SHARP

SCIENTIFIC CALCULATOR OPERATION GUIDE

< EL-W531TH/W531TG/W506T >

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HOW TO OPERATE

Read Before Using

Functions and Key Operations

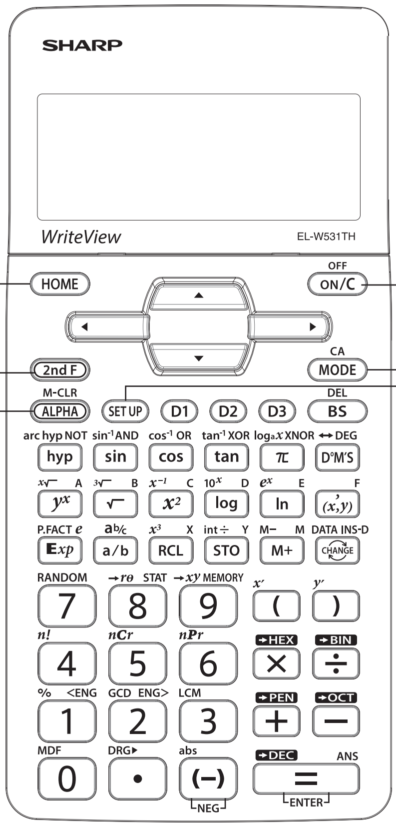
Functions and Key Operations for EL-W506T only

How to Operate

≈Read Before Using≈

This operation guide has been written mainly based on the EL-W531TH/W531TG model.
And some functions described here are featured on the EL-W506T model only.
Note that key operations and symbols on the display may differ according to the model.

1. KEY LAYOUT (EL-W531TH)



● HOME key

Pressing this key will return to NORMAL mode.

● 2nd function, ALPHA keys

Pressing these keys will enable the functions written in orange (2nd F) or green (ALPHA) above the calculator buttons.

● ON/C, OFF key

ON/C <Power on>

2ndF OFF <Power off>

Written in orange above the ON/C key

● MODE key

This calculator can operate in four different modes as follows.

● SET UP key

Pressing this key will display the SET UP menu.
In EL-W506T, use 2ndF SET UP instead of SET UP .

[NORMAL mode]

MODE 0 Normal mode for performing normal arithmetic and function calculations.
(HOME will also be in Normal mode.)

[STAT mode]

MODE 1 Mode for performing 1- or 2-variable statistical calculations.
To select the sub-mode, press the corresponding number key after MODE 1 .

0	Single variable statistic	1	Linear regression
2	Quadratic regression	3	Euler Exponential regression
4	Logarithmic regression	5	Power regression
6	Inverse regression	7	Exponential regression

[TABLE mode]

MODE **2** Mode for showing the changes in values of a function in table format.

[DRILL mode]

MODE **3** Mode for performing drill calculations.
To select the drill sub-mode, press the corresponding number key after **MODE** **3** .

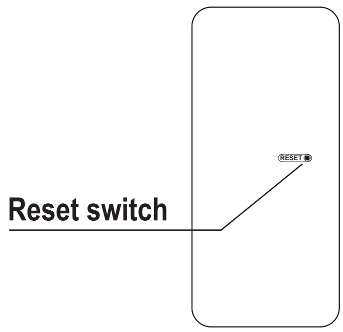
0 (Math): Math drill **1** (Table): Multiplication table drill

NOTE:
The EL-W506T model has another modes (Complex, Equation, Matrix, Vector and Distribution modes).

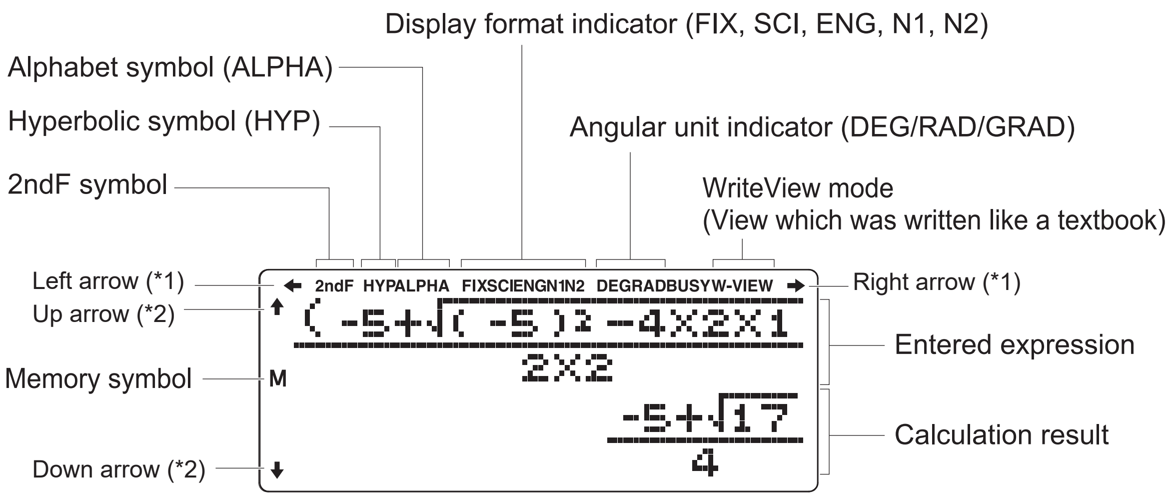
2. RESET SWITCH

If the calculator fails to operate normally, press the reset switch on the back to reinitialize the unit. The display format and calculation mode will return to their initial settings.

NOTE:
Pressing the reset switch will erase any data stored in memory.



3. DISPLAY PATTERN



*1: Appears when the entire equation cannot be displayed.

*2: Indicates that data can be visible above/below the screen.

NOTE:
The actual display does not appear like this. This illustration is for explanatory purposes only.

4. EXPRESSION INPUT FORMAT AND CALCULATION RESULT

In NORMAL mode and TABLE mode, you can select the editor for entering expression.

1) W-VIEW editor

Enter the expression in textbook format.
You can also select the format of the calculation result. (It's valid in NORMAL mode only)

[SET UP] [2] [0] [0] **(EXACT)**

Displays the calculation result including fractions, $\sqrt{\ }$, π.
Use the [CHANGE] key to switch between decimal format, fraction format, $\sqrt{\ }$ and π, if possible.

N1 DEG W-VIEW	N1 DEG W-VIEW	N1 DEG W-VIEW
sin45=	$\frac{1}{2}+\frac{1}{3}=$	1÷3=
$\frac{\sqrt{2}}{2}$	$\frac{5}{6}$	$\frac{1}{3}$

[SET UP] [2] [0] [1] **(APPROX.)**

Displays the calculation result in decimal format (without $\sqrt{\ }$ or π) except for fractional calculation.
Use the [CHANGE] key to switch between decimal and fraction formats, if possible.

N1 DEG W-VIEW	N1 DEG W-VIEW	N1 DEG W-VIEW
sin45=	$\frac{1}{2}+\frac{1}{3}=$	1÷3=
0.707106781	$\frac{5}{6}$	0.333333333

2) LINE editor

[SET UP] [2] [1]

Displays the calculation result in decimal format (without $\sqrt{\ }$ or π) except for fractional calculation.
Use the [CHANGE] key to switch between decimal and fraction formats (line fraction notation).

N1 DEG W-VIEW	N1 DEG	N1 DEG W-VIEW
sin45=	1⌟2+1⌟3=	1÷3=
0.707106781	5⌟6	0.333333333

NOTE:
In EL-W506T, use [2ndF] [SET UP] instead of [SET UP].

5. CHANGE RESULT DISPLAY

According to the editor and answer settings, the display format of the calculation result is changed in the following order by pressing the [CHANGE] key (arrow mark position).
In the following examples of this section, the recurring decimal setting is ON ([SET UP] [5] [1]).

1) W-VIEW editor

1-1) ANSWER : EXACT ([SET UP] [2] [0] [0]).....Default setting

with fraction:

① Mixed fraction		② Improper fraction		③ Recurring decimal		④ Decimal	
14÷3= $4\frac{2}{3}$	⇨	14÷3= $\frac{14}{3}$	⇨	14÷3= $4.\dot{6}$	⇨	14÷3= 4.666666667	⇨ ①

with $\sqrt{\ }$ (angular unit is RAD ([SET UP] [0] [1])):

① Value including $\sqrt{\ }$		② Decimal	
$\sin\frac{\pi}{3}=$ $\frac{\sqrt{3}}{2}$	⇨	$\sin\frac{\pi}{3}=$ 0.866025403	⇨ ①

with π (angular unit is RAD ([SET UP] [0] [1])):

① Value including π		② Decimal	
$\sin^{-1}0.5=$ $\frac{1}{6}\pi$	⇨	$\sin^{-1}0.5=$ 0.523598775	⇨ ①

1-2) ANSWER : APPROX. ([SET UP] [2] [0] [1])

fraction calculation :

① Mixed fraction		② Improper fraction		③ Recurring decimal		④ Decimal	
$\frac{3}{4}+\frac{7}{9}=$ $1\frac{19}{36}$	⇨	$\frac{3}{4}+\frac{7}{9}=$ $\frac{55}{36}$	⇨	$\frac{3}{4}+\frac{7}{9}=$ $1.52\dot{7}$	⇨	$\frac{3}{4}+\frac{7}{9}=$ 1.527777778	⇨ ①

other :

① Decimal		② Mixed fraction		③ Improper fraction		④ Recurring decimal	
14÷3= 4.666666667	⇨	14÷3= $4\frac{2}{3}$	⇨	14÷3= $\frac{14}{3}$	⇨	14÷3= $4.\dot{6}$	⇨ ①

2) LINE editor ([SET UP] [2] [1])

fraction calculation:
① Mixed fraction → ② Improper fraction → ③ Recurring decimal → ④ Decimal → ①

other :
① Recurring decimal → ② Decimal → ③ Mixed fraction → ④ Improper fraction → ①

NOTE:
- If it cannot be a mixed fraction or recurring decimal, the display of the mixed fraction or recurring decimal is skipped. The recurring decimal is displayed only when the setting is ON.
- In the following examples of this book, the explanation is based on the operation with the default settings (W-VIEW editor (EXACT) and the recurring decimal setting is OFF).
- In EL-W506T, use [2ndF] [SET UP] instead of [SET UP].

6. DISPLAY FORMAT AND DECIMAL SETTING FUNCTION

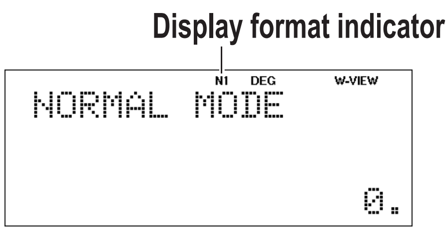
For convenient and easy operation, this model can be used in one of five display format (decimal setting).
The selected display status is shown in the upper part of the display (Display format indicator).

- **Floating decimal point format NORM1/NORM2** (**N1**/**N2** is displayed)
  The calculator has two settings for displaying a floating point number, **NORM1 (default setting)** and NORM2. In each setting, a number is automatically displayed in scientific notation [10-digit (mantissa) + 2-digit (exponent)] when outside a preset range:
  - NORM1:0.000000001≤|x|≤9999999999
  - NORM2:0.01≤|x|≤9999999999
- **Fixed decimal point format** (**FIX** is displayed)
  Displays the fractional part of the numeric value according to the specified number of decimal places.
- **Scientific notation** (**SCI** is displayed)
  Displays in the form of [10-digit (mantissa) + 2-digit (exponent)].
  Frequently used in science to handle extremely small or large numbers.
- **Engineering notation** (**ENG** is displayed)
  In scientific notation, the exponent is a multiple of 3. Convenient for applying engineering units.

Note: If more 0's (zeros) than needed are displayed when the [ON/C] key is pressed, check whether or not the calculator is set to a Special Display Format.

