statistical data List 1 and List 2**

[F1](GPH1)



- The default setting automatically uses List 1 data as x-axis values and List 2 data as y-axis values. Each set of x/y data is a point on the scatter diagram.
- To return to the statistical data list, press [QUIT].

■ Changing Graph Parameters

Use the following procedures to specify the graph draw/non-draw status, the graph type, and other general settings for each of the graphs in the graph menu (GPH1, GPH2, GPH3).

1. Graph draw/non-draw status (SELECT)

The following procedure can be used to specify the draw (On)/non-draw (Off) status of each of the graphs in the graph menu.

•To specify the draw/non-draw status of a graph

1. While the graph menu is on the display, press [▷] [F1] (SEL) to display the graph On/Off screen.

[F1](GRPH)
[▷] [F1](SEL)

[F1] (On) ..... Graph On (graph draw)
[F2] (Off) ..... Graph Off (graph non-draw)
[F4] (DRAW) .... Draw all On graphs

- Note that the S-Grph1 setting is for Graph 1 (GPH1 of the graph menu), S-Grph2 is for Graph 2, and S-Grph3 is for Graph 3.

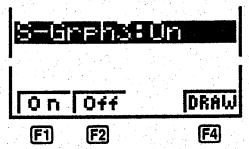
2. Use [▲] and [▼] to move the highlighting to the graph whose draw (On)/non-draw (Off) status you want to change and press [F1] (On) or [F2] (Off).

3. To return to the graph menu, press [QUIT].

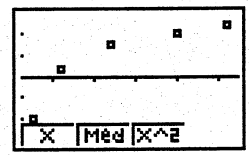
•To draw a graph

Example **To draw a scatter diagram of Graph 3 only**

[F1](GRPH)[▷][F1](SEL)
[F2](Off)
[▼][▼][F1](On)



[F4](DRAW)



2. General graph settings (SET)

This section describes how to use the general graph settings screen to make the following settings for each graph (GPH1, GPH2, GPH3).

• Graph Type

The initial default graph type setting for all the graphs is scatter graph. You can select one of a variety of other statistical graph types for each graph.

• List or Data

The initial default statistical data is List 1 for single-variable data, and List 1 and List 2 for paired-variable data. You can specify which statistical data list you want to use to draw the graph.

• Frequency

Normally, each data item or data pair in the statistical data list is represented on a graph as a point. When you are working with a large number of data items however, this can cause problems because of the number of plot points on the graph. When this happens, you can specify a frequency list that contains values indicating the number of instances (the frequency) of the data items in the corresponding cells of the lists you are using for x-data and y-data. Once you do this, only one point is plotted for the multiple data items, which makes the graph easier to read.

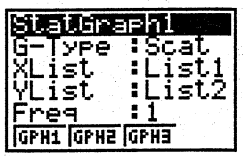
• Mark Type

This setting lets you specify the shape of the plot points on the graph.

•To display the general graph settings (SET) screen

While the graph menu is on the display, press ▷ F4 (SET) to display the general graph settings screen.

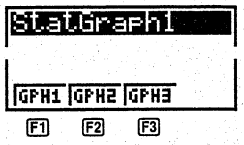
F1 (GRPH)
▷ F4 (SET)



- The settings shown here are examples only. The settings on your general graph settings screen may differ.

•To select the StatGraph area

1. While the general graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the StatGraph item.

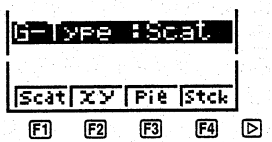


2. Use the function key menu to select the StatGraph area you want to select.

F1 (GPH1) ..... Graph 1
F2 (GPH2) ..... Graph 2
F3 (GPH3) ..... Graph 3

•To select the graph type (G-Type)

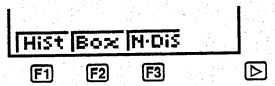
1. While the general graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the G-Type item.



2. Use the function key menu to select the graph type you want to select.

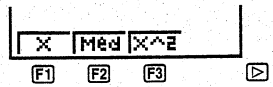
F1 (Scat) ..... Scatter diagram
F2 (*xy*) ..... *xy* line graph
F3 (Pie) ..... Pie chart
F4 (Stck) ..... Stacked bar chart

▷



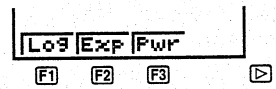
F1 (Hist) ..... Histogram
F2 (Box) ..... Med-box graph
F3 (N•Dis) ..... Normal distribution curve

▷



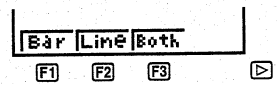
F1 (X) ..... Linear regression graph
F2 (Med) ..... Med-Med graph
F3 (X^2) ..... Quadratic regression graph

▷



F1 (Log) ..... Logarithmic regression graph
F2 (Exp) ..... Exponential regression graph
F3 (Pwr) ..... Power regression graph

▷

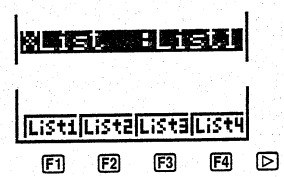


F1 (Bar) ..... Bar graph
F2 (Line) ..... Line graph
F3 (Both) ..... Bar graph and line graph

Press ▷ to return to the previous menu.

•To select the *x*-axis data list (XList)

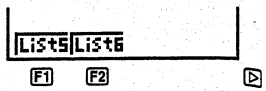
1. While the graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the XList item.



2. Use the function key menu to select the name of the statistical data list whose values you want on the x-axis of the graph.

   [F1] (List1) ..... List 1
   [F2] (List2) ..... List 2
   [F3] (List3) ..... List 3
   [F4] (List4) ..... List 4

   [▷]

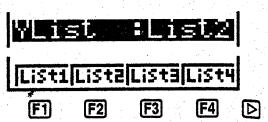


   [F1] (List5) ..... List 5
   [F2] (List6) ..... List 6

   Press [▷] to return to the previous menu.

•To select the y-axis data list (YList)

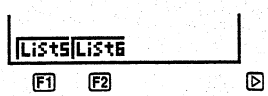
1. While the graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the YList item.



2. Use the function key menu to select the name of the statistical data list whose values you want on the y-axis of the graph.

   [F1] (List1) ..... List 1
   [F2] (List2) ..... List 2
   [F3] (List3) ..... List 3
   [F4] (List4) ..... List 4

   [▷]

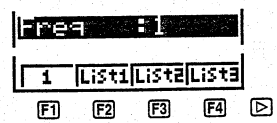


   [F1] (List5) ..... List 5
   [F2] (List6) ..... List 6

   Press [▷] to return to the previous menu.

•To select the frequency data list (Freq)

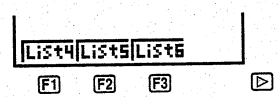
1. While the general graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the Freq item.



2. Use the function key menu to select the frequency setting you want.

   [F1] (1) ..... Plot all data (1-to-1)
   [F2] (List1) ..... List 1 data is frequency data.
   [F3] (List2) ..... List 2 data is frequency data.
   [F4] (List3) ..... List 3 data is frequency data.

   [▷]

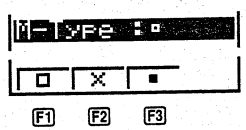


   [F1] (List4) ..... List 4 data is frequency data.
   [F2] (List5) ..... List 5 data is frequency data.
   [F3] (List6) ..... List 6 data is frequency data.

   Press [▷] to return to the previous menu.

•To select the plot mark type (M-Type)

1. While the general graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the M-Type item.

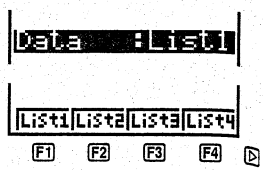


2. Use the function key menu to select the plot mark you want to select.

   [F1] (□) ..... Plot using □
   [F2] (X) ..... Plot using X
   [F3] (•) ..... Plot using •

•To select the data list for a pie chart, stacked bar chart, bar graph or line graph (Data)

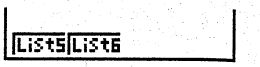
1. While the graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the Data item.



2. Use the function key menu to select the name of the statistical data list whose values you want to use.

F1 (List1) ..... List 1
F2 (List2) ..... List 2
F3 (List3) ..... List 3
F4 (List4) ..... List 4

▷

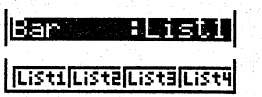


F1 (List5) ..... List 5
F2 (List6) ..... List 6

Press ▷ to return to the previous menu.

•To select the data list for a combined bar graph and line graph (Both)

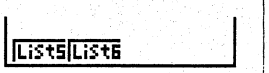
1. While the graph settings screen is on the display, use ▲ and ▼ to move the highlighting to the Bar item.



2. Use the function key menu to select the name of the statistical data list whose values you want to use.

F1 (List1) ..... List 1
F2 (List2) ..... List 2
F3 (List3) ..... List 3
F4 (List4) ..... List 4

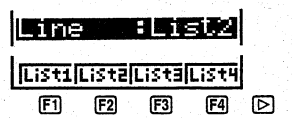
▷



F1 (List5) ..... List 5
F2 (List6) ..... List 6

Press ▷ to return to the previous menu.

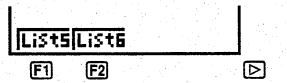
3. Use ▲ and ▼ to move the highlighting to the Line item.



4. Use the function key menu to select the name of the statistical data list whose values you want to use.

F1 (List1) ..... List 1
F2 (List2) ..... List 2
F3 (List3) ..... List 3
F4 (List4) ..... List 4

▷



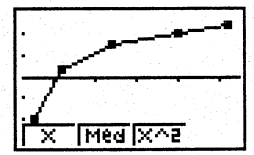
F1 (List5) ..... List 5
F2 (List6) ..... List 6

Press ▷ to return to the previous menu.

P.100
(G-Type)
(*xy*)

■ Drawing an *xy* Line Graph

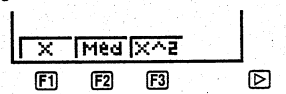
Paired data items can be used to plot a scatter diagram. A scatter diagram where the points are linked is an *xy* line graph.



Press QUIT to return to the statistical data list.

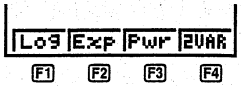
■ Selecting the Regression Type

After you graph statistical data, you can use the function menu at the bottom of the display to select from a variety of different types of regression.



F1 (X) ..... Linear regression
F2 (Med) ..... Med-Med line
F3 (X^2) ..... Quadratic regression

▷



F1 (Log) ..... Logarithmic regression
F2 (Exp) ..... Exponential regression
F3 (Pwr) ..... Power regression
F4 (2VAR) ..... Paired-variable statistical results

Press ▷ to return to the previous menu.

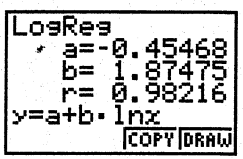
■ Displaying Statistical Calculation Results

Whenever you perform a regression calculation, the regression formula parameter (such as a and b in the linear regression $y = ax + b$) calculation results appear on the display. You can use these to obtain statistical calculation results.

Regression parameters are calculated as soon as you press a function key to select a regression type while a graph is on the display.

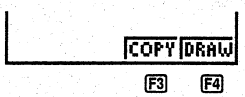
Example **To display logarithmic regression parameter calculation results while a scatter diagram is on the display**

▷ F1 (Log)



■ Graphing statistical calculation results

You can use the parameter calculation result menu to graph the displayed regression formula.



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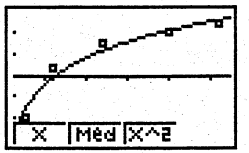
F3 (COPY) ..... Stores the displayed regression formula as a graph function
F4 (DRAW) .... Graphs the displayed regression formula

Example **To graph a logarithmic regression**

While logarithmic regression parameter calculation results are on the display, press F4 (DRAW).

F4 (DRAW)



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For details on the meanings of function menu items at the bottom of the display, see "Selecting the Regression Type".

3. Calculating and Graphing Single-Variable Statistical Data

Single-variable data is data with only a single variable. If you are calculating the average height of the members of a class for example, there is only one variable (height).

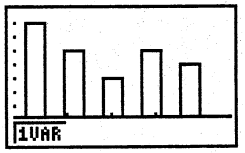
Single-variable statistics include distribution and sum. The following three types of graphs are available for single-variable statistics.

■ Histogram

P.101 (G-Type) (Hist) P.97

From the statistical data list, press F1 (GRPH) to display the graph menu, press ▷ F4 (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to histogram.

Data should already be input in the statistical data list (see "Inputting Data into Lists"). Draw the graph using the procedure described under "Plotting Data".

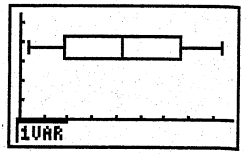


■ Box Graph

P.101 (G-Type) (Box)

This type of graph lets you see how a large number of data items are grouped within specific ranges. A box encloses all the data in an area from the 25th percentile to the 75th percentile, with a line drawn at the 50th percentile. Lines (called whiskers) extend from either end of the box up to the minimum and maximum of the data.

From the statistical data list, press F1 (GRPH) to display the graph menu, press ▷ F4 (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to box graph.



■ Normal Distribution Curve

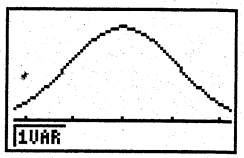
The normal distribution curve is graphed using the following normal distribution function.

$$y = \frac{1}{\sqrt{(2\pi)}\, x\sigma_n}\, e^{-\frac{(x-\bar{x})^2}{2x\sigma_n^2}}$$

P.101 (G-Type) (N•Dis)

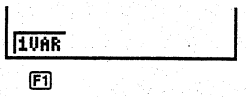
The distribution of characteristics of items manufactured according to some fixed standard (such as component length) fall within normal distribution. The more data items there are, the closer the distribution is to normal distribution.

From the statistical data list, press [F1] (GRPH) to display the graph menu, press [▷] [F4] (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to normal distribution.



■ Displaying Single-Variable Statistical Results

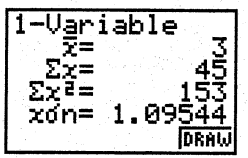
Single-variable statistics can be expressed as both graphs and parameter values. When these graphs are displayed, the menu at the bottom of the screen appears as below.



[F1] (1VAR) ..... Single-variable calculation result menu

Pressing [F1] (1VAR) displays the following screen.

[F1](1VAR)



The following describes the meaning of each of the parameters.

$\bar{x}$ ..... Mean of data
Σx ..... Sum of data
Σx^2 ..... Sum of squares
$x\sigma_n$ ..... Population standard deviation
$x\sigma_{n-1}$ ..... Sample standard deviation
n ..... Number of data items
minX ..... Minimum
Q1 ..... First quartile
Med ..... Median
Q3 ..... Third quartile
maxX ..... Maximum
Mod ..... Mode

- Press [F4] (DRAW) to return to the original single-variable statistical graph.

■ Pie Chart

P.100 (G-Type) (Pie)

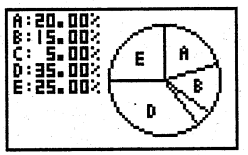
From the statistical data list, press [F1] (GRPH) to display the graph menu, press [▷] [F4] (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to pie chart. Next, move the highlighting to "Display" and then press [F1] or [F2] to select the pie chart data format.

[F1] (%) ..... Displayed values show what percentage of the total data each pie segment represents.
[F2] (Data) ..... Displayed values show actual data.

Press [QUIT] to draw the chart.

Example **To input the following data into List 1 and use it to draw a pie chart: 18.0, 13.5, 4.5, 31.5, 22.5**

[F1](GRPH)[▷][F4](SET)
[F1](GPH1)[▼]
[F3](Pie)[QUIT]
[F1](GRPH)[F1](GPH1)



- A pie chart can have up to eight data items. Attempting to draw a pie chart for a list that has more than eight data items causes an error (Dim ERROR).
- Only positive data can be included in a pie chart. Attempting to draw a pie chart for a list that includes negative data causes an error (Ma ERROR).
- View Window settings are not applied to pie charts.
- A pie chart cannot be superimposed with another graph.
- Values appearing on a pie chart are automatically assigned to the corresponding variables (A, B, C, etc.)

- Performing a trace operation ([SHIFT] [F1] (TRCE)) while a pie chart is on the display causes the pointer to appear at the topmost segment. Pressing ▶ and ◀ moves the pointer to neighboring segments.
- While a pie graph is on the display, you can toggle between the two data formats (percent and data) by pressing [SHIFT] [F4] (CHNG).
- You cannot draw multiple pie charts on the same screen.
- Percent values shown on pie charts are cut off to two decimal places.

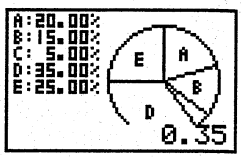
• Performing Mathematical Operations Using Pie Chart Data

Pressing [SHIFT] [F3] (GSLV) causes the cursor to appear at the bottom of the screen. You can then perform mathematical operations using the chart's data.

Example **To perform the operation A + B**

After drawing the pie chart, perform the following operation.

[SHIFT] [F3] (GSLV)
[ALPHA] [A] [+] [ALPHA] [B]
[EXE]



The result shows that A and B account for 35% of the data.

P.100 (G-Type) (Stck)

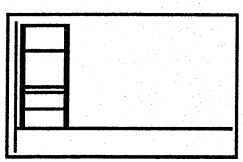
■ Stacked Bar Chart

From the statistical data list, press [F1] (GRPH) to display the graph menu, press ▷ [F4] (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to stacked bar chart.

Press [QUIT] to draw the chart.

Example **To input the following data into List 1 and use it to draw a stacked bar chart: 18.0, 13.5, 4.5, 31.5, 22.5**

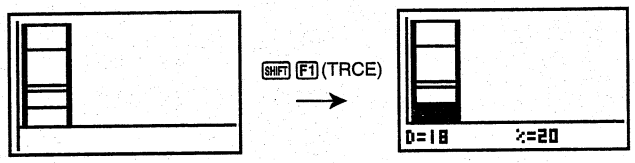
[F1] (GRPH) ▷ [F4] (SET)
[F1] (GPH1) ▼
[F4] (Stck) [QUIT]
[F1] (GRPH) [F1] (GPH1)



- A stacked bar chart can have up to eight data items. Attempting to draw a stacked bar chart for a list that has more than eight data items causes an error (Dim ERROR).

- Only positive data can be included in a stacked bar chart. Attempting to draw a stacked bar chart for a list that includes negative data causes an error (Ma ERROR).
- A stacked bar chart cannot be superimposed with another graph.
- View Window settings are not applied to stacked bar charts.

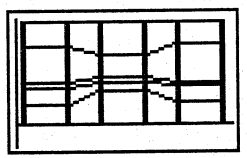
- The following display shows what happens if you perform a trace operation ([SHIFT] [F1] (TRCE)) while a stacked bar chart is on the display.



- Pressing ▲ and ▼ moves the highlighting up and down within the same graph.
- If you have multiple stacked bar charts on the screen, use ◀ and ▶ to move between them.

• Linking the Segments of Stacked Bar Charts with Connecting Lines

While multiple stacked bar charts are on the display, press [SHIFT] [F4] (CNCT) to link their segments with connecting lines.



Redraw the stacked bar charts to clear the connecting lines.

P.101 (G-Type) (Bar)

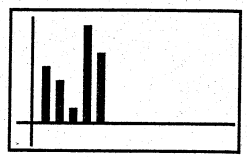
■ Bar Graph

From the statistical data list, press [F1] (GRPH) to display the graph menu, press ▷ [F4] (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to bar graph.

Press [QUIT] to draw the graph.

Example **To input the following data into List 1 and use it to draw a bar graph: 18.0, 13.5, 4.5, 31.5, 22.5**

[F1](GRPH)[▷][F4](SET)
[F1](GPH1)[▼]
[▷][▷][▷][▷][F1](Bar)[QUIT]
[F1](GRPH)[F1](GPH1)



- A bar graph can have up to 14 data items. Attempting to draw a bar graph for a list that has more than 14 data items causes an error (Dim ERROR).
- The x-axis of a bar graph is fixed. The y-axis is controlled by View Window settings only when Man (manual) is specified for the S-Wind (Statistical Graph View Window Setting) on the Set Up screen.
- A bar graph can be superimposed with a line graph only. This is done by selecting [F3] (Both) while specifying the graph type.
- Pressing [SHIFT] [F1] (TRCE) while a bar graph is on the display activates the trace operation. Use [◀] and [▶] to move the pointer.
- You cannot draw multiple bar graphs on the same screen.

P.8

■ Line Graph

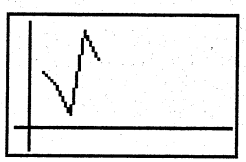
P.101 (G-Type) (Line)

From the statistical data list, press [F1] (GRPH) to display the graph menu, press [▷] [F4] (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to line graph.

Press [QUIT] to draw the graph.

Example **To input the following data into List 1 and use it to draw a line graph: 18.0, 13.5, 4.5, 31.5, 22.5**

[F1](GRPH)[▷][F4](SET)
[F1](GPH1)[▼]
[▷][▷][▷][▷][F2](Line)[QUIT]
[F1](GRPH)[F1](GPH1)



- A line graph can have up to 14 data items. Attempting to draw a line graph for a list that has more than 14 data items causes an error (Dim ERROR).
- The x-axis of a line graph is fixed. The y-axis is controlled by View Window settings only when Man (manual) is specified for the S-Wind (Statistical Graph View Window Setting) on the Set Up screen.
- A line graph can be superimposed with a bar graph only. This is done by selecting [F3] (Both) while specifying the graph type.

P.8

- Pressing [SHIFT] [F1] (TRCE) while a line graph is on the display activates the trace operation. Use [◀] and [▶] to move the pointer.
- You cannot draw multiple line graphs on the same screen.

P.101 (G-Type) (Both) P.8

■ Bar Graph and Line Graph

From the statistical data list, press [F1] (GRPH) to display the graph menu, press [▷] [F4] (SET), and then change the graph type of the graph you want to use (GPH1, GPH2, GPH3) to Both.

When Auto is specified for the S-Wind (Statistical Graph View Window Setting) item on the Set Up screen, you can next move the highlighting to the AutoWin item and press [F1], [F2], or [F3] to make one of the following settings.

[F1] (Sep.G) ..... This setting causes each graph to be drawn in different areas of the display, without superimposing them. The two graphs share the same x-coordinates, however, and the x-axis is displayed for the bar graph only.

[F2] (O.Lap) ..... This setting superimposes the two graphs on each other. Each graph, however, can have its own independent y-axis values.

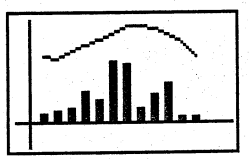
[F3] (Norm) ..... This setting also superimposes the two graphs, with both using the same x- and y-coordinates.

Press [QUIT] to draw the graph.

Example **Draw a graph that shows precipitation in a certain city as a bar graph and average temperature as a line graph.**
Input the precipitation data into List 1 and the temperature data into List 2. Use the following procedure to draw the graph.

	List 1	List 2
1	100	5
2	150	4
3	200	11
4	400	16
5	300	20
6	800	24
7	750	31
8	200	32
9	350	29
10	500	24
11	80	18
12	80	6

[F1](GRPH)[▷][F4](SET)
[F1](GPH1)[▼]
[▷][▷][▷][▷][F3](Both)[QUIT]
[F1](GRPH)[F1](GPH1)



- Pressing [SHIFT] [F1] (TRCE) while the graph is on the display activates the trace operation. Use [◀] and [▶] to move the pointer.
- You cannot draw multiple bar and line graphs on the same screen.

4. Calculating and Graphing Paired-Variable Statistical Data

Under "Plotting a Scatter Diagram," we displayed a scatter diagram and then performed a logarithmic regression calculation. Let's use the same procedure to look at the six regression functions.

P.100

■ Linear Regression Graph

Linear regression plots a straight line that passes close to as many data points as possible, and returns values for the slope and y-intercept (y-coordinate when $x = 0$) of the line.

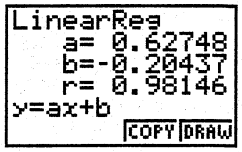
The graphic representation of this relationship is a linear regression graph.

(G-Type) QUIT F1(GRPH) ▷ F4(SET) ▼

(Scat) F1(Scat)

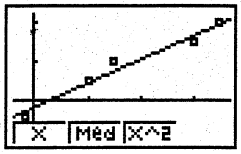
(GPH1) QUIT F1(GRPH) F1(GPH1)

(X) F1(X)



F4

F4(DRAW)



The following are the meanings of the above parameters.

a ..... Regression coefficient (slope)

b ..... Regression constant term (intercept)

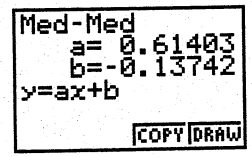
r ..... Correlation coefficient

P.101 (G-Type)

■ Med-Med Graph

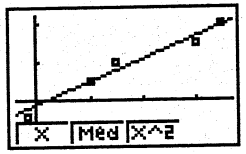
When it is suspected that there are a number of extreme values, a Med-Med graph can be used in place of the least squares method. This is also a type of linear regression, but it minimizes the effects of extreme values. It is especially useful in producing highly reliable linear regression from data that includes irregular fluctuations, such as seasonal surveys.

F2(Med)



F4

F4(DRAW)



The following are the meanings of the above parameters.

a ..... Med-Med graph slope

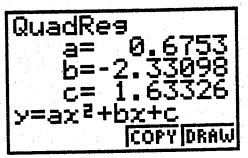
b ..... Med-Med graph intercept

P.101 (G-Type)

■ Quadratic Regression Graph

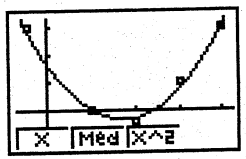
A quadratic regression graph represents connection of the data points of a scatter diagram. It actually is a scattering of so many points that are close enough together to be connected. The formula that represents this is quadratic regression.

F3(X^2)



F4

F4(DRAW)



The following are the meanings of the above parameters.

a ..... Regression second coefficient

b ..... Regression first coefficient

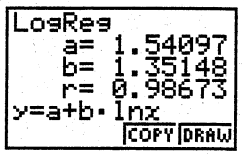
c ..... Regression constant term (intercept)

P.101 (G-Type)

■ Logarithmic Regression Graph

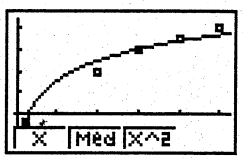
Logarithmic regression expresses y as a logarithmic function of x. The standard logarithmic regression formula is $y = a + b \times \log x$, so if we say X = log$x$, the formula corresponds to linear regression formula $y = a + bX$.

▷ F1 (Log)



F4

F4 (DRAW)



The following are the meanings of the above parameters.

a ..... Regression constant term (intercept)

b ..... Regression coefficient (slope)

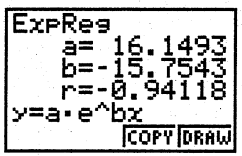
r ..... Correlation coefficient

P.101 (G-Type)

■ Exponential Regression Graph

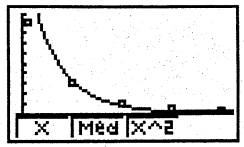
Exponential regression expresses y as a proportion of the exponential function of x. The standard exponential regression formula is $y = a \times e^{bx}$, so if we take the logarithms of both sides we get $\log y = \log a + bx$. Next, if we say Y = log$y$, and $a = \log a$, the formula corresponds to linear regression formula $Y = a + bx$.

▷ F2 (Exp)



F4

F4 (DRAW)



The following are the meanings of the above parameters.

a ..... Regression coefficient

b ..... Regression constant term

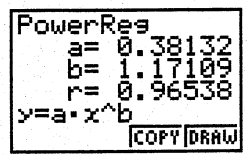
r ..... Correlation coefficient

P.101 (G-Type)

■ Power Regression Graph

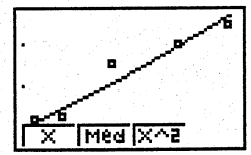
Exponential regression expresses y as a proportion of the power of x. The standard power regression formula is $y = a \times x^b$, so if we take the logarithms of both sides we get $\log y = \log a + b \times \log x$. Next, if we say X = log$x$, Y = log$y$, and $a = \log a$, the formula corresponds to linear regression formula $Y = a + bX$.

▷ F3 (Pwr)



F4

F4 (DRAW)



The following are the meanings of the above parameters.

a ..... Regression coefficient

b ..... Regression power

r ..... Correlation coefficient

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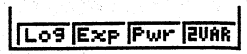
■ Displaying Paired-Variable Statistical Results

Paired-variable statistics can be expressed as both graphs and parameter values. When these graphs are displayed, the menu at the bottom of the screen appears as below.

▷

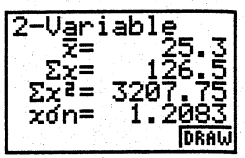


F4

F4 (2VAR) ..... Paired-variable calculation result menu

Pressing F4 (2VAR) displays the following screen.

F4 (2VAR)



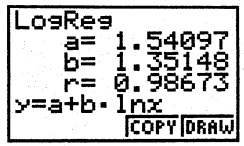
- Use ▼ to scroll the list so you can view the items that run off the bottom of the screen. The following describes the meaning of each of the parameters.

$\bar{x}$ ..... Mean of xList data
Σx ..... Sum of xList data
Σx^2 ..... Sum of squares of xList data
$x\sigma_n$ ..... Population standard deviation of xList data
$x\sigma_{n-1}$ ..... Sample standard deviation of xList data
n ..... Number of xList data items
$\bar{y}$ ..... Mean of yList data
Σy ..... Sum of yList data
Σy^2 ..... Sum of squares of yList data
$y\sigma_n$ ..... Population standard deviation of yList data
$y\sigma_{n-1}$ ..... Sample standard deviation of yList data
Σxy ..... Sum of xList and yList data
minX ..... Minimum of xList data
maxX ..... Maximum of xList data
minY ..... Minimum of yList data
maxY ..... Maximum of yList data

■ Copying a Regression Graph Formula to the Graph Mode

After you perform a regression calculation, you can copy its formula to the **GRAPH Mode**.

The following are the functions that are available in the function menu at the bottom of the display while regression calculation results are on the screen.

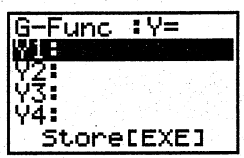


F3 F4

F3 (COPY) ..... Stores the displayed regression formula to the GRAPH Mode
F4 (DRAW) .... Graphs the displayed regression formula

1. Press F3 (COPY) to copy the regression formula that produced the displayed data to the GRAPH Mode.

F3 (COPY)



Note that you cannot edit regression formulas for graph formulas in the GRAPH Mode.

2. Press EXE to save the copied graph formula and return to the previous regression calculation result display.

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■ Multiple Graphs

You can draw more than one graph on the same display by using the procedure under "Changing Graph Parameters" to set the graph draw (On)/non-draw (Off) status of two or all three of the graphs to draw (On), and then pressing F4 (DRAW). After drawing the graphs, you can select which graph formula to use when performing single-variable statistic or regression calculations.

F4

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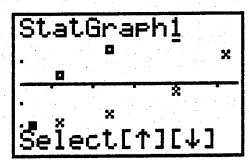
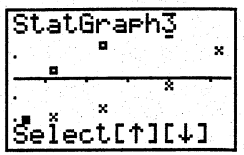
F4 (DRAW)
F1 (X)



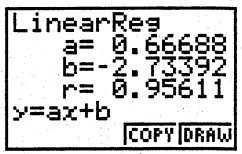
- The text at the top of the screen indicates the currently selected graph (STAT Graph 1 = Graph 1, STAT Graph 2 = Graph 2, STAT Graph 3 = Graph 3).

1. Use ▲ and ▼ to change the currently selected graph. The graph name at the top of the screen changes when you do.

▼



2. When graph you want to use is selected, press EXE.



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P.118

Now you can use the procedures under "Displaying Single-Variable Statistical Results" and "Displaying Paired-Variable Statistical Results" to perform statistical calculations.

5. Manual Graphing

P.8

In all of the graphing examples up to this point, values were calculated in accordance with View Window settings and graphing was performed automatically. This automatic graphing is performed when the S-Wind item of the View Window is set to "Auto" (auto graphing). You can also produce graphs manually, when the automatic graphing capabilities of this calculator cannot produce the results you want.

■ Setting the Width of a Histogram

When the S-Wind item of the View Window is set to "Man" (manual graphing), a screen appears so you can specify the starting point and spacing of histogram bars.

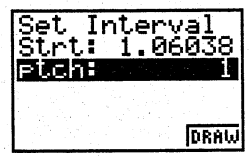
While the statistical data list is on the display, perform the following procedure.

SHIFT SETUP

F2

F2 (Man)
QUIT (Returns to previous menu.)
F1 (GRPH) F1 (GPH1)

Here we will illustrate this operation by making histogram settings for Graph 1.



The following are the meanings of the items that appear in this screen.

Strt ..... Histogram start point (x-coordinate)
ptch ..... Bar spacing (specify as scale unit)

Example **Strt: 0, ptch: 10**

While the statistical data list is on the display, perform the following procedure.

SHIFT SETUP F2 (Man)
QUIT (Returns to previous menu.)
F1 (GRPH) F1 (GPH1)
0 EXE (Start value is x = 0.)
1 0 EXE (pitch = 10)

6. Performing Statistical Calculations

All of the statistical calculations up to this point were performed after displaying a graph. The following procedures can be used to perform statistical calculations alone.

•To specify statistical calculation data lists

You have to input the statistical data for the calculation you want to perform and specify where it is located before you start a calculation. While the statistical data is on the display, perform the following procedure.

F2 (CALC) F4 (SET)

The following is the meaning for each item.

1VarX ..... Specifies list where single-variable statistic x values (XList) are located.

1VarF ..... Specifies list where single-variable frequency values (Frequency) are located.

2VarX ..... Specifies list where paired-variable statistic x values (XList) are located.

2VarY ..... Specifies list where paired-variable statistic y values (YList) are located.

2VarF ..... Specifies list where paired-variable frequency values (Frequency) are located.