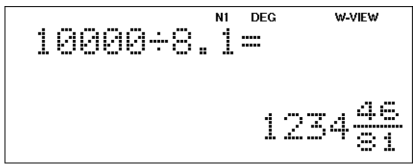
<Example> Let's compare the display result of [10000 ÷ 8.1 =] in each display format.

[HOME] ([MODE] [0])



(NORM1 mode)

10000 [÷] 8.1 [=] (Mixed fractions)



CHANGE (Improper fractions)

N1 DEG W-VIEW
10000÷8.1=
$\frac{100000}{81}$

CHANGE (Decimal numbers)

N1 DEG W-VIEW
10000÷8.1=
1'234.567901

SET UP 1 0 3

FIX DEG W-VIEW
10000÷8.1=
1'234.568

(FIX mode, TAB = 3)

SET UP 1 1 3

SCI DEG W-VIEW
10000÷8.1=
1.23E03

(SCI mode)

SET UP 1 2 3

ENG DEG W-VIEW
10000÷8.1=
1.235E03

(ENG mode)

SET UP 1 3

N1 DEG W-VIEW
10000÷8.1=
1'234.567901

(NORM1 mode)

NOTE:
In EL-W506T, use 2ndF SET UP instead of SET UP.

7. EXPONENT DISPLAY

The distance from the earth to the sun is approx. 150,000,000 (1.5×10^8) km. Values such as this with many zeros are often used in scientific calculations, but entering the zeros one by one is a great deal of work and it's easy to make mistakes. In such cases, the numerical values are divided into mantissa and exponent portions, displayed and calculated.

<Example> What is the number of electrons flowing in a conductor when the electrical charge across a given cross-section is 0.32 coulombs. (The charge on a single electron = 1.6×10^{-19} coulombs).

0.32 ÷ 1.6 Exp 19 =

N1 DEG W-VIEW
0.32÷1.6E19=
2.E-20

8. ANGULAR UNIT

This calculator has 3 types of angular units, which you can select from the SETUP menu.

Degrees (DEG is shown at the top of the display)

A commonly used unit of measure for angles. The angular measure of a circle is expressed as 360°. Press [SET UP] [0] [0].

Radians (RAD is shown at the top of the display)

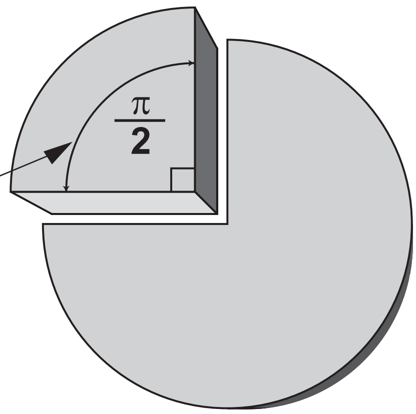
Radians are different from degrees and express angles based on the circumference of a circle. 180° is equivalent to π radians. Therefore, the angular measure of a circle is 2π radians. Press [SET UP] [0] [1].

Grads (GRAD is shown at the top of the display)

Grads are a unit of angular measure used in Europe, particularly in France. An angle of 90 degrees is equivalent to 100 grads. Press [SET UP] [0] [2].

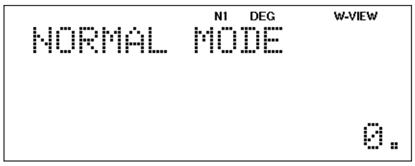
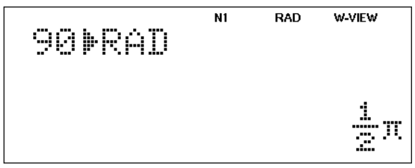
The relationships between the three types of angular units can be expressed as right:

90° (DEG) =
$\pi/2$ (RAD) =
100 (GRAD) =



Angular values are converted from DEG to RAD to GRAD with each push of the [DRG▸] key (2nd function of [•]). This function is used when doing calculations related to trigonometric functions or coordinate geometry conversions.

<Example> Check to confirm 90 degrees equaling $\pi/2$ radians equaling 100 grads. (π=3.14159...)

Operation	Display
[SET UP] [0] [0] (DEG)	
90 [2ndF] [DRG▸]	

2ndF DRG▶

ANS▶GRAD
100.

2ndF DRG▶

ANS▶DEG
90.

NOTE:
In EL-W506T, use 2ndF SET UP instead of SET UP.

9. RECURRING DECIMAL

Calculation results can be shown in a recurring decimal format.

SET UP 5 1 Recurring decimal is ON.

SET UP 5 0 Recurring decimal is OFF.

NOTE:
In EL-W506T, use 2ndF SET UP instead of SET UP.

<Example>

Operation	Display
ON/C SET UP 5 1 (Recurring decimal: ON)	
56 ÷ 99 = CHANGE (The recurring part is indicated by “‒”.)	56÷99= $0.\overline{56}$
CHANGE (Floating point)	56÷99= 0.565656565
CHANGE CHANGE	56÷99= $0.\overline{56}$

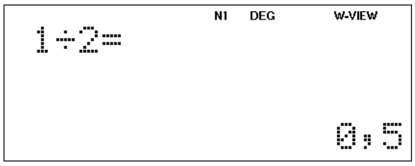
10. DECIMAL POINT OF CALCULATION RESULT

You can show the decimal point in the calculation result as either a dot or comma.

[SET UP] [6] [0] (DOT).....Default setting

[SET UP] [6] [1] (COMMA)

<Example>

Operation	Display
[ON/C] [SET UP] [6] [1] 1 [÷] 2 [=] [CHANGE]	

NOTE:
In EL-W506T, use [2ndF] [SET UP] instead of [SET UP].

≈Functions and Key Operations≈

ON/OFF, Entry Correction Keys

[ON/C] OFF CA

[▲] [▼] [◄] [►] [BS] DEL

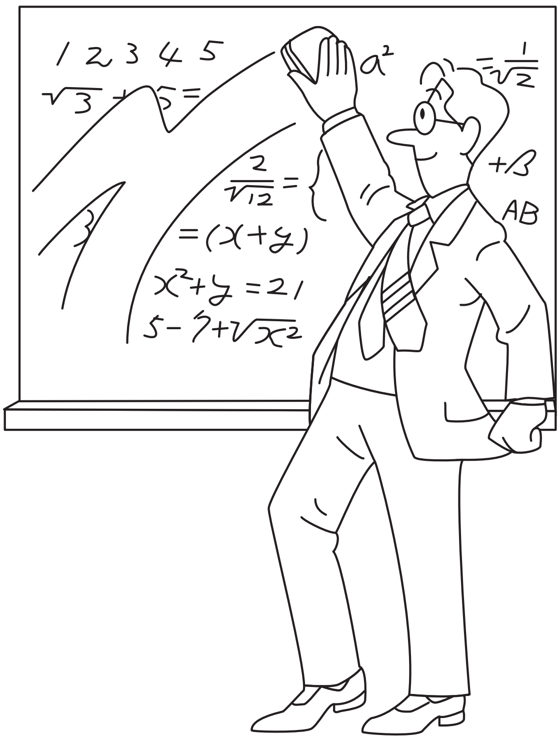
[ON/C] Turns the calculator on or clears the data. It also clears the contents of the calculator display and voids any calculator command; however, statistics, as well as values stored in the memory, are not erased.

OFF Turns the calculator off.

CA Clears all internal values, including the last answer (ANS) and statistics. Values stored in memory are not erased.

[▲] [▼] These arrow keys are useful for Multi-Line playback, which lets you scroll through calculation steps one by one.

[◄] [►] [BS] DEL These keys are useful for editing equations. The [◄] key moves the cursor to the left, and the [►] key moves the cursor to the right. The [BS] key deletes the symbol/number at the left of the cursor, and the DEL key deletes the symbol/number at the cursor.



Numerical Value Entry Keys [•] [(–) NEG] [π] [Exp]

0 to 9 Numeric keys for entering data values.

[•] Decimal point key. Enters a decimal point.

[(–) NEG] Enters the minus symbol.
The subtraction key [–] is not used for entering negative numbers.

[π] Enters π (3.14159...).
The constant π, used frequently in function calculations, is the ratio of the circumference of a circle to its diameter

[Exp] Enter a symbol that represents an exponentiation of 10 in scientific notation. ($1.23 \times 10^{12} \rightarrow$ 1.23E12)

<Example> Provided the earth is moving around the sun in a circular orbit, how many kilometers will it travel in a year?

* The average distance between the earth and the sun being 1.496×10^8 km.

Circumference equals diameter x π; therefore,
$1.496 \times 10^8 \times 2 \times \pi$

Operation	Display
1.496 [Exp] 8 [×] 2 [×] [π] [=]	N1 DEG W-VIEW 1.496E8×2×π= 939'964'522.

Random Function RANDOM

RANDOM Generates random numbers.

Random numbers are three-decimal-place values between 0.000 and 0.999. Using this function enables the user to obtain unbiased sampling data derived from random values generated by the calculator.

NOTE:

In "EXACT" of W-VIEW mode, random numbers are displayed as fractions. It is recommended to set to LINE mode or "APPROX." of W-VIEW mode in advance. When a fraction is displayed, press CHANGE to convert it to decimal form.

<Example>

SET UP 2 1 (LINE mode)

2nd F RANDOM 0 ENTER 0. * * * (A random number is generated.)

[Random Dice]

To simulate a die-rolling, a random integer between 1 and 6 can be generated by pressing 2nd F RANDOM 1 ENTER. To generate the next random dice number, press ENTER.

[Random Coin]

To simulate a coin flip, 0 (heads) or 1 (tails) can be randomly generated by pressing 2nd F RANDOM 2 ENTER. To generate the next random coin number, press ENTER.

[Random Integer]

You can specify a range for the random integer with “R.Int(”.

R.Int(*minimum value*, *maximum value*)

For example, if you enter 2nd F RANDOM 3 1 (x,y) 99) ENTER, a random integer from 1 to 99 will be generated. To generate the next random integer, press ENTER.

APPLICATIONS:

Building sample sets for statistics or research.

Modify Key MDF

MDF Function to round calculation results.
Even after setting the number of decimal places on the display, the calculator performs calculations using a larger number of decimal places than that which appears on the display.
By using this function, internal calculations will be performed using only the displayed value.

NOTE:
This key is valid only when the calculation result is displayed as a decimal. It is recommended to set to LINE mode or "APPROX." of W-VIEW mode in advance. When a fraction is displayed, press CHANGE to convert it to decimal form.

<Example>

FIX mode TAB = 1 (normal calculation)

5 ÷ 9 = **0.6** (internally, 0.5555...)

× 9 = **5.0**

Rounded calculation (MDF)

5 ÷ 9 = **0.6** (internally, 0.5555...)

2ndF MDF (internally, 0.6)

× 9 = **5.4**

APPLICATIONS:
Frequently used in scientific and technical fields, as well as business, when performing chained calculations.

Basic Arithmetic Keys, Parentheses

[+] [–] [×] [÷] [=] [(] [)]

[+] [–] [×] [÷] The four basic operators. Each is used in the same way as a standard calculator:
+ (addition), – (subtraction), x (multiplication), and ÷ (division).

[=] Finds the result in the same way as a standard calculator.

[(] [)] Used to specify calculations in which certain operations have precedence. You can make addition and subtraction operations have precedence over multiplication and division by enclosing them in parentheses.

Percent [%]

[%] For calculating percentages. Four methods of calculating percentages are presented as follows.

1) $125 increased by 10%…137.5

125 [+] 10 [2ndF] [%]

```
N1 DEG W-VIEW
125+10%
                137 1/2
```

[CHANGE] [CHANGE]

```
N1 DEG W-VIEW
125+10%
                137.5
```

2) $125 reduced by 20%…100

125 [−] 20 [2ndF] [%]

```
N1 DEG W-VIEW
125−20%
                100.
```

3) 15% of $125…18.75

125 [×] 15 [2ndF] [%]
[CHANGE] [CHANGE]

```
N1 DEG W-VIEW
125×15%
                18.75
```

4) When $125 equals 5% of X, X equals…2500

125 [÷] 5 [2ndF] [%]

```
N1 DEG W-VIEW
125÷5%
                2'500.
```

NOTE:
In EL-W506T, when “(%)” is specified immediately after a value, the value is treated as a percentage. “(%)” is specified by [MATH] [6] in normal mode.