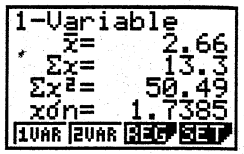
- Calculations in this section are performed based on the above specifications.

■ Single-Variable Statistical Calculations

In the previous examples from "Histogram (Bar Graph)" to "Normal Distribution Curve," statistical calculation results were displayed after the graph was drawn. These were numeric expressions of the characteristics of variables used in the graphic display.

The following operation produces the same values directly from the statistical data list.

F2(CALC) F1(1VAR)



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Now you can press ▲ and ▼ to view variable characteristics.

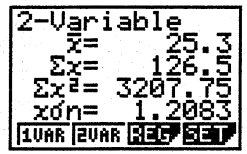
For details on the meanings of these statistical values, see "Displaying Single-Variable Statistical Results".

■ Paired-Variable Statistical Calculations

In the previous examples from "Linear Regression Graph" to "Power Regression Graph," statistical calculation results were displayed after the scatter diagram was drawn. These were numeric expressions of the characteristics of variables used in the graphic display.

The following operation produces the same values directly from the statistical data list.

F2(CALC) F2(2VAR)



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Now you can press ▲ and ▼ to view variable characteristics.

For details on the meanings of these statistical values, see "Displaying Paired-Variable Statistical Results".

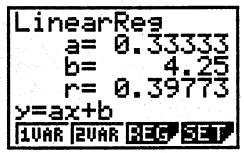
■ Regression Calculation

In the explanations from "Linear Regression Graph" to "Power Regression Graph," regression calculation results were displayed after the graph was drawn. Here, the regression line and regression curve is represented by mathematical expressions.

You can directly determine the same expression from the data input screen.

Perform the following key operation.

F2(CALC) F3(REG)
F1(X)



Single variable regression parameters are displayed.

Next, you can use the following.

F1 (X) ..... Linear regression
F2 (Med) ..... Med-Med regression
F3 (X^2) ..... Quadratic regression
▷
F1 (Log) ..... Logarithmic regression
F2 (Exp) ..... Exponential regression
F3 (Pwr) ..... Power regression

The meanings of the parameters that appear on this screen are the same as those for "Linear Regression Graph" to "Power Regression Graph".

■ Estimated Value Calculation ($\hat{x}$, $\hat{y}$)

After drawing a regression graph with the **STAT Mode**, you can use the **RUN Mode** to calculate estimated values for the regression graph's x and y parameters.

- Note that you cannot obtain estimated values for Med-Med graph and quadratic regression graph.

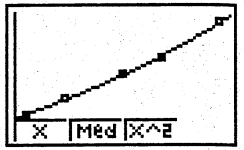
Example **To perform power regression using the following data and estimate the values of $\hat{y}$ and $\hat{x}$ when xi = 40 and yi = 1000**

xi (List 1)	yi (List 2)
28	2410
30	3033
33	3895
35	4491
38	5717

1. In the Main Menu, select the **STAT** icon and enter the STAT Mode.

2. Input data into the list and draw the power regression graph.

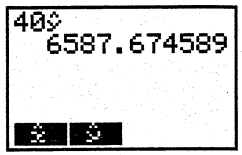
(G-Type) [F1](GRPH)[▷][F4](SET)[▼]
(Scat) [F1](Scat)[▼]
(XList) [F1](List1)[▼]
(YList) [F2](List2)[▼]
(Freq) [F1](1)[▼]
(M-Type) [F1](⊟)[QUIT]
(Auto) [SHIFT][SETUP][F1](Auto)[QUIT][F1](GRPH)[F1](GPH1)[▷]
(Pwr) [F3](Pwr)[F4](DRAW)



3. In the Main Menu, select the **RUN** icon and enter the RUN Mode.

4. Press the keys as follows.

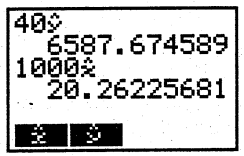
[4][0](value of xi)
[OPTN][F3](STAT)[F2]($\hat{y}$)[EXE]



[F1] [F2]

The estimated value $\hat{y}$ is displayed for xi = 40.

[1][0][0][0](value of yi)
[F1]($\hat{x}$)[EXE]



The estimated value $\hat{x}$ is displayed for yi = 1000.

Chapter 8

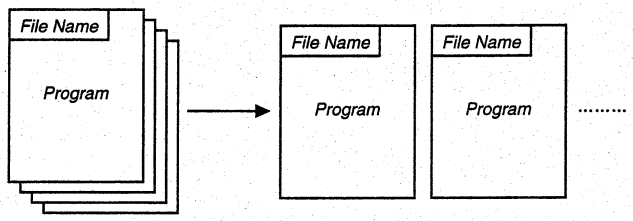
Programming

1. Before Programming
2. Programming Examples
3. Debugging a Program
4. Calculating the Number of Bytes Used by a Program
5. Secret Function
6. Searching for a File
7. Editing Program Contents
8. Deleting a Program
9. Useful Program Commands
10. Command Reference
11. Text Display
12. Using Calculator Functions in Programs

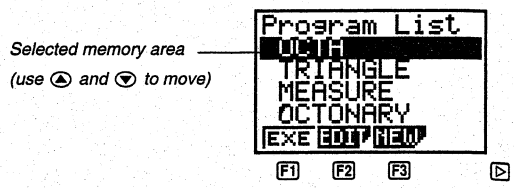
8

1. Before Programming

The programming function helps to make complex, often-repeated calculations quick and easy. Commands and calculations are executed sequentially, just like the manual calculation multistatements. Multiple programs can be stored under file names for easy recall and editing.



Select the **PRGM** icon in the Main Menu and enter the PRGM Mode. When you do, a program list appears on the display.



F1 (EXE)..... Execute program
F2 (EDIT)..... Program edit
F3 (NEW) ..... New program

▷

F1 (DEL)..... Specific program delete
F2 (DEL•A).... Delete all
F3 (SRC)..... File name search

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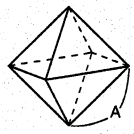
Press ▷ to return to the previous menu.

- If there are not programs stored in memory when you enter the PRGM Mode, the message "**No Programs**" appears on the display and only the NEW item (F3) is shown in the function menu.

2. Programming Examples

Example 1 **To calculate the surface area and volume of three regular octahedrons of the dimensions shown in the table below**

Store the calculation formula under the file name OCTA.



Length of One Side (A)	Surface Area (S)	Volume (V)
7 cm	cm^2	cm^3
10 cm	cm^2	cm^3
15 cm	cm^2	cm^3

The following are the formulas used for calculating surface area S and volume V of a regular octahedron for which the length of one side is known.

$$S = 2\sqrt{3}A^2, \quad V = \frac{\sqrt{2}}{3}A^3$$

When inputting a new formula, you first register the file name and then input the actual program.

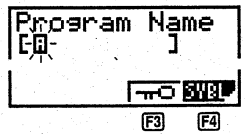
•To register a file name

Example **To register the file name OCTA**

- Note that a file name can be up to eight characters long.

1. While the program list is on the display, press F3 (NEW).

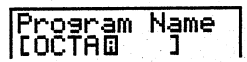
F3 (NEW)



F3 (π0) ..... Password registration
F4 (SYBL)..... Symbol menu

2. Input the name of the file.

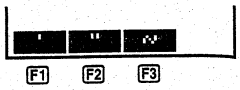
O C T A



- The cursor changes form to indicate alpha character input.
- The following are the characters you can use in a file name:
  A through Z, spaces, [,], {, }, ', ", ~, 0 through 9, ., +, −, ×, ÷

• Pressing [F4] (SYBL) displays a menu of symbols that can be input.

[F4] (SYBL)

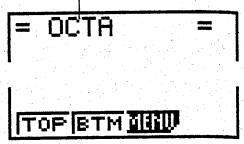


• You can delete a character while inputting a file name by moving the cursor to the character you want to delete and pressing [DEL].

3. Press [EXE] to register the file name and change to the program input screen.

File name

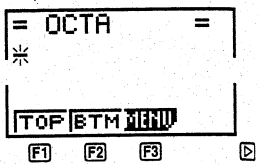
[EXE]



• Registering a file name uses 17 bytes of memory.
• The file name input screen remains on the display if you press [EXE] without inputting a file name.
• To exit the file name input screen and return to the program list without registering a file name, press [QUIT].

•To input a program

Use the program input screen to input the contents of a program.



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[F1] (TOP)..... Top of program

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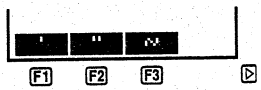
[F2] (BTM) ..... Bottom of program

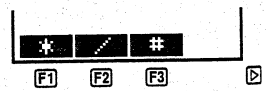
[F3] (MENU) .... Mode menu

• Pressing [▷] displays a menu of symbols that can be input into a program.

[▷]



[▷]



Press [▷] to return to the previous menu.

•To change modes in a program

P.2

• Pressing [F3] (MENU) while the program input screen is on the display causes a mode change menu to appear. You can use this menu to input mode changes into your programs. For details on each of these modes, see "Using the Main Menu", as well as the sections of this manual that describe what you can do in each mode.

[F3] (MENU)

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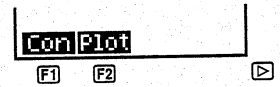
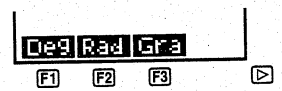
• Pressing [SHIFT] [SET UP] displays a menu of commands that can be used to change set up screen settings inside a program. For details on each of these commands, see "To change a mode set up".

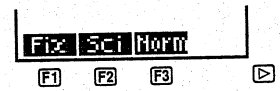
[SHIFT] [SET UP]



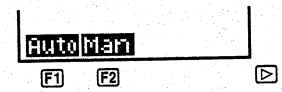
[▷]



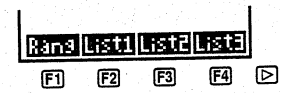
[▷]



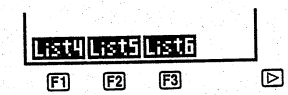
[▷]



[▷]



[▷]



Actual program contents are identical to manual calculations. The following shows how the calculation of the surface area and volume of a regular octahedron would be calculated using a manual calculation.

Surface Area S ... [2] [×] [SHIFT] [√] [3] [×] <value of A> [x²] [EXE]

Volume V ..... [SHIFT] [√] [2] [÷] [3] [×] <value of A> [^] [3] [EXE]

You could also perform this calculation by assigning the value for the length of one side to variable A.

Length of One Side A

..... <value of A> [→] [ALPHA] [A] [EXE]

Surface Area S ... 2 × SHIFT √ 3 × ALPHA A x^2 EXE

Volume V ..... SHIFT √ 2 ÷ 3 × ALPHA A ^ 3 EXE

If you simply input the manual calculations shown above however, the calculator would execute them from beginning to end, without stopping. The following commands make it possible to interrupt a calculation for input of values and display of intermediate results.

?: This command pauses program execution and displays a question mark as a prompt for input of a value to assign to a variable. The syntax for this command is: ? → <variable name>.

◢: This command pauses program execution and displays the last calculation result obtained or text. It is similar to pressing EXE in a manual calculation.

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- For full details on using these and other commands, see "Useful Program Commands".

The following shows examples of how to actually use the ? and ◢ commands.

SHIFT PRGM ▷ F1 (?) → ALPHA A ▷ F3 (:)
2 × SHIFT √ 3 × ALPHA A x^2
▷ ▷ F2 (◢)

```
= OCTA          =
?→A:2×√3×A²◢
_
```

```
? ◢ CLR DISP
```

F1 F2

SHIFT √ 2 ÷ 3 × ALPHA A ^ 3

```
= OCTA          =
?→A:2×√3×A²◢
√2÷3×A^3_
```

QUIT QUIT

```
Program List
 OCTA
```

•To run a program

1. While the program list is on the display, use ▲ and ▼ to highlight the name of the program you want to run.

2. Press F1 (EXE) or EXE to run the program.

Let's try running the program we input above.

Length of One Side (A)	Surface Area (S)	Volume (V)
7 cm	169.7409791 cm²	161.6917506 cm³
10 cm	346.4101615 cm²	471.4045208 cm³
15 cm	779.4228634 cm²	1590.990258 cm³


```
Program List
 OCTA

EXE EDIT NEW
```

F1

F1 (EXE) or EXE

```
?
```

7 EXE
(Value of A)

```
?
7
  169.7409791
    - Disp -
```

Intermediate result produced by ◢

EXE

```
?
7
  169.7409791
  161.6917506
```

EXE

```
?
7
  169.7409791
  161.6917506
?
```

1 0 EXE

```
  161.6917506
?
10
  346.4101615
    - Disp -
```

EXE

```
  161.6917506
?
10
  346.4101615
  471.4045208
```

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- Pressing EXE while the program's final result is on the display re-executes the program.
- You can also run a program while in the **RUN Mode** by inputting: Prog "<file name>" EXE.
- An error (Go ERROR) occurs if the program specified by Prog "<file name>" cannot be found.

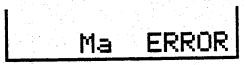
3. Debugging a Program

A problem in a program that keeps the program from running correctly is called a "bug," and the process of eliminating such problems is called "debugging." Either of the following symptoms indicates that your program contains bugs and that debugging is required.

- Error messages appearing when the program is run
- Results that are not within your expectations

•To eliminate bugs that cause error messages

An error message, like the one shown below, appears whenever something illegal occurs during program execution.



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When such a message appears, press ◀ or ▶ to display the location where the error was generated, along with the cursor. Check the "Error Message Table" for steps you should take to correct the situation.

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- Note that pressing ◀ or ▶ will not display the location of the error if the program is password protected.

•To eliminate bugs that cause bad results

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If your program produces results that are not what you normally expect, check the contents of the program and make necessary changes. See "Editing Program Contents" for details on how to change program contents.

4. Calculating the Number of Bytes Used by a Program

This unit comes with 20,000 bytes of memory. A byte is a unit of memory that can be used for storage of data.

There are two types of commands: 1-byte commands and 2-byte commands.

- Examples of 1-byte commands: sin, cos, tan, log, (,), A, B, C, 1, 2, etc.
- Examples of 2-byte commands: Lbl 1, Goto 2, etc.

While the cursor is located inside of a program, each press of ◀ or ▶ causes the cursor to move one byte.

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- You can check how much memory has been used and how much remains at any time by selecting the **MEM** icon in the Main Menu and entering the MEM Mode. See "Memory Status (MEM)" for details.

5. Secret Function

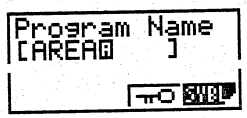
When inputting a program, you can protect it with a password that limits access to the program contents to those who know the password. Password protected programs can be executed by anyone without inputting the password.

•To register a password

Example **To create a program file under the name AREA and protect it with the password CASIO**

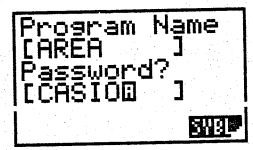
1. While the program list is on the display, press [F3] (NEW) and input the file name of the new program file.

[F3](NEW)
[A][R][E][A]



2. Press [F3] (π0) and then input the password.

[F3](π0)
[C][A][S][I][O]



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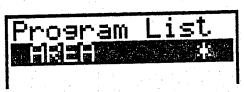
- The password input procedure is identical to that used for file name input.

3. Press [EXE] to register the file name and password. Now you can input the contents of the program file.
   - Registration of a password uses 16 bytes of memory.
   - Pressing [EXE] without inputting a password registers the file name only, without a password.

4. After inputting the program, press [QUIT] to exit the program file and return to the program list. Files that are password protected are indicated by an asterisk to the right of the file name.

[QUIT]

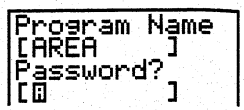


•To recall a program

Example **To recall the file named AREA which is protected by the password CASIO**

1. In the program list, use ▲ and ▼ to move the highlighting to the name of the program you want to recall.
2. Press F2 (EDIT).

F2 (EDIT)



3. Input the password and press EXE to recall the program.
   - The message **"Mismatch"** appears if you input the wrong password.

6. Searching for a File

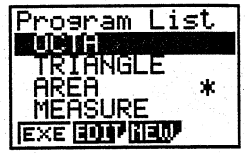
You can search for a specific file name using any of the three following methods.

- Scroll Search — scroll through the file names in the program list.
- File Name Search — input the name of the file.
- Initial Character Search — input the first few letters of the name of the file.

•To find a file using scroll search

Example **To use scroll search to recall the program named OCTA**

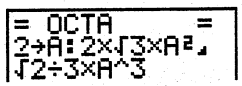
1. While the program list is on the display, use ▲ and ▼ to scroll through the list of program names until you find the one you want.



F2

2. When the highlighting is located at the name of the file you want, press F2 (EDIT) to recall it.

F2 (EDIT)

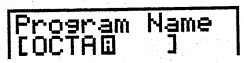


•To find a file using file name search

Example **To use file name search to recall the program named OCTA**

1. While the program list is on the display, press F3 (NEW) and input the name of the file you want to find.

F3 (NEW)
O C T A



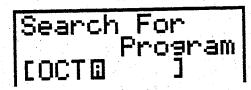
2. Press EXE to recall the program.
   - If there is no program whose file name matches the one you input, a new file is created using the input name.

•To find a file using initial character search

Example **To use initial character search to recall the program named OCTA**

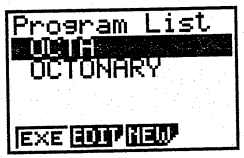
1. While the program list is on the display, press ▷ F3 (SRC) and input the initial characters of the file you want to find.

▷ F3 (SRC)
O C T



2. Press EXE to search.

EXE



   - All files whose file names start with the characters you input are recalled.
   - If there is no program whose file name starts with the characters you input, the message **"Not Found"** appears on the display. If this happens, press QUIT to clear the error message.

3. Use ▲ and ▼ to highlight the file name of the program you want to recall and then press F2 (EDIT) to recall it.

7. Editing Program Contents

•To edit program contents

1. Find the file name of the program you want in the program list.

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2. Recall the program.
   - The procedures you use for editing program contents are identical to those used for editing manual calculations. For details, see "Making Corrections".

- The following function keys are also useful when editing program contents.

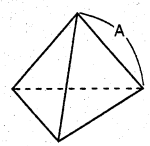
[F1] (TOP) ..... Moves the cursor to the top of the program

```
= OCTA          =
?→A:2×√3×A²◢
√2÷3×A^3
```

[F2] (BTM) ..... Moves the cursor to the bottom of the program

```
= OCTA          =
?→A:2×√3×A²◢
√2÷3×A^3_
```

Example 2 **To use the OCTA program to create a program that calculates the surface area and volume of regular tetrahedrons when the length of one side is known**



Length of One Side (A)	Surface Area (S)	Volume (V)
7 cm	cm^2	cm^3
10 cm	cm^2	cm^3
15 cm	cm^2	cm^3

The following are the formulas used for calculating surface area S and volume V of a regular tetrahedron for which the length of one side is known.

$$S = \sqrt{3}\,A^2, \quad V = \frac{\sqrt{2}}{12}\,A^3$$

Use the following key operations when inputting the program.

Length of One Side A .. [SHIFT] [PRGM] [▷] [F1](?)[→] [ALPHA] [A] [▷] [F3](:)
Surface Area S ..... [SHIFT] [√] [3] [×] [ALPHA] [A] [x^2] [▷] [▷] [F2](◢)
Volume V ..... [SHIFT] [√] [2] [÷] [1] [2] [×] [ALPHA] [A] [^] [3]

Compare this with the program for calculating the surface area and volume of a regular octahedron.

Length of One Side A .. [SHIFT] [PRGM] [▷] [F1](?)[→] [ALPHA] [A] [▷] [F3](:)
Surface Area S ..... [2] [×] [SHIFT] [√] [3] [×] [ALPHA] [A] [x^2] [▷] [▷] [F2](◢)
Volume V ..... [SHIFT] [√] [2] [÷] [3] [×] [ALPHA] [A] [^] [3]

As you can see, you can produce the TETRA program by making the following changes in the OCTA program.
- Deleting [2] [×] (underlined using a wavy line above)
- Changing [3] to [1] [2] (underlined using a solid line above)

Let's edit the program.

[F2](EDIT)

```
= OCTA          =
?→A:2×√3×A²◢
√2÷3×A^3
```

▶▶▶▶ [DEL] [DEL]

```
= OCTA          =
?→A:√3×A²◢
√2÷3×A^3
```

▼◀ [SHIFT] [INS] [1] [2]

```
= OCTA          =
?→A:√3×A²◢
√2÷12×A^3
```

[DEL]

```
= OCTA          =
?→A:√3×A²◢
√2÷12×A^3
```

[QUIT]

Let's try running the program.

Length of One Side (A)	Surface Area (S)	Volume (V)
7 cm	84.87048957 cm^2	40.42293766 cm^3
10 cm	173.2050808 cm^2	117.8511302 cm^3
15 cm	389.7114317 cm^2	397.7475644 cm^3

```
Program List
OCTA

EXE EDIT NEW
```

[F1]

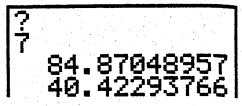
[F1] (EXE) or [EXE]

```
?
```

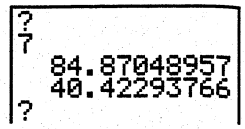
[7] [EXE]
(Value of A)

```
?
7
  84.87048957
    - Disp -
```

[EXE]



[EXE]



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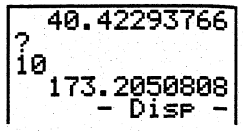
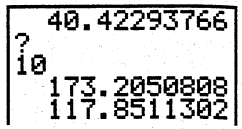
[1] [0] [EXE]



[EXE]



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8. Deleting a Program

P.140
P.141

There are two different ways to delete a file name and its program.

- Specific program delete
- All program delete

•To delete a specific program

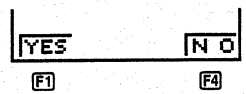
P.141

1. While the program list is on the display, use ▲ and ▼ to move the highlighting to the name of the program you want to delete.

P.141

2. Press [▷] [F1] (DEL).

[▷] [F1] (DEL)



P.142

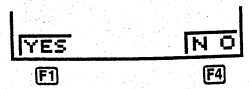
3. Press [F1] (YES) to delete the selected program or [F4] (NO) to abort the operation without deleting anything.

P.142

•To delete all programs

1. While the program list is on the display, press [▷] [F2] (DEL•A).

[▷] [F2] (DEL•A)



2. Press [F1] (YES) to delete all the programs in the list or [F4] (NO) to abort the operation without deleting anything.

- You can also delete all programs using the **MEM Mode**. See "Clearing Memory Contents" for details.

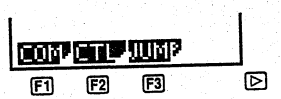
9. Useful Program Commands

In addition to calculation commands, this calculator also includes a variety of relational and jump commands that can be used to create programs that make repeat calculations quick and easy.

Program Menu

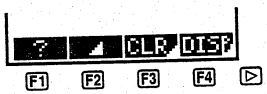
Press [SHIFT] [PRGM] to display the program menu.

[SHIFT] [PRGM]



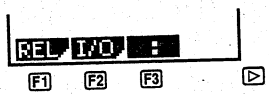
[F1] (COM) ..... Program command menu
[F2] (CTL) ..... Control command menu
[F3] (JUMP) ..... Jump command menu

[▷]



[F1] (?) ..... Input command
[F2] (◢) ..... Output command
[F3] (CLR) ..... Clear command menu
[F4] (DISP) ..... Display command menu

[▷]



[F1] (REL) ..... Conditional jump relational operator menu
[F2] (I/O) ..... Input/output command menu
[F3] (:) ..... Multi-statement command

Press [▷] to return to the previous menu.

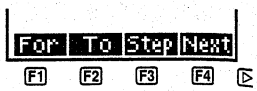
Program Command Menu (COM)

While the program menu is on the display, press F1 (COM) to display the program command menu.

F1 (COM)

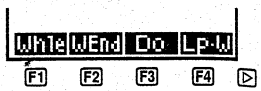
F1 (If) ..... If command
F2 (Then) ..... Then command
F3 (Else) ..... Else command
F4 (I•End) ..... IfEnd command

▷



F1 (For) ..... For command
F2 (To) ..... To command
F3 (Step) ..... Step command
F4 (Next) ..... Next command

▷



F1 (While) ..... While command
F2 (WEnd) ..... WhileEnd command
F3 (Do) ..... Do command
F4 (Lp•W) ..... LpWhile command

Press ▷ to return to the previous menu.

Control Command Menu (CTL)

While the program menu is on the display, press F2 (CTL) to display the control command menu.

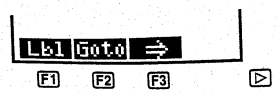
F2 (CTL)

F1 (Prog) ..... Prog command
F2 (Rtrn) ..... Return command
F3 (Brk) ..... Break command
F4 (Stop) ..... Stop command

Jump Command Menu (JUMP)

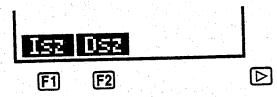
While the program menu is on the display, press F3 (JUMP) to display the jump command menu.

F3 (JUMP)



F1 (Lbl) ..... Lbl command
F2 (Goto) ..... Goto command
F3 (⇒) ..... ⇒ (jump) command

▷



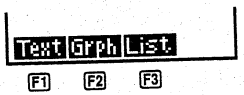
F1 (Isz) ..... Isz command
F2 (Dsz) ..... Dsz command

Press ▷ to return to the previous menu.

Clear Command Menu (CLR)

While the program menu is on the display, press ▷ F3 (CLR) to display the clear command menu.

▷ F3 (CLR)



F1 (Text) ..... ClrText command
F2 (Grph) ..... ClrGraph command
F3 (List) ..... ClrList command

Display Command Menu (DISP)

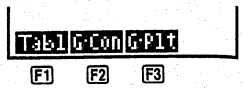
While the program menu is on the display, press ▷ F4 (DISP) to display the display command menu.

▷ F4 (DISP)

F1 (Stat) ..... DrawStat command
F2 (Grph) ..... DrawGraph command
F3 (TABL) ..... Table & Graph command menu

Pressing F3 (TABL) while the display command menu is on the display causes the Table & Graph command menu to appear.

[F3](TABL)

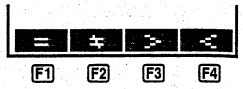


[F1] (Tabl) ..... DispTable command
[F2] (G•Con) .... DrawTG-Con command
[F3] (G•Plt) ..... DrawTG-Plt command

Conditional Jump Relational Operator Menu (REL)

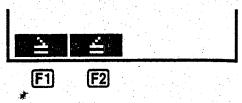
While the program menu is on the display, press [▷] [▷] [F1] (REL) to display the conditional jump relational operator menu.

[▷][▷][F1](REL)



[F1] (=) ..... Relational operator =
[F2] (≠) ..... Relational operator ≠
[F3] (>) ..... Relational operator >
[F4] (<) ..... Relational operator <

[▷]



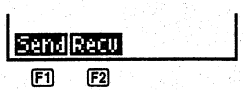
[F1] (≥) ..... Relational operator ≥
[F2] (≤) ..... Relational operator ≤

Press [▷] to return to the previous menu.

Input/Output Commands Menu (I/O)

While the program menu is on the display, press [▷] [▷] [F2] (I/O) to display the input/output command menu.

[▷][▷][F2](I/O)



[F1] (Send) ..... Send (command
[F2] (Recv) ..... Receive (command

10. Command Reference

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The following are conventions that are used in this section when describing the various commands.

Boldface Text ..... Actual commands and other items that always must be input are shown in boldface.

{Curly Brackets} ..... Curly brackets are used to enclose a number of items, one of which must be selected when using a command. Do not input the curly brackets when inputting a command.

[Square Brackets] ..... Square brackets are used to enclose items that are optional. Do not input the square brackets when inputting a command.

Numeric Expressions . Numeric expressions (such as 10, 10 + 20, A) indicate constants, calculations, numeric constants, etc.

Alpha Characters ..... Alpha characters indicate literal strings (such as AB).

■ Basic Operation Commands

? (Input Command)

Function: Prompts for input of values for assignment to variables during program execution.

Syntax: ? → <variable name>

Example: ? → A ↵

Description:

1. This command momentarily interrupts program execution and prompts for input of a value or expression for assignment to a variable. When the input command is executed, "?" to appears on the display and the calculator stands by for input.
2. Input in response to the input command must be a value or an expression, and the expression cannot be a multi-statement.

◢ (Output Command)

Function: Displays and intermediate result during program execution.

Description:

1. This command momentarily interrupts program execution and displays alpha character text or the result of the calculation immediately before it.
2. The output command should be used at locations where you would normally press the EXE key during a manual calculation.

: (Multi-statement Command)

Function: Connects two statements for sequential execution without stopping.

Description:

1. Unlike the output command (◢), statements connected with the multi-statement command are executed non-stop.
2. The multi-statement command can be used to link two calculation expressions or two commands.
3. You can also use a carriage return indicated by ↵ in place of the multi-statement command.

↵ (Carriage Return)

Function: Connects two statements for sequential execution without stopping.

Description:

1. Operation of the carriage return is identical to that of the multi-statement command.
2. Using a carriage return in place of the multi-statement command makes the displayed program easier to read.

■ Program Commands (COM)

If~Then

Function: The Then-statement is executed only when the If-condition is true (non-zero).

Syntax:

If <condition> (numeric expression) { ↵ / : / ◢ } Then <statement> [{ ↵ / : / ◢ } <statement>]

Parameters: condition, numeric expression

Description:

1. The Then-statement is executed only when the If-condition is true (non-zero).
2. If the condition is false (0), the Then-statement is not executed.
3. An If-condition must always be accompanied by a Then-statement. Omitting the Then-statement results in an error (Syn ERROR).

Example: If A = 0 ↵
Then "A = 0"

If~Then~IfEnd

Function: The Then-statement is executed only when the If-condition is true (non-zero). The IfEnd-statement is always executed: after the Then-statement is executed or directly after the If-condition when the If-condition is false (0).

Syntax:

If <condition> (numeric expression) { ↵ / : / ◢ } Then <statement>

[{ ↵ / : / ◢ } <statement>] { ↵ / : / ◢ } IfEnd

Parameters: condition, numeric expression

Description:

This command is almost identical to If~Then. The only difference is that the IfEnd-statement is always executed, regardless of whether the If-condition is true (non-zero) or false (0).

Example: If A = 0 ↵
Then "A = 0" ↵
IfEnd ↵
"END"

If~Then~Else

Function: The Then-statement is executed only when the If-condition is true (non-zero). The Else-statement is executed when the If-condition is false (0).

Syntax:

If <condition> (numeric expression) {↵ : ◢} Then <statement> [{↵ : ◢} <statement>]

{↵ : ◢} Else <statement> [{↵ : ◢} <statement>]

Parameters: condition, numeric expression

Description:

1. The Then-statement is executed when the If-conditions is true (non-zero).
2. The Else-statement is executed when the If-conditions is false (zero).

Example: If A = 0 ↵
Then "TRUE" ↵
Else "FALSE"

If~Then~Else~IfEnd

Function: The Then-statement is executed only when the If-condition is true (non-zero). The Else-statement is executed when the If-condition is false (0). The IfEnd-statement is always executed following either the Then-statement or Else-statement.

Syntax:

If <condition> (numeric expression) {↵ : ◢} Then <statement> [{↵ : ◢} <statement>]

{↵ : ◢} Else <statement> [{↵ : ◢} <statement>] {↵ : ◢} IfEnd

Parameters: condition, numeric expression

Description:

This command is almost identical to If~Then~Else. The only difference is that the IfEnd-statement is always executed, regardless of whether the If-condition is true (non-zero) or false (0).

Example: ? → A ↵
If A = 0 ↵
Then "TRUE" ↵
Else "FALSE" ↵
IfEnd ↵
"END"

For~To~Next

Function: This command repeats everything between the For-statement and the Next-statement. The starting value is assigned to the control variable with the first execution, and the value of the control variable is incremented by one with each execution. Execution continues until the value of the control variable exceeds the ending value.

Syntax:

For <starting value> → <control variable name> To <ending value> {↵ : ◢}

[<statement> {↵ : ◢}] Next

Parameters:

- control variable name: A to Z
- starting value: value or expression that produces a value (i.e. sin x, A, etc.)
- ending value: value or expression that produces a value (i.e. sin x, A, etc.)

Description:

1. When the starting value of the control variable is greater than the ending value, execution continues from the statement following Next, without executing the statements between For and Next.
2. A For-statement must always have a corresponding Next-statement, and the Next-statement must always come after its corresponding For-statement.
3. The Next-statement defines the end of the loop created by For~Next, and so it must always be included. Failure to do so results in an error (Syn ERROR).

Example: For 1 → A To 10 ↵
A × 3 → B ↵
B ◢
Next

For~To~Step~Next

Function: This command repeats everything between the For-statement and the Next-statement. The starting value is assigned to the control variable with the first execution, and the value of the control variable is changed according to the step value with each execution. Execution continues until the value of the control variable exceeds the ending value.

Syntax:

For <starting value> → <control variable name> To <ending value> Step <step value> {↵ : ◢}

Next

Parameters:

- control variable name: A to Z
- starting value: value or expression that produces a value (i.e. sin x, A, etc.)
- ending value: value or expression that produces a value (i.e. sin x, A, etc.)
- step value: numeric value (omitting this value sets the step to 1)

Description:

1. This command is basically identical to For~To~Next. The only difference is that you can specify the step.
2. Omitting the step value automatically sets the step to 1.
3. Making the starting value less than the ending value and specifying a positive step value causes the control variable to be incremented with each execution. Making the starting value greater than the ending value and specifying a negative step value causes the control variable to be decremented with each execution.

Example: For 1 → A To 10 Step 0.1 ↵
A × 3 → B ↵
B ◢
Next

Do~LpWhile

Function: This command repeats specific commands as long as its condition is true (non-zero).