Inverse, Square, Cube, xth Power of y, Square Root, Cube Root, xth Root

x^{-1} x^2 x^3 y^x $\sqrt{\ }$ $\sqrt[3]{\ }$ $\sqrt[x]{\ }$

x^{-1} Calculates the inverse of the value.

x^2 Squares the value.

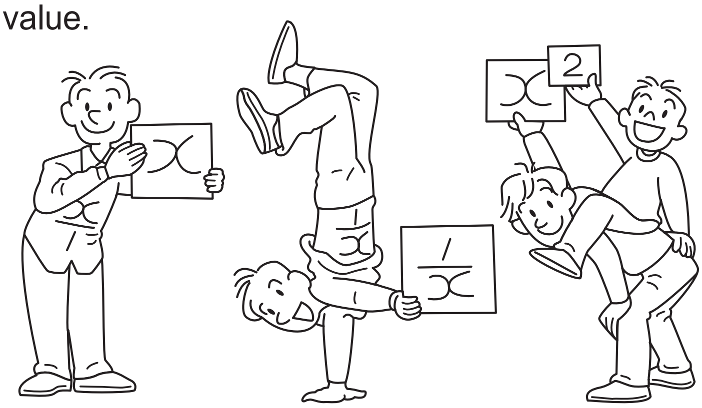
x^3 Cubes the value.

y^x Calculates the x^{th} power of the value.

$\sqrt{\ }$ Calculates the square root of the value.

$\sqrt[3]{\ }$ Calculates the cube root of the value.

$\sqrt[x]{\ }$ Calculates the x^{th} root of the value.



<Example>

Operation	Display
2 [×] 2 [×] 2 [×] 2 [=]	N1 DEG W-VIEW 2×2×2×2= 16.
2 [y^x] 4 [=]	N1 DEG W-VIEW 2^4= 16.
4 [2ndF] [$\sqrt[x]{\ }$] 16 [=]	N1 DEG W-VIEW $\sqrt[4]{16}$= 2.

Power and Radical root [3√]

<Example 1> Design a shaft that bears a torque *T* (= 9,550 Nm).
τ is a constant that is determined by the material of the shaft, and is taken to be τ = 20 N/mm².

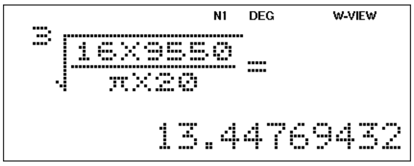
$$d = \sqrt[3]{\frac{16T}{\pi\tau}}$$

Operation

[ON/C] [2ndF] [3√] [a/b] 16 [×]

9550 [▶] [π] [×] 20 [=]

Display



Power and Radical root [y^x] [$\sqrt[x]{\ }$]

<Example 2> If the principal is *a* (\$), the annual interest rate is *r* (%), and the number of years of interest accumulation is *x* (years), the final amount *y* (\$) is given by the following equation:

$$y = a\,(1 + r / 100)^x$$

(1) Find the final amount when a principal of \$400,000 is deposited for three years at an annual interest rate of 5% and the interest is compounded annually.

$$y = 400000\left(1 + \frac{5}{100}\right)^3$$

(2) When a principal of \$300,000 is deposited for five years and the interest is compounded annually, the final amount is \$339,422. The annual interest rate *r* is given by the equation below. Find the annual interest rate *r*.

$$r = 100\left(\sqrt[x]{\frac{y}{a}} - 1\right)$$

$$r = 100\left(\sqrt[5]{\frac{339422}{300000}} - 1\right)$$

Operation	Display
(1) [ON/C] 400000 [(] 1 [+] [a/b] 5 [▶] 100 [▶] [)] [y^x] 3 [=]	N1 DEG W-VIEW $400000\left(1+\frac{5}{100}\right)^3 =$ 463'050.
(2) [ON/C] 100 [(] [2ndF] [$\sqrt[x]{\ }$] 5 [▶] [a/b] 339422 [▶] 300000 [▶] [▶] [−] 1 [)] [=]	N1 DEG W-VIEW $100\left(\sqrt[5]{\frac{339422}{300000}} -1\right)=$ 2.499971984

Power and Radical root [y^x] [$\sqrt[x]{\ }$]

<Example 3> The musical note A is 440 Hz.
Calculate the frequencies of the notes in (1) to (3).

(1) "C" of A, A# (B♭), B, C

$$440 \times (\sqrt[12]{2})^3$$

(2) "C" of A, G, F, E, D, C

$$\frac{440 \times (\sqrt[12]{2})^3}{2}$$

(3) "A" one octave higher

$$440 \times (\sqrt[12]{2})^{12}$$

<u>Operation</u>	<u>Display</u>
(1) [ON/C] 440 [×] [(] [2ndF] [$\sqrt[x]{\ }$] 12 [▶] 2 [▶] [)] [y^x] 3 [=]	N1 DEG W-VIEW $440\times(\sqrt[12]{2})^3=$ 523.2511306
(2) [ON/C] [a/b] 440 [×] [(] [2ndF] [$\sqrt[x]{\ }$] 12 [▶] 2 [▶] [)] [y^x] 3 [▶] [▶] 2 [=]	N1 DEG W-VIEW $\frac{440\times(\sqrt[12]{2})^3}{2}=$ 261.6255653
(3) [ON/C] 440 [×] [(] [2ndF] [$\sqrt[x]{\ }$] 12 [▶] 2 [▶] [)] [y^x] 12 [=]	N1 DEG W-VIEW $440\times(\sqrt[12]{2})^{12}=$ 880.

10 to the Power of x, Common Logarithm, Logarithm of x to Base a

10^x | log | log_a x

10^x Calculates the value of 10 raised to the x^{th} power.

log Calculates the logarithm, the exponent of the power to which 10 must be raised to equal the given value.

log_a x Calculates the logarithm of *x* to power a.

<Example>

Operation	Display
2ndF 10^x 3 =	10^3= 1'000.
log 1000 =	log1000= 3.
2ndF log_a x 3 ▶ 45 =	$\log_3(45)$= 3.464973521

Exponential, Logarithmic [10^x] [log]

<Example 1> If E (units: joules) is the amount of energy released by an earthquake and M is the magnitude, the relation

$$\log E = 4.8 + 1.5M$$

holds.

If E' is the energy when the magnitude increases by N,

$$\frac{E'}{E} = 10^{1.5N}$$

holds.

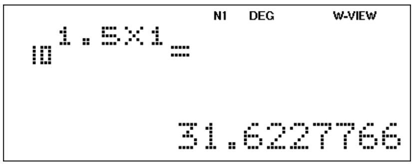
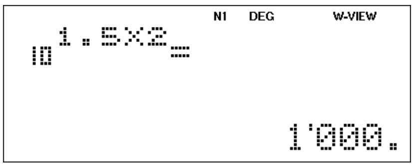
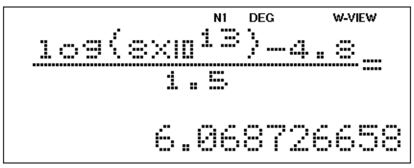
(1) When the magnitude increases by 1, by what factor does the energy increase?

(2) When the magnitude increases by 2, by what factor does the energy increase?

(3) The amount of energy in 20,000 tons of TNT is 8×10^{13} joules. When this energy is converted to a magnitude,

$$M = \frac{\log E - 4.8}{1.5}$$

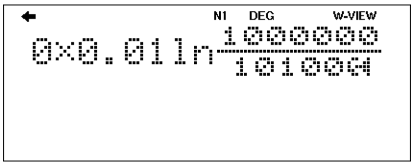
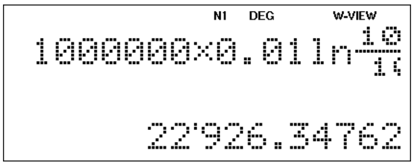
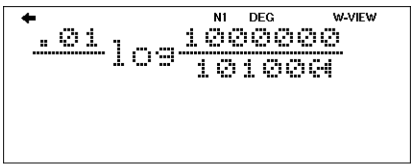
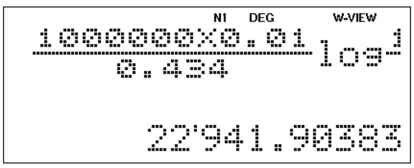
holds. Find the magnitude M.

Operation	Display
(1) [ON/C] [2ndF] [10^x] 1.5 [×] 1 [=]	
(2) [ON/C] [2ndF] [10^x] 1.5 [×] 2 [=]	
(3) [ON/C] [a/b] [log] [(] 8 [×] [2ndF] [10^x] 13 [▶] [)] [−] 4.8 [▶] 1.5 [=]	

Exponential, Logarithmic ln log

<Example 2> Air is held inside a cylinder of volume V_1 (= 0.01 m^3) at a pressure P_1 (= 1,000,000 Pa) at 27°C with a piston.
Find the quantity of thermal energy Q needed to expand the air at constant temperature to a pressure of P_2 (= 101,000 Pa).

$$Q = p_1 V_1 \ln \frac{p_1}{p_2}$$
$$\approx \frac{p_1 V_1}{0.434} \log \frac{p_1}{p_2}$$

Operation	Display
ON/C 1000000 × 0.01 ln	
a/b 1000000 ▶ 101000	
=	
ON/C a/b 1000000 × 0.01 ▶	
0.434 ▶ log a/b 1000000	
▶ 101000	
=	

Exponential, Logarithmic 10^x $\log_a x$

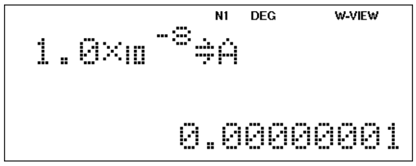
<Example 3> Find the pH of hydrochloric acid HCl at a concentration of 1.0 x 10^{-8} mol/L
* pH = 7 (neutral), pH < 7 (acidic), pH > 7 (alkaline)

$$\mathrm{pH} = -\log_{10}\left(a + \frac{\sqrt{a^2+4\times10^{-14}} - a}{2}\right)$$

<u>Operation</u>	<u>Display</u>

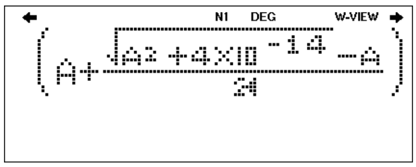
Enter the value of *a*

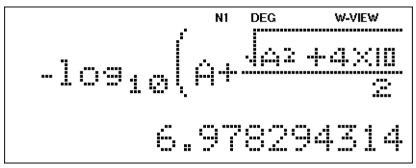
ON/C 1.0 × 2ndF 10^x (−) 8
STO A



Calculate the pH

(−) 2ndF $\log_a x$ 10 ▶ ALPHA A
+ a/b √ ALPHA A x^2 +
4 × 2ndF 10^x (−) 14 ▶
▶ − ALPHA A ▶ 2
=





e to the Power of x, Natural Logarithm [e^x] [ln]

[e^x] Calculates powers based on the constant e (2.718281828).

[ln] Calculates the value of the natural logarithm, the exponent of the power to which e must be raised to equal the given value.

<Example>

Operation	Display
[2ndF] [e^x] 5 [=]	N1 DEG W-VIEW $e^5=$ 148.4131591
[ln] 10 [=]	N1 DEG W-VIEW ln10= 2.302585093

Factorials n!

n! The product of a given positive integer *n* multiplied by all the lesser positive integers from 1 to *n*-1 is indicated by *n*! and called the factorial of *n*.