Syntax:

Do { ↵ / : / ◢ } ~ LpWhile <expression>

Parameters: expression

Description:

1. This command repeats the commands contained in the loop as long as its condition is true (non-zero). When the condition becomes false (0), execution proceeds from the statement following the LpWhile-statement.
2. Since the condition comes after the LpWhile-statement, the condition is tested (checked) after all of the commands inside the loop are executed.

Example: Do ↵
? → A ↵
A × 2 → B ↵
B ◢
LpWhile B >10

While~WhileEnd

Function: This command repeats specific commands as long as its condition is true (non-zero).

Syntax:

While <expression> { ↵ / : / ◢ } ~ WhileEnd

Parameters: expression

Description:

1. This command repeats the commands contained in the loop as long as its condition is true (non-zero). When the condition becomes false (0), execution proceeds from the statement following the WhileEnd-statement.
2. Since the condition comes after the While-statement, the condition is tested (checked) before the commands inside the loop are executed.

Example: 10 → A ↵
While A > 0 ↵
A – 1 → A ↵
"GOOD" ↵
WhileEnd

■ Program Control Commands (CTL)

Break

Function: This command breaks execution of a loop and continues from the next command following the loop.

Syntax: Break ↵

Description:

1. This command breaks execution of a loop and continues from the next command following the loop.
2. This command can be used to break execution of a For-statement, Do-statement, and While-statement.

Example: While A>0 ↵
If A > 2 ↵
Then Break ↵
IfEnd ↵
WhileEnd ↵
A ◢ ←——— Executed after Break

Prog

Function: This command specifies execution of another program as a subroutine. In the RUN Mode, this command executes a new program.

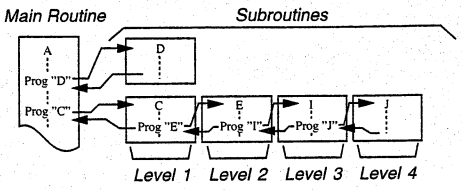
Syntax: Prog "file name" ↵

Example: Prog "ABC" ↵

Description:

1. Even when this command is located inside of a loop, its execution immediately breaks the loop and launches the subroutine.
2. This command can be used as many times as necessary inside of a main routine to call up independent subroutines to perform specific tasks.

3. A subroutine can be used in multiple locations in the same main routine, or it can be called up by any number of main routines.



4. Calling up a subroutine causes it to be executed from the beginning. After execution of the subroutine is complete, execution returns to the main routine, continuing from the statement following the Prog command.
5. A Goto~Lbl command inside of a subroutine is valid inside of that subroutine only. It cannot be used to jump to a label outside of the subroutine.
6. If a subroutine with the file name specified by the Prog command does not exist, an error (Go ERROR) occurs.
7. In the **RUN Mode**, inputting the Prog command and pressing [EXE] launches the program specified by the command.

Return

Function: This command returns from a subroutine.

Syntax: Return ↵

Description:

Execution of the Return command inside a main routine causes execution of the program to stop.

Example:

```
Prog "A"          Prog "B"
1 → A↵            For A → B To 10↵
Prog "B"↵         B + 1 → C↵
C ◢               Next↵
                  Return
```

Executing the program in File A displays the result of the operation (11).

Stop

Function: This command terminates execution of a program.

Syntax: Stop ↵

Description:

1. This command terminates program execution.
2. Execution of this command inside of a loop terminates program execution without an error being generated.

Example:

```
For 2 → I To 10↵
If I = 5↵
Then "STOP" : Stop↵
IfEnd↵
Next
```

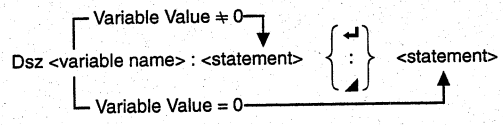
This program counts from 2 to 10. When the count reaches 5, however, it terminates execution and displays the message "STOP."

■ Jump Commands (JUMP)

Dsz

Function: This command is a count jump that decrements the value of a control variable by 1, and then jumps if the current value of the variable is zero.

Syntax:



Parameters:

Variable Name: A to Z

[Example] Dsz B : Decrements the value assigned to variable B by 1.

Description:

This command decrements the value of a control variable by 1, and then tests (checks) it. If the current value is non-zero, execution continues with the next statement. If the current value is zero, execution jumps to the statement following the multi-statement command (:), display command (◢), or carriage return (↵).

Example:

```
10 → A : 0 → C :
Lbl 1 : ? → B : B+C → C :
Dsz A : Goto 1 : C ÷ 10
```

This program prompts for input of 10 values, and then calculates the average of the input values.

Goto~Lbl

Function: This command performs an unconditional jump to a specified location.

Syntax: Goto <value or variable> ~ Lbl <value or variable>

Parameters: Value (from 0 to 9), variable (A to Z)

Description:

1. This command consists of two parts: Goto *n* (where *n* is a value from 0 to 9) and Lbl *n* (where *n* is the value specified for Goto). This command causes program execution to jump to the Lbl-statement whose value matches that specified by the Goto-statement.
2. This command can be used to loop back to the beginning of a program or to jump to any location within the program.

3. This command can be used in combination with conditional jumps and count jumps.
4. If there is no Lbl-statement whose value matches that specified by the Goto-statement, an error (Go ERROR) occurs.

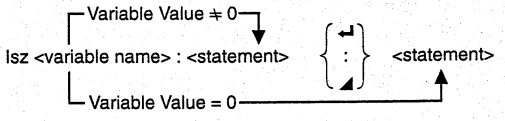
Example: ? → A : ? → B : Lbl 1 :
? → X : A × X + B ◢
Goto 1

This program calculates $y = AX + B$ for as many values for each variable that you want to input. To quit execution of this program, press [AC].

Isz

Function: This command is a count jump that increments the value of a control variable by 1, and then jumps if the current value of the variable is zero.

Syntax:



Parameters:

Variable Name: A to Z

[Example] Isz A : Increments the value assigned to variable A by 1.

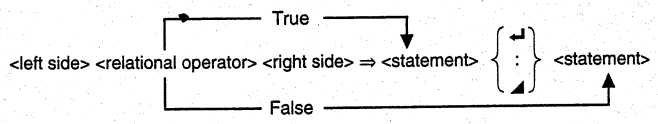
Description:

This command increments the value of a control variable by 1, and then tests (checks) it. If the current value is non-zero, execution continues with the next statement. If the current value is zero, execution jumps to the statement following the multi-statement command (:), display command (◢), or carriage return (↵).

⇒ (Jump Code)

Function: This code is used to set up conditions for a conditional jump. The jump is executed whenever the conditions are false.

Syntax:



Parameters:

left side/right side: variable (A to Z), numeric constant, variable expression (such as: A × 2)

relational operator: =, ≠, >, <, ≥, ≤

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Description:

1. The conditional jump compares the contents of two variables or the results of two expressions, and a decision is made whether or not to execute the jump based on the results of the comparison.
2. If the comparison returns a true result, execution continues with the statement following the ⇒ command. If the comparison returns a false result, execution jumps to the statements following the multi-statement command (:), display command (◢), or carriage return (↵).

Example: Lbl 1 : ? → A :
A ≧ 0 ⇒ √A ◢
Goto 1

With this program, inputting a value of zero or greater calculates and displays the square root of the input value. Inputting a value less than zero returns to the input prompt without calculating anything.

■ Clear Commands (CLR)

ClrGraph

Function: This command clears the graph screen.

Syntax: ClrGraph↵

Description: This command clears the graph screen during program execution.

ClrList

Function: This command clears list data.

Syntax: ClrList↵

Description: This command clears the contents of the currently selected list (List 1 to List 6) during program execution.

ClrText

Function: This command clears the text screen.

Syntax: ClrText↵

Description:

This command clears text from the screen during program execution.

■ Display Commands (DISP)

DrawStat

Function: This draws a statistical graph.

Syntax:

DrawStat↵

Description:

This command draws a statistical graph in accordance with conditions defined within the program.

DrawGraph

Function: This command draws a graph.

Syntax: DrawGraph ↵

Description: This command draws a graph in accordance with the drawing conditions defined within the program.

DispTable

Function: These commands display numeric tables.

Syntax:

DispTable ↵

Description:

These commands generate numeric tables during program execution in accordance with conditions defined within the program.

DrawTG-Con, DrawTG-Plt

Function: These commands graph functions.

Syntax:

DrawTG-Con ↵

DrawTG-Plt ↵

Description:

1. These commands graph functions in accordance with conditions defined within the program.
2. DrawTG-Con produces a connect type graph, while DrawTG-Plt produces a plot type graph.

■ Input/Output Commands (I/O)

Receive (

Function: This command receives data from an external device.

Syntax: Receive (<data>) (...ex. Receive (List 1))

Description:

1. This command receives data from an external device.
2. The following types of data can be received by this command.
   - Individual values assigned to variables
   - List data (all values - individual values cannot be specified)

Send (

Function: This command sends data to an external device.

Syntax: Send (<data>) (...ex. Send (List 1))

Description:

1. This command sends data to an external device.
2. The following types of data can be sent by this command.
   - Individual values assigned to variables
   - List data (all values - individual values cannot be specified)

■ Conditional Jump Relational Operators (REL)

=, ≠, >, <, ≥, ≤

Function: These relational operators are used in combination with the conditional jump command.

Syntax:

<left side> <relational operator> <right side> ⇒ <statement> { ↵ / : / ◢ } <statement>

(With Jump Code)

Parameters:

left side/right side: variable (A to Z), numeric constant, variable expression (such as: A × 2)

relational operator: =, ≠, >, <, ≥, ≤

Description:

1. The following six relational operators can be used in the conditional jump command
   - <left side> = <right side> : true when <left side> equals <right side>
   - <left side> ≠ <right side> : true when <left side> does not equal <right side>
   - <left side> > <right side> : true when <left side> is greater than <right side>
   - <left side> < <right side> : true when <left side> is less than <right side>
   - <left side> ≥ <right side> : true when <left side> is greater than or equal to <right side>
   - <left side> ≤ <right side> : true when <left side> is less than or equal to <right side>
2. See "⇒ (Jump Code)" for details on using the conditional jump.

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11. Text Display

You can include text in a program by simply enclosing it between double quotation marks. Such text appears on the display during program execution, which means you can add labels to input prompts and results.

Program	Display
? → X	?
"X =" ? → X	X = ?

- If the text is followed by a calculation formula, be sure to insert a display command (◢) between the text and calculation.
- Inputting more than 13 characters causes the text to move down to the next line. The screen scrolls automatically if the text causes the screen to become full.

12. Using Calculator Functions in Programs

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■ Using Graph Functions in a Program

You can incorporate graph functions into a program to draw complex graphs and to overlay graphs on top of each other. The following shows various types of syntax you need to use when programming with graph functions.

- View Window

  View Window –5, 5, 1, –5, 5, 1 ↵
- Graph function input

  Y = Type ↵ ..... Specifies graph type.

  "X² – 3" → Y1 ↵
- Graph draw operation

  DrawGraph ↵

Example Program

① ClrGraph ↵
② View Window –10, 10, 2, –120, 150, 50 ↵
③ Y = Type ↵
"X ^ 4–X ^ 3–24X² + 4X + 80" → Y1 ↵ (④)
⑤ G SelOn 1 ↵
⑥ DrawGraph

① SHIFT PRGM ▷ F3 F2
② SHIFT F3 F1 QUIT
③ F3 F3 F2 F1 QUIT
④ VARS ▷ F2 F1 QUIT
⑤ F3 F3 F1 F1
⑥ SHIFT PRGM ▷ F4 F2

Executing this program produces the result shown here.

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■ Using Table & Graph Functions in a Program

Table & Graph functions in a program can generate numeric tables and perform graphing operations. The following shows various types of syntax you need to use when programming with Table & Graph functions.

- Table range setting

  1 → F Start ↵

  5 → F End ↵

  1 → F pitch ↵
- Numeric table generation

  DispTable ↵
- Graph draw operation

  Connect type: DrawTG-Con ↵

  Plot type: DrawTG-Plt ↵

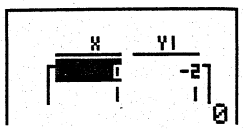
Example Program

ClrGraph ↵
ClrText ↵
View Window 0, 6, 1, –2, 106, 20 ↵
Y = Type ↵
"3X² – 2" → Y1 ↵
① T SelOn 1 ↵
0 → ② F Start ↵
6 → ③ F End ↵
1 → ④ F pitch ↵
⑤ DispTable ◢
⑥ DrawTG-Con

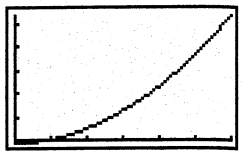
① F3 F4 F1 QUIT
② VARS ▷ F3 F1
③ F2
④ F3 QUIT
⑤ SHIFT PRGM ▷ F4 F3 F1 QUIT
⑥ SHIFT PRGM ▷ F4 F3 F2 QUIT

Executing this program produces the results shown here.

Numeric Table



Graph
EXE



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■ Using List Sort Functions in a Program

These functions let you sort the data in lists into ascending or descending order.

• Ascending order

① SortA (② List 1, List 2, List 3)

Lists to be sorted (up to six can be specified)

① F3 F2 F1 QUIT

② OPTN F1 F1

• Descending order

SortD (List 1, List 2, List 3)

Lists to be sorted (up to six can be specified)

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■ Using Statistical Calculations and Graphs in a Program

Including statistical calculations and graphing operations into program lets you calculate and graph statistical data.

•To set conditions and draw a statistical graph

Following "StatGrph", you must specify the following graph conditions:

- Graph draw/non-draw status (DrawOn/DrawOff)
- Graph Type
- x-axis data location (list name)
- y-axis data location (list name)
- Frequency data location (list name)
- Mark Type

The graph conditions that are required depends on the graph type. See "Changing Graph Parameters".

- The following is a typical graph condition specification for a scatter diagram or xy line graph.

  S-Gph1 DrawOn, Scatter, List1, List2, 1, Square↵

  In the case of an xy line graph, replace "Scatter" in the above specification with "xyLine".

- The following is a typical graph condition specification for a pie chart.

  S-Gph1 DrawOn, Pie, List1, % (data display format)↵

- The following is a typical graph condition specification for a stacked bar chart, bar graph, or line graph.

  Stacked bar chart: ..... S-Gph1 DrawOn, StackedBar, List1↵

  Bar graph: ..... S-Gph1 DrawOn, Bar, List1↵

  Line graph: ..... S-Gph1 DrawOn, LineG, List1↵

- The following is a typical graph condition specification for a superimposed bar and line graph.

  S-Gph1 DrawOn, Both, List1 (bar graph list), List2 (line graph list), Sep. G(AutoWin setting)↵

- The following is a typical graph condition specification for a single-variable graph.

  S-Gph1 DrawOn, Hist, List1, List2↵

  The same format can be used for the following types of graphs, by simply replacing "Hist" in the above specification with the applicable graph type.

  Histogram: ..... Hist

  Median Box: ..... MedBox

  Normal Distribution: ..... N-Dist

- The following is a typical graph condition specification for a regression graph.

  S-Gph1 DrawOn, Linear, List1, List2, List3↵

  The same format can be used for the following types of graphs, by simply replacing "Linear" in the above specification with the applicable graph type.

  Linear Regression: ..... Linear

  Med-Med: ..... Med-Med

  Quadratic Regression: ... Quad

  Logarithmic Regression: . Log

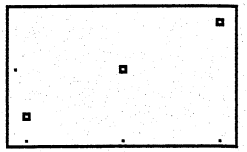
  Exponential Regression: Exp

  Power Regression : ..... Power

Example Program

ClrGraph↵	① SHIFT SETUP ▷ ▷ ▷ F1 QUIT
①S-WindAuto↵	② OPTN F1 F1
{1, 2, 3} → ②List 1↵	③ F1 QUIT
{1, 2, 3} → ③List 2↵	④ F3 F1 F2 F1 QUIT
④S-Gph1 ⑤DrawOn,	⑤ F3 F1 F1 F1 QUIT
⑥Scatter, List1, List2, 1, ⑦Square↵	⑥ F3 F1 F2 ▷ F1 QUIT
⑧DrawStat	⑦ F3 F1 F4 F1 QUIT
	⑧ SHIFT PRGM ▷ F4 F1 QUIT

Executing this program produces the scatter diagram shown here.



■ Performing Statistical Calculations

• Single-variable statistical calculation

① 1-Variable List 1, List 2
- List 2: *Frequency data (Frequency)*
- List 1: *x-axis data (XList)*

① F3 F1 ▷ F1 F1 QUIT

```
1-Variable
   x̄= 2.33333
  Σx=        14
 Σx²=        36
 xσn= 0.74535
```

• Paired-variable statistical calculation

2-Variable List 1, List 2, List 3
- List 3: *Frequency data (Frequency)*
- List 2: *y-axis data (YList)*
- List 1: *x-axis data (XList)*

```
2-Variable
   x̄= 2.33333
  Σx=        14
 Σx²=        36
 xσn= 0.74535
```


• Regression statistical calculation

①LinearReg List 1, List 2, List 3
- *Calculation type**
- List 3: *Frequency data (Frequency)*
- List 2: *y-axis data (YList)*
- List 1: *x-axis data (XList)*

① F3 F1 ▷ F1 ▷ F1 QUIT

```
LinearReg
   a= 0.64641
   b=-0.71186
   r= 0.87959
y=ax+b
```

* Any one of the following can be specified as the calculation type.

LinearReg ..... linear regression
Med-MedLine .. Med-Med calculation
QuadReg ..... quadratic regression
LogReg ..... logarithmic regression
ExpReg ..... exponential regression
PowerReg ..... power regression

Chapter 9

Data Communications

This chapter tells you everything you need to know to transfer programs between the fx-7400G PLUS and certain CASIO Graphic Scientific Calculator models connected with an optionally available SB-62 cable. To transfer data between a unit and a personal computer, you will need to purchase the separately available CASIO Interface Unit.

This chapter also contains information on how to use the optional SB-62 cable to connect to a CASIO Label Printer to transfer screen data for printing.

1. **Connecting Two Units**
2. **Connecting the Unit with a Personal Computer**
3. **Connecting the Unit with a CASIO Label Printer**
4. **Before Performing a Data Communication Operation**
5. **Performing a Data Transfer Operation**
6. **Screen Send Function**
7. **Data Communications Precautions**

1. Connecting Two Units

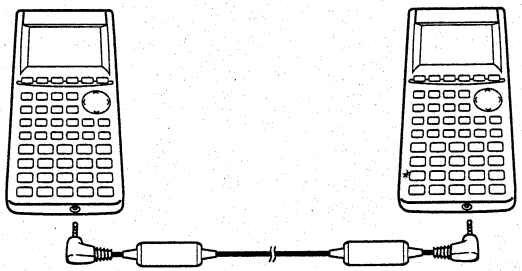
The following procedure describes how to connect two units with an optional SB-62 connecting cable for transfer of programs between them.

•To connect two units

1. Check to make sure that the power of both units is off.

2. Remove the covers from the connectors of the two units.
   - Be sure you keep the connector covers in a safe place so you can replace them after you finish your data communications.

3. Connect the two units using the SB-62 cable.



SB-62 cable

- Keep the connectors covered when you are not using them.

2. Connecting the Unit with a Personal Computer

To transfer data between the unit and a personal computer, you must connect them through a separately available CASIO Interface Unit.

For details on operation, the types of computer that can be connected, and hardware limitations, see the user's guide that comes with the Interface Unit.

Some types of data may not be able to be exchanged with a personal computer.

•To connect the unit with a personal computer

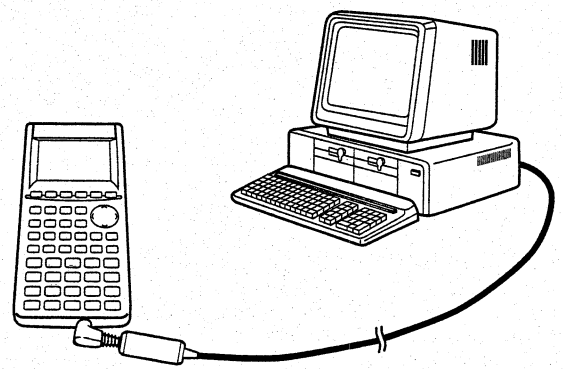
1. Check to make sure that the power of the unit and the personal computer is off.

2. Connect the personal computer to the Interface Unit.

3. Remove the cover from the connector of the unit.
   - Be sure you keep the connector cover in a safe place so you can replace it after you finish your data communications.

4. Connect the unit to the Interface Unit.

5. Turn on the power of the unit, followed by the personal computer.
   - After you finish data communications, turn off power in the sequence: the unit first, and then the personal computer. Finally, disconnect the equipment.



3. Connecting the Unit with a CASIO Label Printer

After you connect the unit to a CASIO Label Printer with an optional SB-62 cable, you can use the Label Printer to print screen shot data from the unit. See the user's guide that comes with your Label Printer for details on how to perform this operation.

- The operation described above can be performed using the following Label Printer models: KL-2000, KL-2700, KL-8200, KL-8700 (as of February 1999).

•To connect the unit with a Label Printer

1. Check to make sure that the power of the unit and the Label Printer is off.
2. Connect the optional SB-62 cable to the Label Printer.

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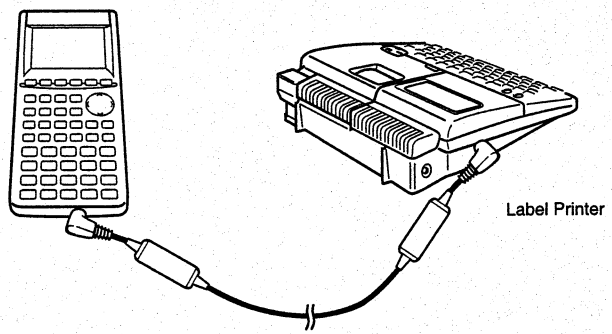
3. Remove the cover from the connector of the unit.
   - Be sure you keep the connector cover in a safe place so you can replace it after you finish your data communications.
4. Connect the other end of the SB-62 cable to the unit.
5. Turn on the power of the unit, followed by the Label Printer.



Label Printer

SB-62 cable

- After you finish data communications, turn off power in the sequence: the unit first, and then the Label Printer. Finally, disconnect the equipment.

4. Before Performing a Data Communication Operation

In the Main Menu, select the **LINK** icon and enter the LINK Mode. The following data communication main menu appears on the display.

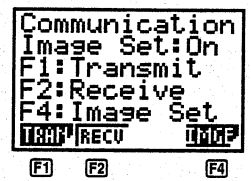


Image Set: ..... Indicates the status of the graphic image send features.
- Off: Graphic images not sent.
- On: Pressing F-D sends graphic images.

F1 (TRAN) ..... Menu of send settings
F2 (RECV) ..... Menu of receive settings
F4 (IMGE) ..... Menu of graphic image transfer settings

Communications parameters are fixed at the following settings.

- Speed (BPS): 9600 bits per second
- Parity (PARITY): NONE

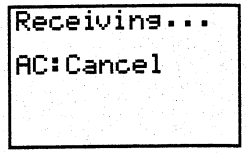
5. Performing a Data Transfer Operation

Connect the two units and then perform the following procedures.

Receiving unit

To set up the calculator to receive data, press [F2] (RECV) while the data communication main menu is displayed.

[F2] (RECV)

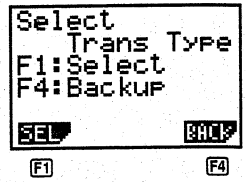


The calculator enters a data receive standby mode and waits for data to arrive. Actual data receive starts as soon as data is sent from the sending unit.

Sending unit

To set up the calculator to send data, press [F1] (TRAN) while the data communication main menu is displayed.

[F1] (TRAN)



Press the function key that corresponds to the type of data you want to send.

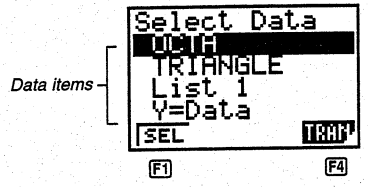
[F1] (SEL) ..... Selects data items and sends them

[F4] (BACK) ..... All memory contents, including mode settings

•To send selected data items

Press [F1] (SEL) to display a data item selection screen.

[F1] (SEL)



[F1] (SEL) ..... Selects data item where cursor is located.

[F4] (TRAN) ..... Sends selected data items.

Use the ▲ and ▼ cursor keys to move the cursor to the data item you want to select and press [F1] (SEL) to select it. Currently selected data items are marked with "▶". Pressing [F4] (TRAN) sends all the selected data items.

- To deselect a data item, move the cursor to it and press [F1] (SEL) again.

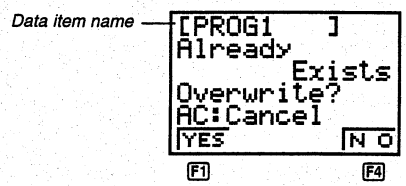
Only items that contain data appear on the data item selection screen. If there are too many data items to fit on a single screen, the list scrolls when you move the cursor to the bottom line of the items on the screen.

The following are the types of data items that can be sent.

Data Item	Contents	Overwrite Check*1	Password Check*2
Program	Program contents	Yes	Yes
List *n*	List memory (1 to 6) contents	Yes	
Y=Data	Graph expressions, graph write/non-write status, View Window contents, zoom factors	No	
V-Win	View Window memory contents	No	
Variable	Variable assignments	No	

*1 No overwrite check: If the receiving unit already contains the same type of data, the existing data is overwritten with the new data.

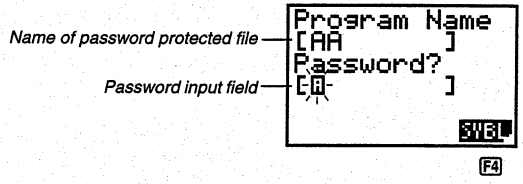
With overwrite check: If the receiving unit already contains the same type of data, a message appears to ask if the existing data should be overwritten with the new data.



F1 (YES) ..... Replaces the receiving unit's existing data with the new data.

F4 (NO) ..... Skips to next data item.

*2 With password check: If a file is password protected, a message appears asking for input of the password.



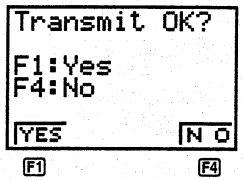
F4 (SYBL) ..... Symbol input

After inputting the password, press EXE.

•To execute a send operation

After selecting the data items to send, press F4 (TRAN). A message appears to confirm that you want to execute the send operation.

F4 (TRAN)

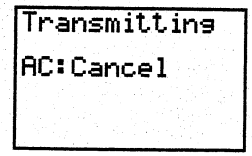


F1 (YES) ..... Sends data.

F4 (NO) ..... Returns to data selection screen.

Press F1 (YES) to send the data.

F1 (YES)

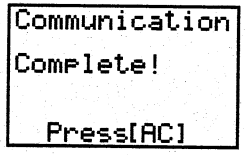


- You can interrupt a data operation at any time by pressing AC.

The following shows what the displays of the sending and receiving units look like after the data communication operation is complete.

Sending Unit

Receiving Unit



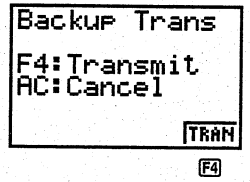
Press AC to return to the data communication main menu.

•To send backup data

This operation allows you to send all memory contents, including mode settings.

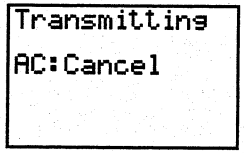
While the send data type selection menu is on the screen, press F4 (BACK), and the back up send menu shown below appears.

F4 (BACK)



Press F4 (TRAN) to start the send operation.

F4 (TRAN)



The following shows what the displays of the sending and receiving units look like after the data communication operation is complete.

Sending Unit	Receiving Unit
Communication Complete! Press[AC]	Communication Complete! Press[AC]

Press [AC] to return to the data communication main menu.

- Data can become corrupted, necessitating a RESET of the receiving unit, should the connecting cable become disconnected during data transfer. Make sure that the cable is securely connected to both units before performing any data communication operation.

6. Screen Send Function

The following procedure sends a bit mapped screen shot of the display to a connected computer.

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•To send the screen

1. Connect the unit to a personal computer or to a CASIO Label Printer.
2. In the data communication main menu, press [F4] (IMGE), and the following display appears.

[F4](IMGE)

```
Image Set
F1:Off
F2:On
[F-D]key:Copy
 Off  On
```

[F1] [F2]

[F1](Off) ..... Graphic images not sent
[F2](On) ..... Bitmap

3. Display the screen you want to send.
4. Set up the personal computer or Label Printer to receive data. When the other unit is ready to receive, press [F-D] to start the send operation.

You cannot send the following types of screens to a computer.

- The screen that appears while a data communication operation is in progress.
- A screen that appears while a calculation is in progress.
- The screen that appears following the reset operation.
- The low battery message.

- The flashing cursor is not included in the screen image that is sent from the unit.
- If you send a screen shot of any of the screens that appear during the data send operation, you will not be able to then use the sent screen to proceed with the data send operation. You must exit the data send operation that produced the screen you sent and restart the send operation before you can send additional data.
- You cannot use 6mm wide tape to print a screen shot of a graph.

7. Data Communications Precautions

Note the following precautions whenever you perform data communications.

- An error occurs whenever you try to send data to a receiving unit that is not yet standing by to receive data. When this happens, press [AC] to clear the error and try again, after setting up the receiving unit to receive data.
- An error occurs whenever the receiving unit does not receive any data approximately six minutes after it is set up to receive data. When this happens, press [AC] to clear the error.
- An error occurs during data communications if the cable becomes disconnected, if the parameters of the two units do not match, or if any other communications problem occurs. When this happens, press [AC] to clear the error and correct the problem before trying data communications again. If data communications are interrupted by [AC] key operation or an error, any data successfully received up the interruption will be in the memory of the receiving unit.
- An error occurs if the receiving unit memory becomes full during data communications. When this happens, press [AC] to clear the error and delete unneeded data from the receiving unit to make room for the new data, and then try again.
- To send picture (graph) memory data, the receiving unit need 1-kbytes of memory for use as a work area in addition to the data being received.

Chapter 10

Program Library

1 **Prime Factor Analysis**
2 **Greatest Common Measure**
3 ***t*-Test Value**
4 **Circle and Tangents**
5 **Rotating a Figure**

Before using the Program Library

- Be sure to check how many bytes of unused memory is remaining before attempting to perform any programming.
- This Program Library is divided into two sections: a numeric calculation section and a graphics section. Programs in the numeric calculation section produce results only, while graphics programs use the entire display area for graphing. Also note that calculations within graphics programs do not use the multiplication sign (×) wherever it can be dropped (i.e. in front of open parenthesis).

CASIO PROGRAM SHEET

Program for	No.
Prime Factor Analysis	1

Description

Produces prime factors of arbitrary positive integers

For $1 < m < 10^{10}$

Prime numbers are produced from the lowest value first. "END" is displayed at the end of the program.

(Overview)

m is divided by 2 and by all successive odd numbers ($d = 3, 5, 7, 9, 11, 13, ...$) to check for divisibility.

Where d is a prime factor, $m_i = m_{i-1}/d$ is assumed, and division is repeated until $\sqrt{m_i} + 1 \leqq d$.

Example

[1]

$119 = 7 \times 17$

[2]

$440730 = 2 \times 3 \times 3 \times 5 \times 59 \times 83$

[3]

$262701 = 3 \times 3 \times 17 \times 17 \times 101$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	F1 (EXE)	M?	11	EXE	83
2	119 EXE	7	12	EXE	END
3	EXE	17	13	EXE	M?
4	EXE	END	14	262701 EXE	3
5	EXE	M?	15	EXE	3
6	440730 EXE	2	16	EXE	17
7	EXE	3	17	EXE	17
8	EXE	3	18	EXE	101
9	EXE	5	19	EXE	END
10	EXE	59	20		

: No. 1

Line	Program																			
File name	P	R	M	"	F	A	C	T												
1	Lbl	0	:	"	M	"	?	→	A	:	Goto	2	:							
2	Lbl	1	:	2	◢	A	÷	2	→	A	:	A	=	1	⇒	Goto	9	:		
3	Lbl	2	:	Frac	(	A	÷	2	)	=	0	⇒	Goto	1	:	3	→	B	:	
4	Lbl	3	:	√‾	A	+	1	→	C	:										
5	Lbl	4	:	B	≥	C	⇒	Goto	8	:	Frac	(	A	÷	B	)	=	0	⇒	
6	Goto	6	:																	
7	Lbl	5	:	B	+	2	→	B	:	Goto	4	:								
8	Lbl	6	:	A	÷	B	×	B	−	A	=	0	⇒	Goto	7	:	Goto	5	:	
9	Lbl	7	:	B	◢	A	÷	B	→	A	:	Goto	3	:						
10	Lbl	8	:	A	◢															
11	Lbl	9	:	"	E	N	D	"	◢	Goto	0									
12																				
13																				
14																				
15																				
16																				
17																				
18																				
19																				
20																				
21																				
22																				
23																				
24																				
25																				
26																				
27																				

Memory Contents												
A	m_i	H		O		V	
B	d	I		P		W	
C	$\sqrt{m_i}+1$	J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M		T			
G		N		U			

CASIO PROGRAM SHEET

Program for	No.
Greatest Common Measure	**2**

Description

Euclidean general division is used to determine the greatest common measure for two interers a and b.

For $|a|, |b| < 10^9$, positive values are taken as $< 10^{10}$

(Overview)

$n_0 = \max(|a|, |b|)$

$n_1 = \min(|a|, |b|)$

$$n_k = n_{k-2} - \left[\frac{n_{k-2}}{n_{k-1}}\right] n_{k-1}$$

$k = 2, 3....$

If $n_k = 0$, then the greatest common measure (c) will be n_{k-1}.