<Example 1>

Operation	Display
7 [2ndF] [n!] [=]	N1 DEG W-VIEW 7!= 5'040.

cf.
$n! = 1 \times 2 \times 3 \times \ldots \times n$

<Example 2> How many arrangements exist of cards of three colors: red, blue, and yellow?

3! = 3 x 2 x 1 = 6

Operation	Display
[ON/C] 3 [2ndF] [n!] [=]	N1 DEG W-VIEW 3!= 6.

APPLICATIONS:
Used in statistics and mathematics. In statistics, this function is used in calculations involving combinations and permutations.

Permutations, Combinations nPr nCr

nPr This function finds the number of different possible orderings in selecting *r* objects from a set of *n* objects. For example, there are six different ways of ordering the letters ABC in groups of three letters—ABC, ACB, BAC, BCA, CAB, and CBA.
The calculation equation is ${}_3P_3 = 3 \times 2 \times 1 = 6$ (ways).

nCr This function finds the number of ways of selecting *r* objects from a set of *n* objects. For example, from the three letters ABC, there are three ways we can extract groups of two different letters—AB, AC, and CB.
The calculation equation is ${}_3C_2$.

<Example 1>

Operation	Display
6 [2ndF] [nPr] 4 [=]	N1 DEG W-VIEW 6P4= 360.
6 [2ndF] [nCr] 4 [=]	N1 DEG W-VIEW 6C4= 15.

APPLICATIONS:
Used in statistics (probability calculations) and in simulation hypotheses in fields such as medicine, pharmaceutics, and physics. Also, can be used to determine the chances of winning in lotteries.

Permutations, Combinations nPr nCr

<Example 2> (1) When three cards are selected from five cards numbered 1 to 5 and placed in a row, how many possible orderings of the cards are there?

$$_5P_3 = 5 \times 4 \times 3$$

(2) When three cards are selected from five cards numbered 1 to 5, how many ways of selecting the cards are possible?

Let the number of ways of selecting the cards be *C*. There are 3! possible orderings of the cards, and thus when ordered in a row

$$C \times 3! = {_5P_3}$$

Therefore *C* is

$$C = {_5P_3} \div 3!$$

*This is written as $_5C_3$.

Operation	Display
(1) ON/C 5 2ndF nPr 3 =	N1 DEG W-VIEW 5P3= 60.
(2) ON/C 5 2ndF nPr 3 ÷ 3 2ndF n! =	N1 DEG W-VIEW 5P3÷3!= 10.
ON/C 5 2ndF nCr 3 =	N1 DEG W-VIEW 5C3= 10.

Permutations, Combinations [nCr]

<Example 3> Find the probability of drawing one pair when 5 cards are drawn from a deck of 52 cards.
No jokers are included in the deck.

Probability of drawing one pair =
Ways of selecting one pair ÷ Ways of selecting 5 cards

Ways of selecting one pair =
Ways of selecting two cards to make a pair x Ways of selecting 3 remaining cards

Ways of selecting two cards to make a pair
Ways of selecting the number: 13 possibilities from 1 to 13 (King)
Ways of selecting the suit: Two suits selected from four, ${}_4C_2$
Hence

$13 \times {}_4C_2$

Ways of selecting remaining three cards
Ways of selecting the number: Three types are selected from (13 - 1) types ${}_{(13-1)}C_3$

Ways of selecting the suit: For each number on the three cards, there are 4 types of suit 4^3
Hence

${}_{12}C_3 \times 4^3$

Ways of selecting five cards

${}_{52}C_5$

The probability of drawing one pair is
$(13 \times {}_4C_2) \times ({}_{12}C_3 \times 4^3) \div {}_{52}C_5$

Operation	Display
[ON/C] [(] 13 [×] 4 [2ndF] [nCr]	
2 [)] [×] [(] 12 [2ndF] [nCr]	
3 [×] 4 [2ndF] [x^3] [)] [÷]	
52 [2ndF] [nCr] 5	N1 DEG W-VIEW (12C3×4³)÷52C5_
[=] [CHANGE]	N1 DEG W-VIEW (13×4C2)×(12C3×4 0.422569027

Quotient Remainder Calculation, Prime Factorization

int÷ P.FACT

int÷ Calculates the quotient (Q) and the remainder (R).

P.FACT The calculation result can be shown as a product of prime numbers.

<Example>

Operation	Display
ON/C 185 2ndF int÷ 36 =	185÷36= Q: 5. R: 5.
3 y^x 18 ▶ 2ndF int÷ 17 =	3^{18}÷17= Q: 22'789'440. R: 9.
ON/C 900 = 2ndF P.FACT	900= $2^2 \times 3^2 \times 5^2$

Greatest Common Divisor, Least Common Multiple

GCD LCM

GCD	Calculates the greatest common divisor.
LCM	Calculates the least common multiple.

<Example>

Operation	Display
ON/C 12 2ndF GCD 16 =	12GCD16= 4.
128 2ndF GCD 200 =	128GCD200= 8.
ON/C 12 2ndF LCM 16 =	12LCM16= 48.
128 2ndF LCM 200 =	128LCM200= 3'200.

Sexagesimal Calculation (Time) [D°M′S] [↔DEG]

[D°M′S] Inputs values in sexagesimal notation (degrees, minutes, seconds).

[↔DEG] Converts a sexagesimal value displayed in degrees, minutes, seconds to decimal notation. Also, converts a decimal value to sexagesimal notation (degrees, minutes, seconds).

<Example>

Operation	Display
2 [D°M′S] 35 [D°M′S] 45 [+] 1 [D°M′S] 19 [D°M′S] 30 [=]	N1 DEG W-VIEW 2°35°45°+1°19°30 3°55'15."
[2ndF] [↔DEG]	N1 DEG W-VIEW ANS= $3\frac{221}{240}$
[CHANGE] [CHANGE]	N1 DEG W-VIEW ANS= 3.920833333
[2ndF] [↔DEG]	N1 DEG W-VIEW ANS= 3°55'15."

APPLICATIONS:
Used in calculations of angles and angular velocity in physics, and latitude and longitude in geography.

Fractional Calculations a/b $a\frac{b}{c}$

a/b Inputs proper or improper fractions which consist of a numerator and denominator.

$a\frac{b}{c}$ Inputs a mixed fraction.

<Example> Add $3\frac{1}{2}$ and $\frac{5}{7}$, and convert to decimal notation.

Operation	Display
3 2ndF $a\frac{b}{c}$ 1 ▶ 2 ▶ + 5 a/b 7 =	N1 DEG W-VIEW $3\frac{1}{2}+\frac{5}{7}=$ $4\frac{3}{14}$
CHANGE Convert to an improper fraction	N1 DEG W-VIEW $3\frac{1}{2}+\frac{5}{7}=$ $\frac{59}{14}$
CHANGE Convert to decimal notation	N1 DEG W-VIEW $3\frac{1}{2}+\frac{5}{7}=$ 4.214285714
CHANGE	N1 DEG W-VIEW $3\frac{1}{2}+\frac{5}{7}=$ $4\frac{3}{14}$

APPLICATIONS:
There is a wide variety of applications for this function because fractions are such a basic part of mathematics. This function is useful for calculations involving electrical circuit resistance.

Memory Calculations

STO RCL M+ M–

A ~ F X Y M

STO	Stores displayed values in memories A~F, X, Y, M.
RCL	Recalls values stored in A~F, X, Y, M.
M+	Adds the displayed value to the value in the independent memory M.
M–	Subtracts the displayed value from the value in the independent memory M.
A ~ F X Y	Temporary memories
M	Independent memory

<Example 1>

Operation	Display
0 STO M (Enter 0 for M)	N1 DEG W-VIEW 0⇒M 0.
25 × 27 M+	N1 DEG W-VIEW 25×27M+ M 675.
7 × 3 M+	N1 DEG W-VIEW 7×3M+ M 21.
RCL M	N1 DEG W-VIEW M= M 696.

Memory Calculations

STO RCL M+ M–

A ~ F X Y M

<Example 2>

Calculates $/¥ at the designated exchange rate.

$1 = ¥110 ➡ ¥26,510 = $? $2,750 = ¥?

Operation	Display
110 STO Y	N1 DEG W-VIEW 110→Y 110.
26510 ÷ RCL Y =	N1 DEG W-VIEW 26510÷Y= 241.
2750 × RCL Y =	N1 DEG W-VIEW 2750×Y= 302'500.

Last Answer Memory [ANS]

[ANS] Recalls the last answer calculated by pressing [=]

<**Example**> Solve for *x* first and then solve for *y* using *x*.

$$x = \sqrt{2} + 3 \quad \text{and} \quad y = 4 \div x$$

Operation	**Display**
[√‾] 2 [▶] [+] 3 [=]	N1 DEG W-VIEW $\sqrt{2}+3=$ $3+\sqrt{2}$
4 [÷] [ALPHA] [ANS] [=]	N1 DEG W-VIEW 4÷ANS= $\frac{12-4\sqrt{2}}{7}$
[CHANGE]	N1 DEG W-VIEW 4÷ANS= 0.906163678

User-Defined Memories D1 ~ D3

D1 ~ D3 Recall a function that was defined by the user.

<Example>

Operation	Display
STO D1	STORING D1 SELECT FUNCTION
2ndF arc hyp sin^{-1}	STORED!
D1 26 =	sinh^{-1}26= 3.951613336

APPLICATIONS:
Functions that you have previously defined, including those using common 2nd Function buttons, can be stored in D1~ D3 for later use, thus saving time on keystrokes.

Absolute Value [abs]

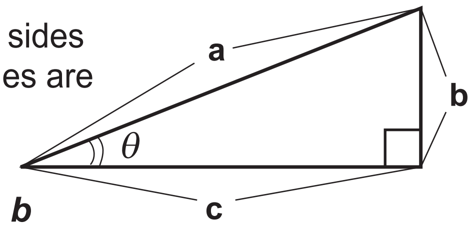
[abs] Returns an absolute value.

<Example>

Operation	Display
[2ndF] [abs] 3 [×] −4([(−)] [4]) [=]	N1 DEG W-VIEW $\lvert 3\times -4\rvert =$ 12.

Trigonometric Functions **sin** **cos** **tan**

Trigonometric functions determine the ratio of three sides of a right triangle. The combinations of the three sides are sin, cos, and tan. Their relations are:



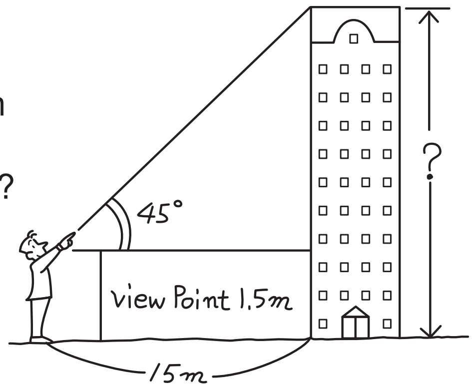
sin Calculates the sine of an angle. $\sin\theta = \dfrac{b}{a}$

cos Calculates the cosine of an angle. $\cos\theta = \dfrac{c}{a}$

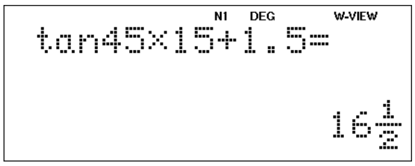
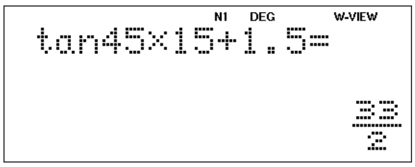
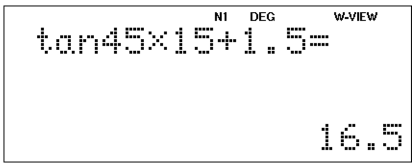
tan Calculates the tangent of an angle. $\tan\theta = \dfrac{b}{c}$

<Example 1>

The angle from a point 15 meters from a building to the highest floor of the building is 45°. How tall is the building?



[DEG mode]

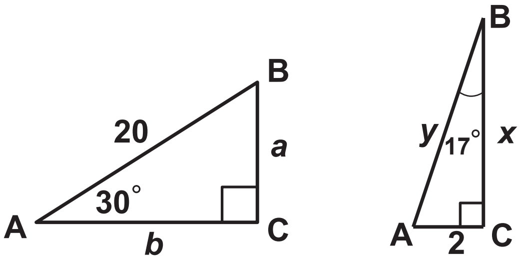
Operation	Display
tan 45 **×** 15 **+** 1 **•** 5 **=** (View point)	
CHANGE	
CHANGE	

APPLICATIONS:
Trigonometric functions are useful in mathematics and various engineering calculations. They are often used in astronomical observations, civil engineering and in calculations involving electrical circuits, as well as in calculations for physics such as parabolic motion and wave motion.

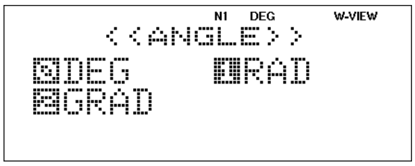
Trigonometric Functions [sin] [cos] [tan]

<Example 2>

Find the length of the side of the following triangle.



$$a = 20 \sin 30$$
$$b = 20 \cos 30$$
$$x = \frac{2}{\tan 17}$$
$$y = \frac{2}{\sin 17}$$

Operation	Display
[SET UP] [0] (DRG)	
[0] (DEG)	

<Angle setting "∘" (DEG)>

NOTE:
In EL-W506T, use [2ndF] [SET UP] instead of [SET UP].

Trigonometric Functions [sin] [cos] [tan]

[ON/C]

20 [sin] 30 [=]

N1	DEG	W-VIEW

20sin30=

10.

20 [cos] 30 [=]

N1	DEG	W-VIEW

20cos30=

$10\sqrt{3}$

[a/b] 2 [▶] [tan] 17 [=]

N1	DEG	W-VIEW

$\frac{2}{\tan 17}=$

6.541705237

[a/b] 2 [▶] [sin] 17 [=]

N1	DEG	W-VIEW

$\frac{2}{\sin 17}=$

6.84060724

Trigonometric Functions [sin]

<Example 3>

The instantaneous value V of the AC voltage is expressed by the equation below.

$$V = \sqrt{2}V_e\sin(2\pi ft)\ [V]$$

Root mean square value $V_e = 100$ [V]

Frequency $f = 60$ [Hz]

Find the instantaneous value of the AC voltage at time t = 2.000, 2.002, 2.004, 2.008, 2.012, 2.016

Operation	Display
[SET UP] [0] (DRG)	N1 DEG W-VIEW <<ANGLE>> 0DEG 1RAD 2GRAD
[1] (RAD)	

<Angle setting "rad" (RAD)>

NOTE:
In EL-W506T, use [2ndF] [SET UP] instead of [SET UP].

Operation	Display
[ON/C] [√] 2 [▶] [×] 100 [sin] [(] 2 [×] [π] [×] 60 [×] 2.000 [)]	← N1 RAD W-VIEW (2×π×60×2.000)_
[=]	N1 RAD W-VIEW √2×100sin(2×π×60 0.
[◀] [◀] [BS] 2	← N1 RAD W-VIEW (2×π×60×2.002
[=]	N1 RAD W-VIEW √2×100sin(2×π×60 96.80958013

Trigonometric Functions sin

◀ ◀ BS 4

=

(2×π×60×2.004

√2×100sin(2×π×60

141.1422935

◀ ◀ BS 8

=

(2×π×60×2.008

√2×100sin(2×π×60

17.72479587

◀ ◀ BS BS 12

=

(2×π×60×2.012

√2×100sin(2×π×60

-138.9163952

◀ ◀ BS BS 16

=

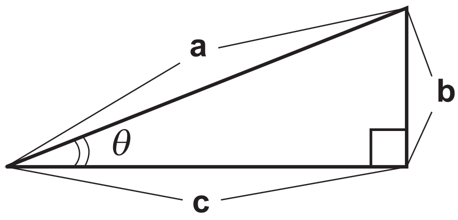
(2×π×60×2.016

√2×100sin(2×π×60

-35.17006113

Arc Trigonometric Functions [sin⁻¹] [cos⁻¹] [tan⁻¹]

Arc trigonometric functions, the inverse of trigonometric functions, are used to determine an angle from ratios of a right triangle.
The combinations of the three sides are $\sin^{-1}$, $\cos^{-1}$, and $\tan^{-1}$. Their relations are;



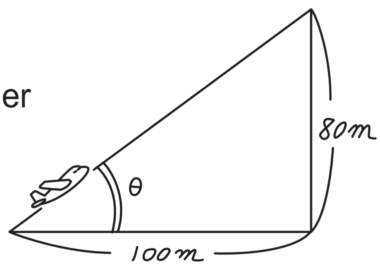
[sin⁻¹] (arc sine) Determines an angle based on the ratio *b*/*a* of two sides of a right triangle. $\theta = \sin^{-1}\frac{b}{a}$

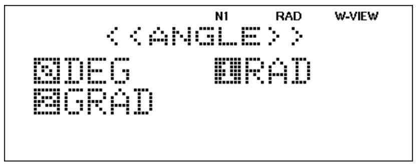
[cos⁻¹] (arc cosine) Determines an angle based on the ratio *c*/*a* for two sides of a right triangle. $\theta = \cos^{-1}\frac{c}{a}$

[tan⁻¹] (arc tangent) Determines an angle based on the ratio *b*/*c* for two sides of a right triangle. $\theta = \tan^{-1}\frac{b}{c}$

<Example>

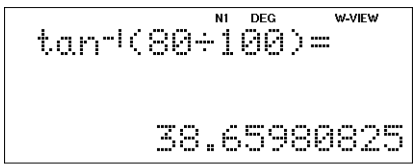
At what angle should an airplane climb in order to climb 80 meters in 100 meters?



Operation	Display
[SET UP] [0] (DRG)	
[0] (DEG)	

<Angle setting "∘" (DEG)>

NOTE:
In EL-W506T, use [2ndF] [SET UP] instead of [SET UP].

Operation	Display
[2ndF] [tan⁻¹] [(] 80 [÷] 100 [)] [=]	

Hyperbolic Functions hyp arc hyp

hyp The hyperbolic function is defined by using natural exponents in trigonometric functions.

arc hyp Arc hyperbolic functions are defined by using natural logarithms in trigonometric functions.

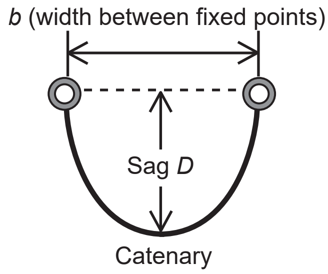
APPLICATIONS:
Hyperbolic and arc hyperbolic functions are very useful in electrical engineering and physics.

Hyperbolic Functions [hyp] [cos] [sin]

<Example 1>

The curve that forms when a rope hangs from two fixed points is called a "catenary", and the sag *D* of the rope can be expressed using a hyperbolic function.

$$D = a\cosh\frac{b}{2a} - a$$



The length *L* of rope that creates this sag is expressed by the following equation.

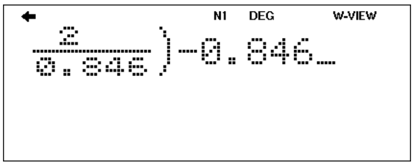
$$L = 2a\sinh\frac{b}{2a}$$

When a = 0.846 and b = 2, find the rope sag *D* and the rope length *L*.

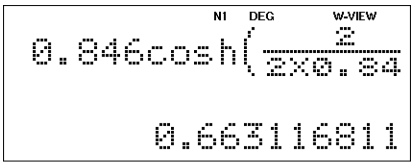
* The value *a* is called the catenary factor, and determines the shape of the curve.

Operation / **Display**

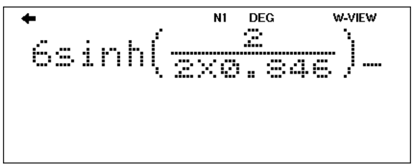
[ON/C] 0.846 [hyp] [cos] [(]
[a/b] 2 [▶] 2 [×] 0.846



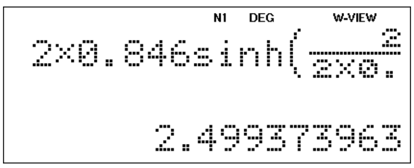
[▶] [)] [−] 0.846
[=]



[ON/C] 2 [×] 0.846 [hyp] [sin]
[(] [a/b] 2 [▶] 2 [×]



0.846 [▶] [)]
[=]



Hyperbolic Functions [hyp] [tan]

(This example is for EL-W506T only.)

<Example 2>

A drop of rain falls against an air resistance proportional to the square of the fall velocity. The velocity *v* at time *t* seconds after the start of the fall is given by the following equation:

$$v = A\tanh Bt \ \text{[m/s]}$$

$A = 6.82$
$B = 1.44$
(A and B are constants determined by a raindrop diameter of 1 mm and the physical properties of air.)

Find the fall velocity at time $t = 0, 1, 2, 5, 10, 15$.

*As the calculations are continued, *v* approaches 6.82. Therefore, the velocity of a raindrop is about 6.82 m/s (24.6 km/h) when it reaches the ground.

Note: The fall distance from time $t = 0$ to 15 [s] is given by the following equation. (Calculation of integral)

$$\int_0^{15} (6.82\tanh(1.44x))\,dx = 99.01718518$$

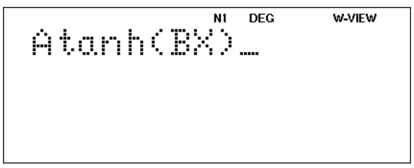
Answer

x	v
0	0
1	6.0950185
2	6.777153851
5	6.819992397
10	6.82
15	6.82

NOTE:
This example is solved by the Simulation calculation (ALGB).
EL-W506T has the Simulation calculation (ALGB).
This function is convenient for repeated calculations using varying values of *X*.

1. Enter *A*tan*h*(*BX*) (use the characters *A*, *B*, and *X* to enter).

[DEG mode]

Operation	Display
[ON/C] [ALPHA] [A] [hyp] [tan] [(] [ALPHA] [B] [ALPHA] [X] [)]	

Hyperbolic Functions [hyp] [tan]

2. Enter the Simulation calculation.

[2ndF] ALGB

<Simulation calculation>

```
Atanh(BX)
A:▒                    0.
```

3. Enter the value of *A.*

6.82 [=]

```
Atanh(BX)
A:6.82_
```

(If 6.82 appears, press only the [=] key)

4. Enter the value of *B.*

1.44 [=]

```
Atanh(BX)
B:1.44_
```

(If 1.44 appears, press only the [=] key)

5. Enter the value of *X.*

For example,

1 [=]

```
Atanh(BX)
X:1_
```

6. The answer is obtained.

```
Atanh(BX)=
              6.0950185
```

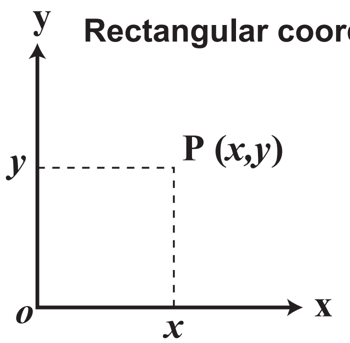
Repeat 2 to 6

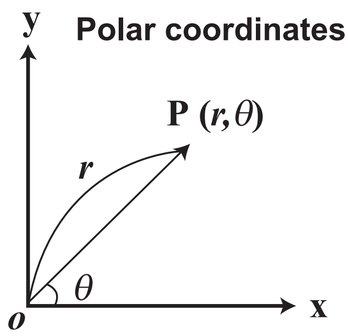
Coordinate Conversion →rθ →xy (x,y)

→rθ Converts rectangular coordinates to polar coordinates (x, $y \rightarrow r$, θ)

→xy Converts polar coordinates to rectangular coordinates (r, $\theta \rightarrow x$, y)

(x,y) Splits data used for dual-variable data input.