Example

	[1]	[2]	[3]
When	$a = 238$	$a = 23345$	$a = 522952$
	$b = 374$	$b = 9135$	$b = 3208137866$
	↓	↓	↓
	$c = 34$	$c = 1015$	$c = 998$

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	F1 (EXE)	A?	11		
2	238 EXE	B?	12		
3	374 EXE	34	13		
4	EXE	A?	14		
5	23345 EXE	B?	15		
6	9135 EXE	1015	16		
7	EXE	A?	17		
8	522952 EXE	B?	18		
9	3208137866 EXE	998	19		
10			20		

No. **2**

Line	Program
File name	C M N F A C T
1	Lbl 1 : " A " ? → A : " B " ? → B :
2	Abs A → A : Abs B → B :
3	B < A ⇒ Goto 2 :
4	A → C : B → A : C → B :
5	Lbl 2 : (-) (Int (A ÷ B) × B − A) → C :
6	C = 0 ⇒ Goto 3 :
7	B → A : C → B : Goto 2 :
8	Lbl 3 : B ◢ Goto 1
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	

Memory Contents

A	a, n_0	H		O		V	
B	b, n_1	I		P		W	
C	n_k	J		Q		X	
D		K		R		Y	
E		L		S		Z	
F		M		T			
G		N		U			

CASIO PROGRAM SHEET

Program for	No.
***t*-Test Value**	3

Description

The mean (sample mean) and sample standard deviation can be used to obtain a *t*-test value.

$$t = \frac{(\bar{x} - m)}{\frac{x\sigma_{n-1}}{\sqrt{n}}}$$

$\bar{x}$: mean of x data
$x\sigma_{n-1}$: sample standard deviation of x data
n : number of data items
m : hypothetical population standard deviation (normally represented by μ, but m is used here because of variable name limitations)

Example

To determine whether the population standard deviation for sample data 55, 54, 51, 55, 53, 53, 54, 52, is 53.

Perform a *t*-test with a level of significance of 5%.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Step	Key operation	Display	Step	Key operation	Display
1	F1 (EXE)	M?	3		
2	53 EXE	T= 0.7533708035	4		

The above operation produces a *t*-test value of $t(53) = 0.7533708035$. According to the *t*-distribution table in the next page, a level of significance of 5% and a degree of freedom of 7 ($n - 1 = 8 - 1 = 7$) produce a two-sided *t*-test value of approximately 2.365. Since the calculated *t*-test value is lower than the table value, the hypothesis that population mean m equals 53 is accepted.

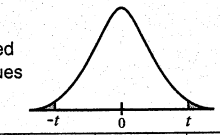
No.	3

Line	Program
File name	T T E S T
1	{ 5 5 , 5 4 , 5 1 , 5 5 , 5 3 , 5 3 ,
2	5 4 , 5 2 } → List 1 ↵
3	l-Var List 1 , 1 ↵
4	Lbl 0 : " M " ? → M ↵
5	($\bar{x}$ − M) ÷ ($x\sigma_{n-1}$ ÷ √‾ n) → T ↵
6	" T = " : T ◢
7	Goto 0

Memory Contents												
	A		H		O		V	
	B		I		P		W	
	C		J		Q		X	
	D		K		R		Y	
	E		L		S		Z	
	F		M	m	T	t		
	G		N		U			

• *t*-distribution table

The values in the top row of the table show the probability (two-sided probability) that the absolute value of t is greater than the table values for a given degree of freedom.



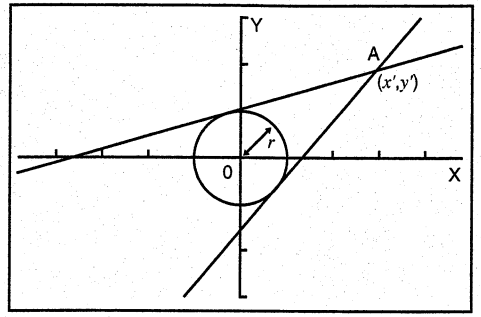
M : ALPHA M
T : ALPHA T

Degree of Freedom \ P (Probability)	0.2	0.1	0.05	0.01
1	3.078	6.314	12.706	63.657
2	1.886	2.920	4.303	9.925
3	1.638	2.353	3.182	5.841
4	1.533	2.132	2.776	4.604
5	1.476	2.015	2.571	4.032
6	1.440	1.943	2.447	3.707
7	1.415	1.895	2.365	3.499
8	1.397	1.860	2.306	3.355
9	1.383	1.833	2.262	3.250
10	1.372	1.812	2.228	3.169
15	1.341	1.753	2.131	2.947
20	1.325	1.725	2.086	2.845
25	1.316	1.708	2.060	2.787
30	1.310	1.697	2.042	2.750
35	1.306	1.690	2.030	2.724
40	1.303	1.684	2.021	2.704
45	1.301	1.679	2.014	2.690
50	1.299	1.676	2.009	2.678
60	1.296	1.671	2.000	2.660
80	1.292	1.664	1.990	2.639
120	1.289	1.658	1.980	2.617
240	1.285	1.651	1.970	2.596
∞	1.282	1.645	1.960	2.576

CASIO PROGRAM SHEET

Program for	No.
Circle and Tangents	4

Description



Formula for circle:
$x^2 + y^2 = r^2$

Formula for tangent line passing through point A (x', y'):
$y - y' = m(x - x')$

* m represents the slope of the tangent line

With this program, slope m and intercept b $(= y' - mx')$ are obtained for lines drawn from point A (x', y') and are tangent to a circle with a radius of r. The trace function is used to read out the coordinates at the points of tangency, and factor zoom is used to enlarge the graph.

Example

To determine m and b for the following values:

$r = 1$
$x' = 3$
$y' = 2$

Notes

- The point plotted for A cannot be moved. Even if it is moved on the graph, the calculation is performed using the original value.
- An error (Ma ERROR) occurs when $r = x'$.
- Be sure to always perform a trace operation whenever you select trace and the message TRACE is on the display.

Preparation and operation

- Store the program written on the next page.
- Execute the program as shown below.

Memory Contents								
	A		H		O		V	
	B		I		P		W	
	C		J		Q		X	
	D		K		R		Y	
	E		L		S		Z	
	F		M		T			
	G		N		U			

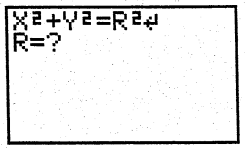
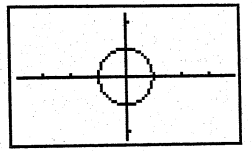
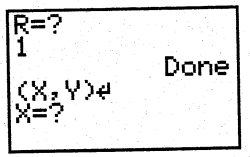
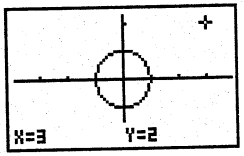
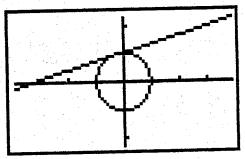
No. 4

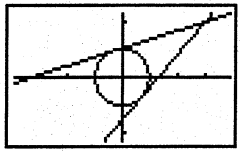
Line	Program
File name	T A N G E N T
1	Prog " W I N D O W " ↵
2	" X x^2 + Y x^2 = R x^2 ↵
3	R = " ? → R ↵
4	Prog " C I R C L E " ◢
5	" (X , Y) ↵
6	X = " ? → A ↵
7	" Y = " ? → B ↵
8	Plot A , B ◢
9	R x^2 (A x^2 + B x^2 − R x^2) → P ↵
10	(√ P − A B) (R x^2 − A x^2) x^{-1} → M ↵
11	Lbl 6 ↵
12	Graph Y= M (X − A) + B ◢
13	" M = " : M ◢
14	" B = " : B − M A ◢
15	Lbl 0 ↵
16	" T R A C E ? ↵
17	Y E S ⇒ 1 ↵
18	N O ⇒ 0 " : ? → Z ↵
19	1 → S : Z = 1 ⇒ Goto 1 ↵
20	Z = 0 ⇒ Goto 2 : Goto 0 ↵
21	Lbl 2 ↵
22	((−) A B − √ P) (R x^2 − A x^2) x^{-1} → N ↵
23	Graph Y= N (X − A) + B ◢
24	" M = " : N ◢
25	" B = " : B − N A ◢
26	Lbl 5 ↵
27	" T R A C E ? ↵
28	Y E S ⇒ 1 ↵
29	N O ⇒ 0 " : ? → Z ↵
30	2 → S : Z = 1 ⇒ Goto 1 ↵
31	Z = 0 ⇒ Goto 3 : Goto 5 ↵
32	Lbl 1 ↵
33	" T R A C E " ◢
34	" Factor N : N = " ? → F : Factor F ↵

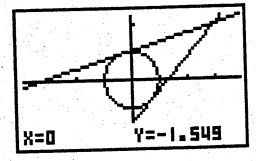
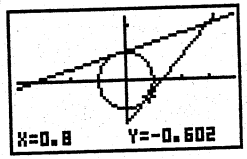
No. 4

Line	Program
35	Prog " C I R C L E " : S = 1 ⇒ Goto 9 ↵
36	S = 2 ⇒ Graph Y= M (X − A) + B ↵
37	Graph Y= N (X − A) + B ◢
38	Goto 3 ↵
39	Lbl 9 ↵
40	Graph Y= M (X − A) + B ◢
41	Prog " W I N D O W " : Prog " C I R C L E "
42	: Goto 6 ↵
43	Lbl 3 ↵
44	" E N D "
File name	W I N D O W
1	View Window (−) 3 . 9 , 3 . 9 , 1 , (−) 2 . 3 , 2 .
2	3 , 1
File name	C I R C L E
1	Graph Y= √ (R x^2 − X x^2) ↵
2	Graph Y= (−) √ (R x^2 − X x^2)

Program for **Circle and Tangents** No. 4

Step	Key Operation	Display
1	F1 (EXE)	
2	1 EXE	
3	EXE	
4	3 EXE 2 EXE	
5	EXE	

Program for **Circle and Tangents**		No. **4**
Step	**Key Operation**	**Display**
6	EXE	Done Done M= 0.3169872981 - Disp -
7	EXE	M= 0.3169872981 B= 1.049038106 - Disp -
8	EXE	1.049038106 TRACE?↵ YES⇒1↵ NO⇒0 ?
9	0 EXE	
10	EXE	0 Done M= 1.183012702 - Disp -

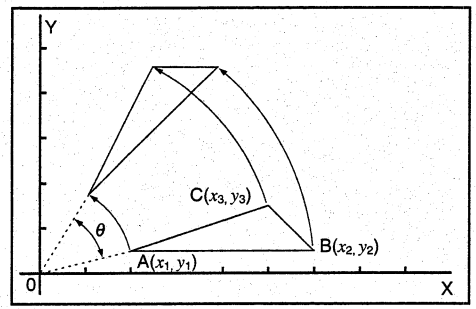
Program for **Circle and Tangents**		No. **4**
Step	**Key Operation**	**Display**
11	EXE	M= 1.183012702 B= -1.549038106 - Disp -
12	EXE	-1.549038106 TRACE?↵ YES⇒1↵ NO⇒0 ?
13	1 EXE	NO⇒0 ? 1 TRACE - Disp -
14	SHIFT F1 (TRC)	
15	▶~▶	

Program for Circle and Tangents		No. 4
Step	**Key Operation**	**Display**
16	EXE	NO⇒0 ? 1 TRACE Factor N:N=?
17	4 EXE	
18	EXE	TRACE Factor N:N=? 4 Done END

CASIO PROGRAM SHEET

Program for Rotating a Figure	No. 5

Description



Formula for coordinate transformation:

$(x, y) \rightarrow (x', y')$

$x' = x \cos \theta - y \sin \theta$

$y' = x \sin \theta + y \cos \theta$

Graphing of rotation of any geometric figure by θ degrees.

Example

To rotate by 30° the triangle defined by points A (2, 0.5), B (6, 0.5), and C (5, 1.5)

Notes

- Use the cursor keys to move the pointer around the display.
- To interrupt program execution, press AC while the graphic screen is on the display.
- The triangle cannot be drawn if the result of the coordinate transformation operation exceeds View Window parameters.

Preparation and operation

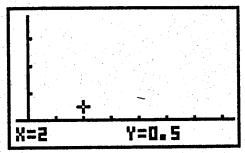
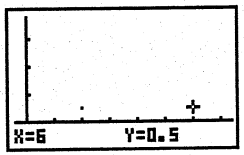
- Store the program written on the next page.
- Execute the program as shown below.

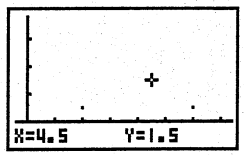
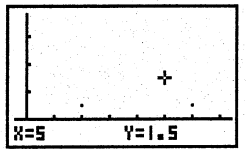
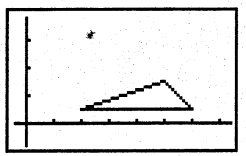
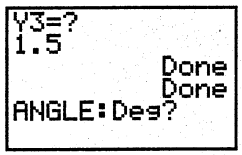
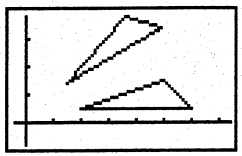
Memory Contents								
A	x_1	H	y'_1	O		V		
B	y_1	I	x'_2	P		W		
C	x_2	J	y'_2	Q	θ	X		
D	y_2	K	x'_3	R		Y		
E	x_3	L	y'_3	S		Z		
F	y_3	M		T				
G	x'_1	N		U				

No.	5

Line	Program
File name	R O T A T E
1	View Window (–) 0 . 4 , 7 . 4 , 1 , (–) 0 . 8 , 3 .
2	8 , 1 : Deg ↵
3	" (X 1 , Y 1) ↵
4	X 1 = " ? → A ↵
5	" Y 1 = " ? → B ↵
6	Plot A , B ◢
7	X → A : Y → B ↵
8	" (X 2 , Y 2) ↵
9	X 2 = " ? → C ↵
10	" Y 2 = " ? → D ↵
11	Plot C , D ◢
12	X → C : Y → D ↵
13	" (X 3 , Y 3) ↵
14	X 3 = " ? → E ↵
15	" Y 3 = " ? → F ↵
16	Plot E , F ◢
17	X → E : Y → F ↵
18	Lbl 1 ↵
19	Line : Plot A , B : Line : Plot C , D : Line ◢
20	" A N G L E : Deg " ? → Q ↵
21	A cos Q – B sin Q → G ↵
22	A sin Q + B cos Q → H ↵
23	Plot G , H ↵
24	C cos Q – D sin Q → I ↵
25	C sin Q + D cos Q → J ↵
26	Plot I , J : Line ↵
27	E cos Q – F sin Q → K ↵
28	E sin Q + F cos Q → L ↵
29	Plot K , L : Line ↵
30	Plot G , H : Line ◢
31	Cls : Plot C , D : Plot E , F : Goto 1
32	
33	
34	

Program for	Rotating a Figure	No. 5

Step	Key Operation	Display
1	F1 (EXE)	(X1,Y1)↵ X1=?
2	2 EXE 0.5 EXE	
3	EXE	Y1=? 0.5 Done (X2,Y2)↵ X2=?
4	6 EXE 0.5 EXE	
5	EXE	Y2=? 0.5 Done (X3,Y3)↵ X3=?

Program for **Rotating a Figure**		No. **5**
Step	**Key Operation**	**Display**
6	4.5 EXE 1.5 EXE	
7	▶~▶ (Locate the pointer at X = 5)	
8	EXE	
9	EXE	
10	30 EXE	

Continue, repeating from step 8.

Appendix

Appendix A Resetting the Calculator
Appendix B Power Supply
Appendix C Error Message Table
Appendix D Input Ranges
Appendix E Specifications

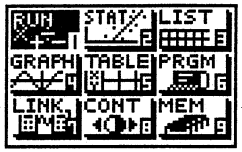
Appendix A Resetting the Calculator

Warning!

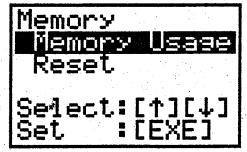
The procedure described here clears all memory contents. Never perform this operation unless you want to totally clear the memory of the calculator. If you need the data currently stored in memory, be sure to write it down somewhere before performing the RESET operation.

•To reset the calculator

1. Press [MENU] to display the main menu.



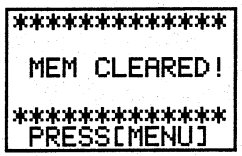
2. Highlight the **MEM** icon and press [EXE], or press [9].



3. Use ▼ to move the highlighting down to "Reset" and then press [EXE].

[F1] [F4]

4. Press [F1] (YES) to reset the calculator or [F4] (NO) to abort the operation without resetting anything.

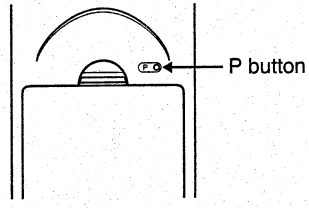


- If the display appears to dark or dim after you reset the calculator, adjust contrast.

Resetting the calculator initializes it to the following settings.

Item	Initial Setting
Icon	RUN
Angle Unit	Rad
Exponent Display Range	Norm 1
Fraction Reduction	Automatic
Mixed Fraction	Display
Graph Type	Rectangular coordinate (Y=)
Statistical Graph	Automatic
Variable Memory	Clear
Answer Memory (Ans)	Clear
Graphic Display/Text Display	Clear
View Window	Clear (initialized)
View Window Memory	Clear
Graph Function	Clear
Enlargement/Reduction Factor	Clear (initialized)
Table & Graph Data	Clear
List Data	Clear
Statistical Calculation/Graph Memory	Clear
Program	Clear
Input Buffer/AC Replay	Clear

- Performing the RESET operation while an internal calculation is being performed will cause all data in memory to be deleted. Make sure that no calculation be being performed before starting a RESET operation.