<**Example**> Determine the polar coordinates (r, θ) when the rectangular coordinates of Point P are (x = 7, y = 3).

[DEG mode]

Operation	Display
7 (x,y) 3 2ndF →rθ	N1 DEG W-VIEW 7,3→rθ r: 7.615773106 θ: 23.19859051
7.6 (x,y) 23.2 2ndF →xy	N1 DEG W-VIEW 7.6,23.2→xy X: 6.985428578 Y: 2.993958513

APPLICATIONS:
Coordinate conversion is often used in mathematics and engineering, especially for impedance calculations in electronics and electrical engineering.

Binary, Pental, Octal, Decimal, and Hexadecimal Operations (N-Base)

→BIN →PEN →OCT →DEC →HEX

This calculator can perform conversions between numbers expressed in binary, pental, octal, decimal, and hexadecimal systems. It can also perform the four basic arithmetic operations, calculations with parentheses and memory calculations using binary, pental, octal, decimal, and hexadecimal numbers. In addition, the calculator can carry out the logical operations AND, OR, NOT, NEG, XOR, and XNOR on binary, pental, octal, and hexadecimal numbers.

→BIN	Converts to the binary system. "BIN" appears.
→PEN	Converts to the pental system. "PEN" appears.
→OCT	Converts to the octal system. "OCT" appears.
→HEX	Converts to the hexadecimal system. "HEX" appears.
→DEC	Converts to the decimal system. "BIN", "PEN", "OCT", and "HEX" disappear from the display.

Conversion is performed on the displayed value when these keys are pressed.

<Example 1> HEX(1AC) →BIN →PEN →OCT →DEC

Operation	Display
2ndF →HEX 1AC	1AC_ HEX
2ndF →BIN	1AC→BIN BIN 110101100
2ndF →PEN	ANS→PEN PEN 3203
2ndF →OCT	ANS→OCT OCT 654
2ndF →DEC	ANS→DEC 428.

<Example 2> 1011 AND 101 = (BIN) →DEC

Operation	Display
ON/C 2ndF →BIN 1011 AND 101 =	1011AND101= BIN 1
2ndF →DEC	ANS→DEC 1.

Statistics Functions [MODE] [(x,y)] [DATA] [INS-D] [STAT]

The statistics function is excellent for analyzing qualities of an event. Though primarily used for engineering and mathematics, the function is also applied to nearly all other fields including economics and medicine.

[(x,y)] Splits data used for X and FRQ data input (or X, Y, and FRQ data input).

[DATA] Close/display the input table.

[INS-D] Insert a line in the input table for data insertion.

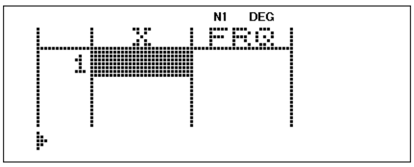
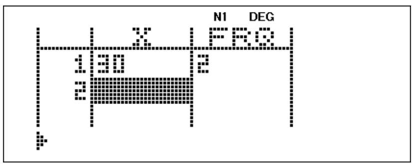
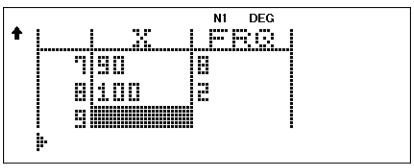
[STAT] Statistical values can be calculated from the STAT menu.

DATA INPUT FOR 1-VARIABLE STATISTICS

<Example 1> Here is a table of examination results. Input this data for analysis.

Data table 1

No.	1	2	3	4	5	6	7	8
Score	30	40	50	60	70	80	90	100
No. of pupils	2	4	5	7	12	10	8	2

Operation	Display
[MODE] [1] [0] Select single-variable statistics mode (The input table is displayed.)	
30 [(x,y)] 2 [ENTER] ⋮ 100 [(x,y)] 2 [ENTER]	 

ANALYSIS RESULTS FOR 1-VARIABLE STATISTICS

Let's check the results based on the previous data.

Operation	Display
[DATA] (Close the input table.)	
[ALPHA] [STAT] [0]	N1 DEG n = 50. x̄ = 69. sx = 17.7568613 s²x = 315.306122
Calculates Statistical values. [▼] [▼] [▼]	N1 DEG σx = 17.5783958 σ²x = 309. Σx = 3'450. Σx² = 253'500.
	N1 DEG xmin= 30. Q1 = 60. Med = 70. Q3 = 80.
	N1 DEG xmax= 100.

Statistics:

n	Number of samples
$\bar{x}$	Mean (average) of samples (x data)
sx	Standard deviation of samples (x data)
s^2x	Variance of samples (x data)
σx	Standard deviation of the population (x data)
σ^2x	Variance of the population (x data)
Σx	Sum of samples (x data)
Σx^2	Sum of squares of samples (x data)
$xmin$	Minimum value of samples (x data)
Q_1	First quartile of samples (x data)
Med	Median of samples (x data)
Q_3	Third quartile of samples (x data)
$xmax$	Maximum value of samples (x data)

APPLICATIONS:
Single-variable statistical calculations are used in a broad range of fields, including engineering, business, and economics. They are most often applied to analysis in atmospheric observations and physics experiments, as well as for quality control in factories.

<Example 2>

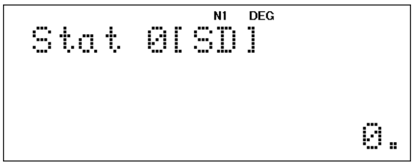
No	Weight [g]
1	97.27
2	96.83
3	96.65
4	96.90
5	96.77

When the weight of a calculator was measured, the results at left were obtained.
Find the average and standard deviation of the weight.

Operation | **Display**

MODE 1 0

2ndF CA



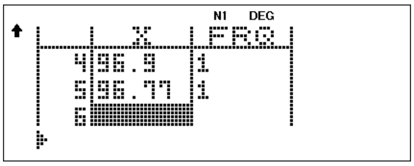
DATA (Display the input table.)

97.27 ENTER

96.83 ENTER

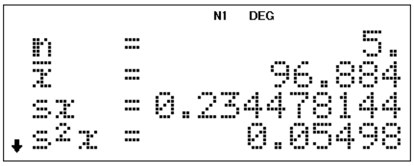
...

96.77 ENTER

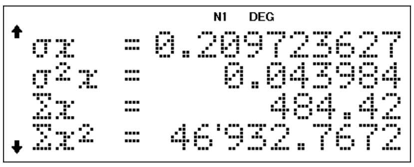


DATA (Close the input table.)

ALPHA STAT 0



▼



Average = 96.884

Standard deviation = 0.209723627

DATA CORRECTION

Move the cursor ([▲] [▼] [◄] [►]) to the data that you want to correct, enter the numeric value, and press [ENTER].

- To insert a line in front of the cursor position, press [ALPHA] [INS-D].
- To delete the entire line where cursor is positioned, press [2ndF] [DEL].

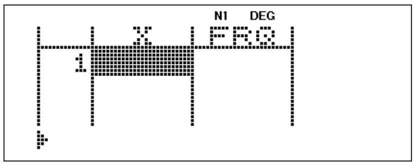
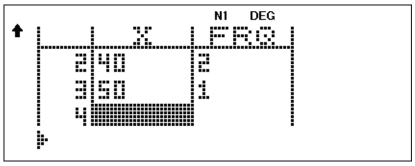
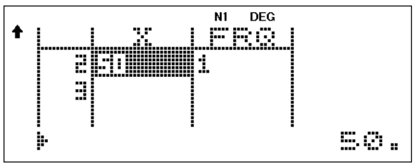
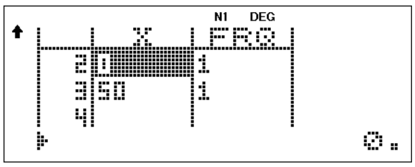
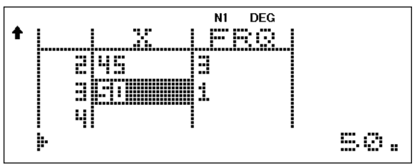
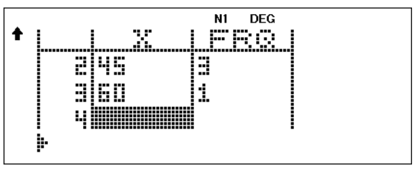
<Example 3>

Data table 2

X: 30, 40, 40, 50

⬇

X: 30, 45, 45, 45, 60

Operation	Display
[MODE] [1] [0] [2ndF] [CA] [DATA]	
30 [ENTER]	
40 [(x,y)] 2 [ENTER]	
50 [ENTER]	
[▲] [▲] [2ndF] [DEL]	
[ALPHA] [INS-D]	
45 [(x,y)] 3 [ENTER]	
60 [ENTER]	

DATA INPUT FOR 2-VARIABLE STATISTICS

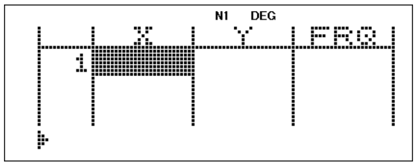
<Example 4> The table below summarizes the dates in April when cherry blossoms bloom, and the average temperature for March in that same area. Determine basic statistical quantities for data X and data Y based on the data table.

Data table 3

	Year	2010	2011	2012	2013	2014	2015	2016	2017
x	**Average temperature**	6.2	7.0	6.8	8.7	7.9	6.5	6.1	8.2
y	**Date blossoms bloom**	13	9	11	5	7	12	15	7

Operation | **Display**

[MODE] [1] [1]

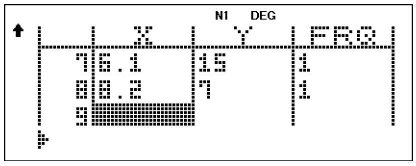


Select two-variable statistics mode and linear regression calculation in sub-mode. (The input table is displayed.)

6.2 [(x,y)] **13** [ENTER]

⋮

8.2 [(x,y)] **7** [ENTER]



ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS

Let's check the results based on the previous data.

Operation	Display
DATA (Close the input table.)	
ALPHA STAT 0 Calculates Statistical values.	N1 DEG n = 8. x̄ = 7.175 sx = 0.973579551 s²x = 0.947857142
▼ ▼ ▼ ▼ ▼	N1 DEG σx = 0.91070028 σ²x = 0.829375 Σx = 57.4 Σx² = 418.48
	N1 DEG xmin= 6.1 xmax= 8.7 ȳ = 9.875 sy = 3.44082631
	N1 DEG s²y = 11.8392857 σy = 3.2185983 σ²y = 10.359375 Σy = 79.
	N1 DEG Σy² = 863. Σxy = 544.1 Σx²y= 3'800.51 Σx³ = 3'100.276
	N1 DEG Σx⁴ = 23'331.6196 ymin= 5. ymax= 15.

The following statistics are added to that of 1-variable statistics excluding the quartile.

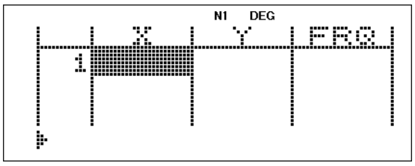
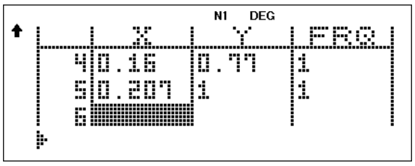
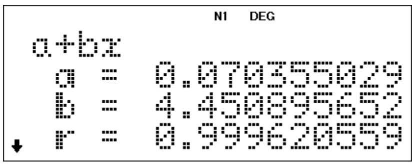
Statistics:

$\bar{y}$	Mean (average) of samples (y data)
sy	Standard deviation of samples (y data)
s^2y	Variance of samples (y data)
σy	Standard deviation of the population (y data)
$\sigma^2 y$	Variance of the population (y data)
Σy	Sum of samples (y data)
Σy^2	Sum of squares of samples (y data)
Σxy	Sum of products of samples (x,y)
Σx^2y	Sum of products of samples (x^2,y)
Σx^3	Sum of 3rd powers of samples (x data)
Σx^4	Sum of 4th powers of samples (x data)
$ymin$	Minimum value of samples (y data)
$ymax$	Maximum value of samples (y data)

<Example 5>

Spring extension *x* [m]	Force *F* [N]
0.028	0.2
0.073	0.39
0.118	0.6
0.16	0.77
0.207	1

When a weight was hung on a spring, the following relation was obtained for the extension of the spring and the force applied to the spring. Use linear regression to find the coefficients *a* and *b* of the relational expression $y = a + bx$, and the correlation coefficient *r*.

Operation	**Display**
MODE 1 1 2ndF CA DATA	
0.028 (x,y) 0.20 ENTER 0.073 (x,y) 0.39 ENTER ... 0.207 (x,y) 1.00 ENTER	
DATA (Close the input table.)	
ALPHA STAT 1	

<Example 6>

The hot water inside an electric pot is maintained at 92°C.
When a thermometer is placed in this hot water, the values indicated by the thermometer at times x and the differences y between these values and the temperature of the hot water are shown below. Using Euler's exponential regression, find the formula that expresses the relation between each time x and the temperature difference y.

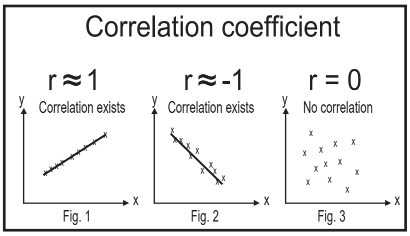
(Room temperature 25°C, hot water temperature 92°C)

Time x [S]	Thermometer temperature [°C]	Temperature difference y [°C] from liquid
0	25	67
4	55	37
8	71	21
12	79	13
16	85	7
20	88	4
24	90	2
28	90	2
32	91	1
36	91	1
40	91	1

e: Napier's constant
e=2.718281828···

When x and y are in the following relationship, use Euler's exponential regression to find the coefficients a and b of the relational expression $y = ae^{bx}$, and the correlation coefficient r.

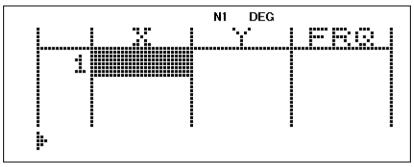
x	y
0	67
4	37
8	21
12	13
16	7
20	4
24	2
28	2
32	1
36	1
40	1



Operation / **Display**

MODE 1 3

2nd F CA DATA

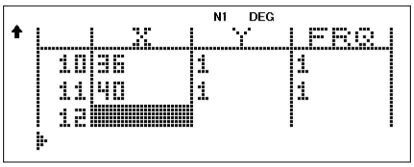


0 (x,y) 67 ENTER

4 (x,y) 37 ENTER

•••

40 (x,y) 1 ENTER



DATA (Close the input table.)

ALPHA STAT 1

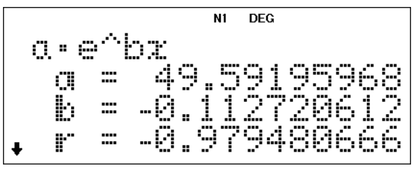


Table Mode [MODE] [x]

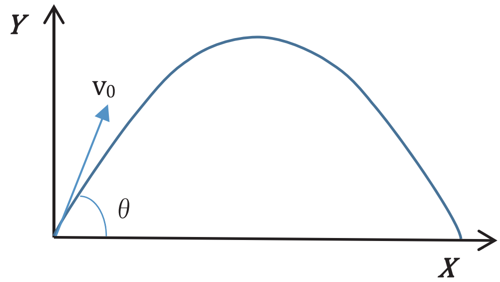
You can see the changes in values of one or two functions.

<Example>

For a parabola with an initial velocity V_0 and an angle θ, the height y and the distance x after t seconds are calculated by the following formulas.

$$ditance\ \boldsymbol{X} = v_0 \cdot cos\theta \cdot t$$

$$height\ \boldsymbol{Y} = v_0 \cdot sin\theta \cdot t - \frac{1}{2} \cdot g \cdot t^2$$



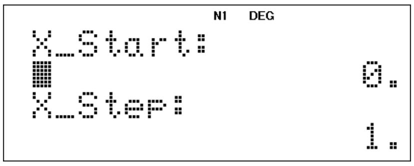
(1) Assuming an initial velocity of 20 m / s and an angle of 40 °, check the transition of height and distance after x seconds. (g=9.8)

$$distance = 20 \cdot (cos40)x$$
$$height = 20 \cdot (sin40)x - 4.9x^2$$

Operation	Display
[MODE] [2] (TABLE)	NI DEG W-VIEW TABLE MODE Function1?
Enter expression of distance. 20 [(] [cos] 40 [)] [ALPHA] [x]	NI DEG W-VIEW 20(cos40)X_
[ENTER]	NI DEG W-VIEW Function2?
Enter expression of height. 20 [(] [sin] 40 [)] [ALPHA] [x] [−] 4.9 [ALPHA] [x] [x^2]	← NI DEG W-VIEW sin40)X-4.9X²_

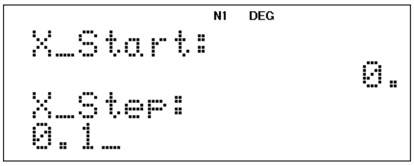
Table Mode MODE x

ENTER

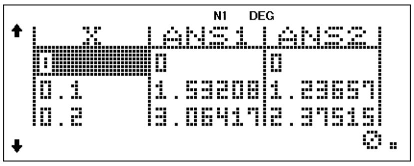


Enter start value and step value.

0 ENTER 0.1

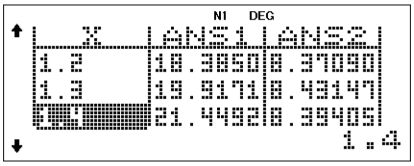


ENTER



Check distance (ANS1) and height (ANS2) at x second.

▼ (14 times)



(2) Find the angle that gives the longest distance.

Transform the distance formula.

$$t = \frac{X}{V_0 \cdot cos\theta}$$

Eliminate t from the height formula.

$$Y = V_0 \cdot sin\theta \cdot \frac{X}{V_0 \cdot cos\theta} - \frac{1}{2} g \left(\frac{X}{V_0 \cdot cos\theta}\right)^2$$

$$= tan\theta \cdot X - \frac{g}{2{V_0}^2 \cdot cos^2\theta} X^2 \qquad {}^*tan\,\theta = \frac{sin\,\theta}{cos\,\theta}$$

$$= X\left(tan\theta - \frac{g}{2{V_0}^2 \cdot cos^2\theta} X\right)$$

Since we need a distance where the height becomes 0, solve the following equation with Y = 0.

$$X\left(tan\theta - \frac{g}{2{V_0}^2 \cdot cos^2\theta} X\right) = 0$$

Transform the equation to find a solution other than X = 0

$$tan\theta - \frac{g}{2{V_0}^2 \cdot cos^2\theta} X = 0$$

$$\frac{g}{2{V_0}^2 \cdot cos^2\theta} X = tan\theta$$

$$X = tan\theta \cdot \frac{2{V_0}^2 \cdot cos^2\theta}{g}$$

$$= \frac{{V_0}^2 \cdot 2 \cdot sin\theta \cdot cos\theta}{g} \qquad {}^*sin\,2\theta = 2\,sin\,\theta\,cos\,\theta$$

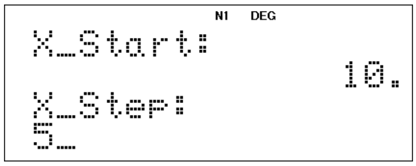
$$= \frac{{V_0}^2 sin2\theta}{g}$$

Operation	**Display**
Enter the expression. MODE 2 (TABLE) 20 x^2 sin 2 ALPHA X ÷ 9.8 ENTER ENTER Skip next expression.	N1 DEG W-VIEW 20²sin2X÷9.8_

Table Mode MODE x

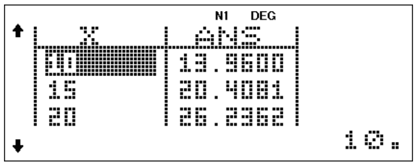
Enter start value 10 and step value 5.

10 ENTER **5**



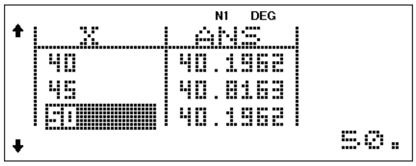
ENTER

Check the distance(ANS) with ▼ key.



Press ▼ key until the value of ANS decreases.

The value decreased at 50°,
so the distance is the longest at 45°.



Drill Mode MODE

Operation	Display
MODE 3 (In EL-W506T, use MODE 8 instead of MODE 3.)	N1 DEG W-VIEW <<DRILL>> 0Math 1Table (Multiplication)
Select type. 1 (Table)	× Table 1~12? 01 ◀Serial Random▶ SELECT & [ENTER]
Select row & order. ▲ ▲ (row:3, order:Serial)	× Table 1~12? 03 ◀Serial Random▶ SELECT & [ENTER]
ENTER	× Table Multiply by:03 Type:Serial READY
	× Table Multiply by:03 Type:Serial GO!
Enter the answer.	× Table 12 3× 1=_
3 ENTER	× Table 11 ✔ 3× 1=3 3× 2=_
(12 questions in total)	⋮
36 ENTER	× Table 0 ✔ 3×11=33 ✔ 3×12=36 PRESS [ENTER]
Display the correct answer rate. ENTER	× Table Multiply by:03 Type:Serial ✔ : 10(83%)

≈Functions and Key Operations for EL-W506T only≈

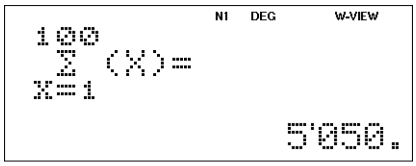
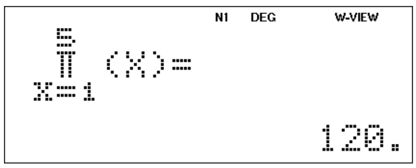
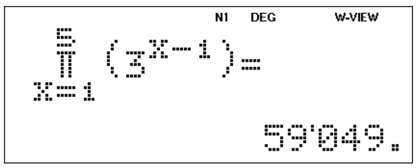
Σ Calculations, Π Calculations

Σ Calculates the cumulative sum of a given expression from an initial value to an end value.

Π Calculates the product of a given expression from an initial value to an end value.

(This example is for EL-W506T only.)

<Example>

Operation	Display
ON/C ALPHA Σ 1 ▶ 100 ▶ ALPHA x =	
ALPHA Π 1 ▶ 5 ▶ ALPHA x =	
ALPHA Π 1 ▶ 5 ▶ 3 y^x ALPHA x − 1 =	

Integer Part, Fraction Part, Closest Integer

MATH 3 ~ 5

MATH 3 **(ipart)** Returns only the integer part of a decimal number.

MATH 4 **(fpart)** Returns only the fraction part of a decimal number.

MATH 5 **(int)** Rounds down a decimal number to the closest integer.

(This example is for EL-W506T only.)

<Example>

Operation	Display
ON/C MATH 3 √‾ 2 =	N1 DEG W-VIEW ipart√2= 1.
MATH 4 √‾ 2 =	N1 DEG W-VIEW fpart√2= 0.414213562
MATH 5 (−) NEG 34.5 =	N1 DEG W-VIEW int-34.5= -35.
MATH 5 (69 ÷ 2) =	N1 DEG W-VIEW int(69÷2)= 34.