- If the calculator stops operating correctly for some reason, use a thin, pointed object to press the P button on the back of the calculator. This should make the RESET confirmation screen appear on the display. Perform the procedure to complete the RESET operation.

Appendix B Power Supply

This unit is powered by two AAA-size (LR03 (AM4) or R03 (UM-4)) batteries. In addition, it uses a single CR2032 lithium battery as a back up power supply for the memory.

If the following message appears on the display, immediately stop using the calculator and replace batteries.

If you try to continue using the calculator, it will automatically switch power off, in order to protect memory contents. You will not be able to switch power back on until you replace batteries.

Be sure to replace the main batteries at least once every two years, no matter how much you use the calculator during that time.

Warning!

If you remove both the main power supply and the memory back up batteries at the same time, all memory contents will be erased. If you do remove both batteries, correctly reload them and then perform the reset operation.

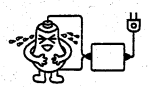
The batteries that come with this unit discharge slightly during shipment and storage. Because of this, they may require replacement sooner than the normal expected battery life.

■ Replacing Batteries

Precautions:

Incorrectly using batteries can cause them to burst or leak, possibly damaging the interior of the unit. Note the following precautions:

- Be sure that the positive (+) and negative (–) poles of each battery are facing in the proper directions.
- Never mix batteries of different types.
- Never mix old batteries and new ones.
- Never leave dead batteries in the battery compartment.
- Remove the batteries if you do not plan to use the unit for long periods.
- Never try to recharge the batteries supplied with the unit.
- Do not expose batteries to direct heat, let them become shorted, or try to take them apart.



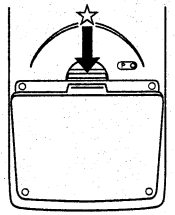
(Should a battery leak, clean out the battery compartment of the unit immediately, taking care to avoid letting the battery fluid come into direct contact with your skin.)

Keep batteries out of the reach of small children. If swallowed, consult with a physician immediately.

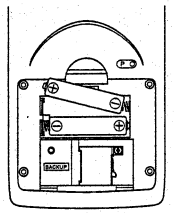
•To replace the main power supply batteries

- * Never remove the main power supply and the memory back up batteries from the unit at the same time.
- * Be sure to switch the unit off before replacing batteries. Replacing batteries with power on will cause data in memory to be deleted.
- * Never replace the back cover or switch the calculator on while the main power supply batteries are removed from the calculator or not loaded correctly. Doing so can cause memory data to be deleted and malfunction of the calculator. If mishandling of batteries causes such problems, correctly load batteries and then perform the RESET operation to resume normal operation.
- * Be sure to replace all two batteries with new ones.

1. Press [SHIFT] [OFF] to turn the calculator off.
   - Making sure that you do not accidently press the [AC/ON] key, slide the case onto the calculator and then turn the calculator over.



2. Remove the back cover from the unit by pulling with your finger at the point marked ☆.
3. Remove the two old batteries.
4. Load a new set of two batteries, making sure that their positive (+) and negative (–) ends are facing in the proper directions.



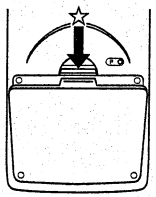
5. Replace the back cover and press [AC/ON] to turn power on. The memory back-up battery provides power to the memory while the main batteries are removed, so memory data is not lost.
   - Power will not switch on if you press [AC/ON] while the back cover is open.
   - Do not leave the unit without main power supply batteries loaded for long periods. Doing so can cause deletion of data stored in memory.
   - If the figures on the display appear too light and hard to see after you turn on power, adjust the contrast.

P.11

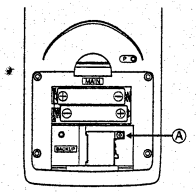
•To replace the memory back up battery

* Before replacing the memory back up battery, switch on the unit and check to see if the "Low battery!" message appears on the display. If it does, replace the main power supply batteries before replacing the back up power supply battery.
* Never remove the main power supply and the memory back up batteries from the unit at the same time.
* Be sure to switch the unit off before replacing battery. Replacing battery with power on will cause data in memory to be deleted.
* Be sure to replace the back up power supply battery at least once 2 years, regardless of how much you use the unit during that time. Failure to do so can cause data in memory to be deleted.

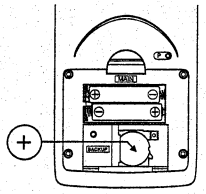
1. Press [SHIFT] [OFF] to turn the calculator off.
   • Making sure that you do not accidently press the [AC/ON] key, slide the case onto the calculator and then turn the calculator over.



2. Remove the back cover from the unit by pulling with your finger at the point marked ☆.
3. Remove screw Ⓐ on the back of the calculator, and remove the back up battery holder.



4. Remove the old battery.
5. Wipe off the surfaces of a new battery with a soft, dry cloth. Load it into the calculator so that its positive (+) side is facing up.
6. Pressing down on the battery with the battery holder, replace the screw that secures the holder in place.



7. Replace the back cover and press [AC/ON] to turn power on. The main batteries provide power to the memory while the back-up battery is removed, so memory data is not lost.

■ About the Auto Power Off Function

The calculator switches power off automatically if you do not perform any key operation for about 6 minutes. To restore power, press [AC/ON].

The calculator automatically turns off it is left for about 60 minutes with a calculation stopped by an output command (◢), which is indicated by the "–Disp–" message on the display.

Appendix C Error Message Table

Message	Meaning	Countermeasure
Syn ERROR	① Calculation formula contains an error. ② Formula in a program contains an error.	① Use ◀ or ▶ to display the point where the error was generated and correct it. ② Use ◀ or ▶ to display the point where the error was generated and then correct the program.
Ma ERROR	① Calculation result exceeds calculation range. ② Calculation is outside the input range of a function. ③ Illogical operation (division by zero, etc.) ④ Poor precision in differential calculation results.	①②③ Check the input numeric value and correct it. When using memories, check that the numeric values stored in memories are correct. ④ Try using a smaller value for Δx (x increment/decrement).
Go ERROR	① No corresponding Lbl n for Goto n. ② No program stored in program area Prog "file name". ③ No corresponding "Next" for "For", no corresponding "LpWhile" for "Do", or no corresponding "WhileEnd" for "While".	① Correctly input a Lbl n to correspond to the Goto n , or delete the Goto n if not required. ② Store a program in program area Prog "file name", or delete the Prog "file name" if not required. ③ Correctly match "Next" with "For", "LpWhile" with "Do", or "WhileEnd" with "While".
Ne ERROR	• Nesting of subroutines exceeds 10 levels.	• Ensure that Prog "file name" is not used to return from subroutines to main routine. If used, delete any unnecessary Prog "file name". • Trace the subroutine jump destinations and ensure that no jumps are made back to the original program area. Ensure that returns are made correctly.

Message	Meaning	Countermeasure
Stk ERROR	• Execution of calculations that exceed the capacity of the stack for numeric values or stack for commands.	• Simplify the formulas to keep stacks within 10 levels for the numeric values and 26 levels for the commands. • Divide the formula into two or more parts.
Mem ERROR	① Not enough memory to hold function input in the Graph Mode for graph drawing. ② Not enough memory to hold function input in the TABLE Mode. ③ Not enough memory to store data in list function.	①②③ • Keep the number of variables you use for the operation within the number of variables currently available. • Simplify the data you are trying to store to keep it within the available memory capacity. • Delete no longer needed data to make room for the new data.
Arg ERROR	• Incorrect argument specification for a command that requires an argument.	Correct the argument. • Fix n, Sci n : n = integer from 0 through 9. • Lbl n , Goto n : n = integer from 0 through 9.
Dim ERROR	• Illegal dimension used during list calculations.	• Check list dimension.
Com ERROR	• Problem with cable connection or parameter setting during program data communications.	• Check cable connection.
Transmit ERROR!	• Problem with cable connection or parameter setting during data communications.	• Check cable connection.
Receive ERROR!	• Problem with cable connection or parameter setting during data communications.	• Check cable connection.
Memory Full!	• Memory of receiving unit became full during program data communications.	• Delete some data stored in the receiving unit and try again.

Appendix D Input Ranges

Function	Input ranges	Internal digits	Precision	Notes
$\sin x$ $\cos x$ $\tan x$	(DEG) $\|x\| < 9 \times 10^{9}$° (RAD) $\|x\| < 5 \times 10^{7}\pi$rad (GRA) $\|x\| < 1 \times 10^{10}$grad	15 digits	As a rule, precision is ±1 at the 10th digit.	However, for $\tan x$: $\|x\| \neq 90(2n+1)$:DEG $\|x\| \neq \pi/2(2n+1)$:RAD $\|x\| \neq 100(2n+1)$:GRA
$\sin^{-1}x$ $\cos^{-1}x$	$\|x\| \leqq 1$	"	"	
$\tan^{-1}x$	$\|x\| < 1 \times 10^{100}$			
$\log x$ $\ln x$	$1 \times 10^{-99} \leqq x < 1 \times 10^{100}$	"	"	
10^{x}	$-1 \times 10^{100} < x < 100$	"	"	
e^{x}	$-1 \times 10^{100} < x \leqq 230.2585092$			
$\sqrt{x}$	$0 \leqq x < 1 \times 10^{100}$	"	"	
x^{2}	$\|x\| < 1 \times 10^{50}$			
$1/x$	$\|x\| < 1 \times 10^{100}$, $x \neq 0$	"	"	
$\sqrt[3]{x}$	$\|x\| < 1 \times 10^{100}$			
$x!$	$0 \leqq x \leqq 69$ (x is an integer)	"	"	
nPr nCr	Result $< 1 \times 10^{100}$ n, r (n and r are integers) $0 \leqq r \leqq n$, $n < 1 \times 10^{10}$	"	"	
Pol (x, y)	$\sqrt{x^2 + y^2} < 1 \times 10^{100}$	"	"	
Rec (r, θ)	$\|r\| < 1 \times 10^{100}$ (DEG) $\|\theta\| < 9 \times 10^{9}$° (RAD) $\|\theta\| < 5 \times 10^{7}\pi$ rad (GRA) $\|\theta\| < 1 \times 10^{10}$grad	"	"	However, for $\tan\theta$: $\|\theta\| \neq 90(2n+1)$:DEG $\|\theta\| \neq \pi/2(2n+1)$:RAD $\|\theta\| \neq 100(2n+1)$:GRA

Function	Input ranges	Internal digits	Precision	Notes
° ' "	$\|a\|, b, c < 1 \times 10^{100}$ $0 \leqq b, c$	15 digits	As a rule, precision is ±1 at the 10th digit.	
$\overleftarrow{\text{° ' "}}$	$\|x\| < 1 \times 10^{100}$ Sexagesimal display: $\|x\| < 1 \times 10^{7}$			
$\wedge(x^y)$	$x > 0$: $-1 \times 10^{100} < y\log x < 100$ $x = 0 : y > 0$ $x < 0$: $y = n, \frac{1}{2n+1}$ (n is an integer) However; $-1 \times 10^{100} < \frac{1}{y}\log \|x\| < 100$	"	"	
$\sqrt[x]{y}$	$y > 0 : x \neq 0$ $-1 \times 10^{100} < \frac{1}{x}\log y < 100$ $y = 0 : x > 0$ $y < 0 : x = 2n+1, \frac{1}{n}$ ($n \neq 0$, n is an integer) However; $-1 \times 10^{100} < \frac{1}{x}\log \|y\| < 100$	"	"	*
$a^b/_c$	Total of integer, numerator and denominator must be within 10 digits (includes division marks).	"	"	
STAT	$\|x\| < 1 \times 10^{50}$ $\|y\| < 1 \times 10^{50}$ $\|n\| < 1 \times 10^{100}$ $x\sigma_n, y\sigma_n, \bar{x}, \bar{y}, a, b, c, r$: $n \neq 0$ $x\sigma_{n-1}, y\sigma_{n-1}$: $n \neq 0, 1$	"	"	

* Errors may be cumulative with internal continuous calculations such as $\wedge(x^y)$, $\sqrt[x]{y}$, $x!$, $\sqrt[3]{x}$, sometimes affecting precision.

Appendix E Specifications

Variables: 26

Calculation range:

$\pm 1 \times 10^{-99}$ to $\pm 9.999999999 \times 10^{99}$ and 0. Internal operations use 15-digit mantissa.

Exponential display range: Norm 1: $10^{-2} > |x|, |x| \geqq 10^{10}$
Norm 2: $10^{-9} > |x|, |x| \geqq 10^{10}$

Program capacity:

20,000 bytes (max.)

Power supply:

Main: Two AAA-size batteries (LR03 (AM4) or R03 (UM-4))

Back-up: One CR2032 lithium battery

Power consumption: 0.05W

Battery life

Main:

LR03 (AM4): Approximately 1,500 hours (continuous display of main menu)
Approximately 700 hours (continuous operation)

R03 (UM-4): Approximately 900 hours (continuous display of main menu)
Approximately 400 hours (continuous operation)

Back-up: Approximately 2 years (when main batteries are not supplying power)

Auto power off:

Power is automatically turned off approximately six minutes after last operation.

The calculator automatically turns off if it is left for about 60 minutes with a calculation stopped by an output command (◢), which is indicated by the "–Disp–" message on the display.

Ambient temperature range: 0°C to 40°C

Dimensions: 19.3 mm (H) × 81.5 mm (W) × 163 mm (D)
3/4" (H) × 3" (W) × 6 1/4" (D)

Weight: 160g (including batteries)

Data Communications

Functions:

Program contents and file names; function memory data; list data; variable data; Table & Graph data; graph functions

Method: Start-stop (asynchronous), half-duplex

Transmission speed (BPS): 9600 bits/second

Parity: none

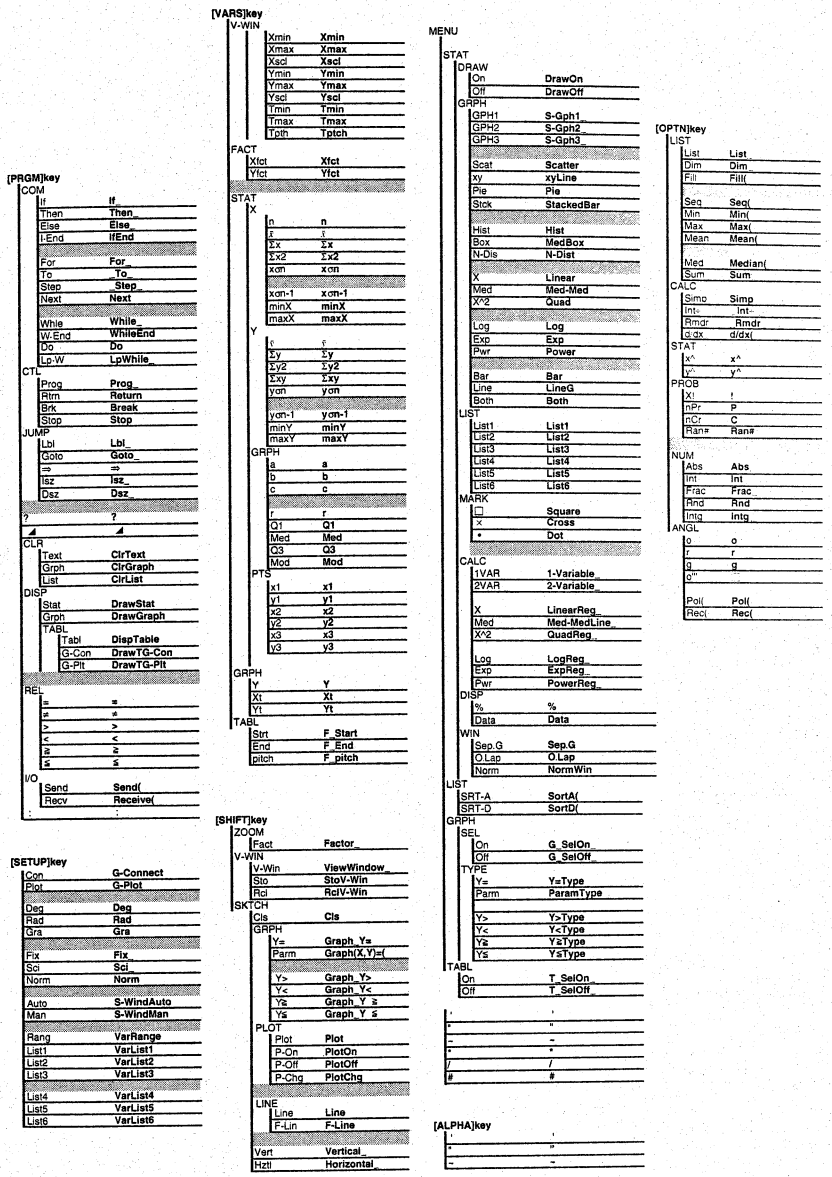
Bit length: 8 bits

Stop bit:

Send: 2 bits

Receive: 1 bit

Program Mode Command List



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