Engineering Prefixes

MATH 0

(This example is for EL-W506T only.)

<Example>

Find the speed per hour of movement due to the rotation of the earth when standing on the equator.

- Assuming the circumference of the earth is 40,000 km on the equator.
- Use “k” of engineering prefixes.
- The earth turns around in 24 hours.

Operation	Display
ON/C 40000	
MATH 0 (ENG. SYMBOL)	N1 DEG W-VIEW <<ENG.SYMBOL>> 0k 1M 2G 3T 4m 5μ 6n 7p 8f
0 (k)	
÷ 24 = CHANGE	N1 DEG W-VIEW 40000k÷24= 1'666'666.667

Differentiation Calculation d/dx x

(This example is for EL-W506T only.)

<Example 1>

If the demand curve is expressed by

$$D = \frac{25920}{P} - 24$$

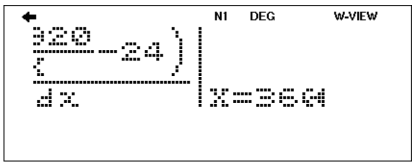
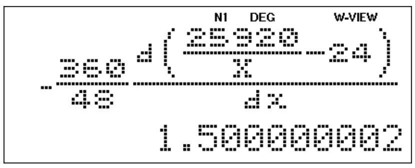
find the price elasticity of demand when P=360 (D=48).

*Price elasticity of demand:
A value that indicates how sensitive demand is to changes of price.

$$\text{Price elasticity of demand} = -\frac{\text{Rate of demand change}}{\text{Rate of price change}} = -\frac{\frac{dD}{D}}{\frac{dP}{P}} = -\frac{P}{D}\frac{dD}{dP}$$

Find the following value when P=360 and D=48.

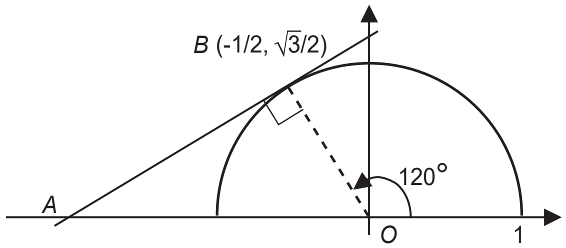
$$-\frac{P}{D}\left.\frac{d\left(\frac{25920}{x} - 24\right)}{dx}\right|_{x = 360}$$

Operation	Display
[ON/C] [(−) NEG] [a/b] 360 [▶] 48	
[▶] [ALPHA] [d/dx] [a/b] 25920	
[▶] [ALPHA] [x] [▶] [−] 24	
[▶] 360	
[=]	

Differentiation Calculation d/dx x

(This example is for EL-W506T only.)

<Example 2>



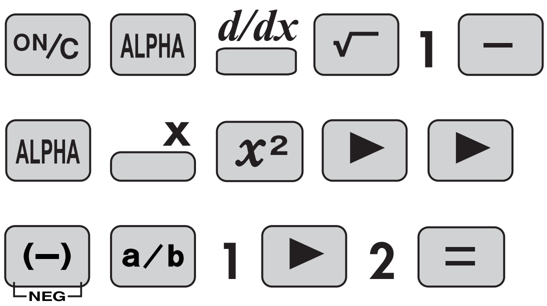
The semicircle above is given by the equation

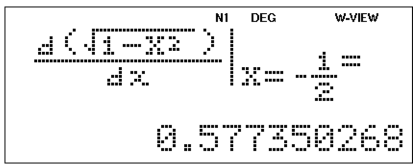
$$y = \sqrt{1 - x^2}$$

Find the slope of the tangent *AB* at point *B* (-1/2, √3/2) on the semicircle.

$$\left.\frac{d(\sqrt{1 - x^2})}{dx}\right|_{x = -\frac{1}{2}}$$

Operation | **Display**





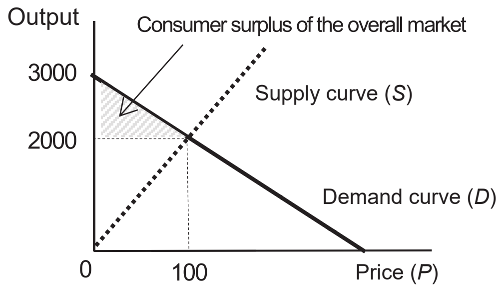
Integration Calculation $\int dx$ x

(This example is for EL-W506T only.)

<Example 1>

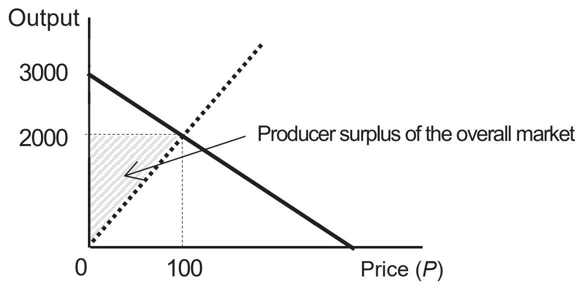
Let the demand curve of the overall market be *D* = 3000 - 10*P*, the supply curve be *S* = 20*P*, the equilibrium price be 100, and the equilibrium output be 2000.

(1) Find the consumer surplus of the overall market.



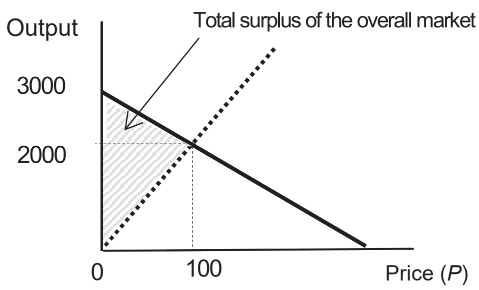
$$\int_0^{100} (3000 - 10x - 2000)\, dx$$

(2) Find the producer surplus of the overall market.



$$\int_0^{100} (2000 - 20x)\, dx$$

(3) Find the total surplus of the overall market.



$$\int_0^{100} (3000 - 10x - 20x)\, dx$$

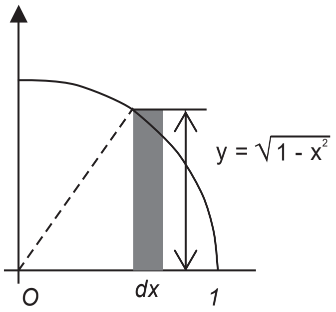
Integration Calculation ∫dx X

Operation	Display
(1)	
ON/C ALPHA ∫dx 0 ▶ 100	
▶ (3000 − 10	N1 DEG W-VIEW 000−10X−2000)dx
ALPHA X − 2000)	
=	N1 DEG W-VIEW $\int_{0}^{100}$ (3000−10X−20 50'000.
(2)	
ON/C ALPHA ∫dx 0 ▶ 100	
▶ (2000 − 20	N1 DEG W-VIEW $\int_{0}^{100}$ (2000−20X)dx
ALPHA X) =	100'000.
(3)	
ON/C ALPHA ∫dx 0 ▶ 100	
▶ (3000 − 10	
ALPHA X − 20 ALPHA	N1 DEG W-VIEW 0 (3000−10X−20X)d
X)	
=	N1 DEG W-VIEW $\int_{0}^{100}$ (3000−10X−20 150'000.

Integration Calculation [∫dx] [x]

(This example is for EL-W506T only.)

<Example 2>



The fan shaped curve at left is given by the equation

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

Find the area of the fan shape with radius 1 and central angle 90°.

$$\int_0^1 \sqrt{1 - x^2}\, dx$$

Operation	Display
[ON/C] [ALPHA] [∫dx] 0 [▶] 1 [▶] [√‾] 1 [−] [ALPHA] [x] [x^2] [=]	N1 DEG W-VIEW $\int_0^1 \sqrt{1-X^2}\,dx=$ 0.785357562

Simulation Calculation (ALGB)

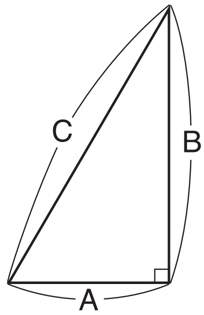
ALGB

If you have to find values consecutively using the same expression, once you enter the expression, all you have to do is to specify the value for the variable in the equation.

(This example is for EL-W506T only.)

<Example>

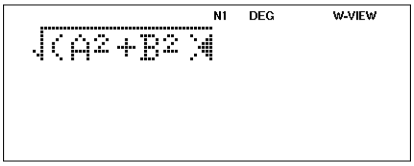
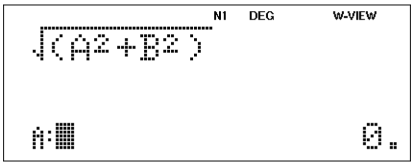
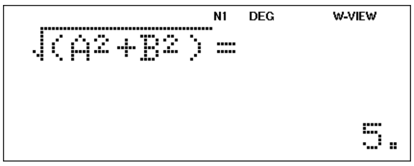
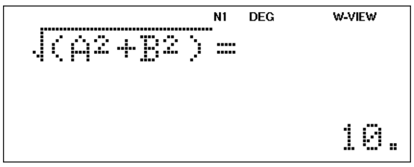
Find the length of the remaining side when the two sides of the right triangle are known.
Use the Pythagoras theorem.



- From the Pythagoras theorem, input the expression.

$$A^2+B^2=C^2$$
$$\sqrt{A^2+B^2}=C$$

-Find C from A and B.

Operation	Display
ON/C √ (ALPHA A x² + ALPHA B x²)	
2ndF ALGB (Simulation Calculation)	
3 ENTER 4 ENTER (A=3, B=4)	
2ndF ALGB 6 ENTER 8 ENTER (A=6, B=8)	

Solver Function

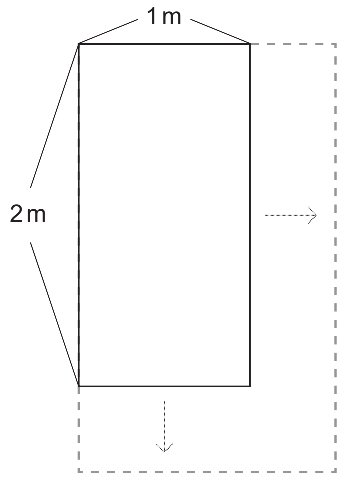
SOLVER

The solver function finds the value for *x* that reduces the entered expression to zero.

(This example is for EL-W506T only.)

<Example>

When the rectangle with lengths and widths of 2 m and 1 m were lengthened by the same length and width, the area increased by 10 m².
How many meters did you make it longer?



- Create an expression with the desired value as *x*, and then, transform the expression (= 0).

  $(2+x)(1+x)=2+10$

  $(2+x)(1+x)-12=0$

- Perform the solver function. (”start=0” and “d*x*=0.00001)

Operation	Display
ON/C (2 + ALPHA x)	
(1 + ALPHA x)	
− 12	
2ndF SOLVER ENTER ENTER	N1 DEG W-VIEW (2+X)(1+X)-12= X= 2.

Complex Calculation MODE →xy →rθ i ∠

(This example is for EL-W506T only.)

<Example 1>

An AC sine wave voltage of 100 V, 50 Hz is applied to a circuit consisting of a resistor (R = 250Ω) and capacitor (C = 20 x 10^{-6}F) connected in parallel. Find the impedance of this circuit.

Circuit impedance = Value of polar coordinate r

Let R = 250, C = 20 x 10^{-6}, and f = 50.
If the complex number Z = 1÷((1÷R) + 2πfCi),
find the value of the complex number Z and the values of r.

Operation	Display
MODE 3 (COMPLEX) <Complex mode> 2nd F →xy (Rectangular coordinates)	N1 DEG COMPLEX MODE xy 0.
1 ÷ ((1 ÷ 250) + 2 π × 50 × 20 Exp (−) 6 i) =	N1 DEG 1÷((1÷250)+2π×50 ×20E -6i)= xy 72.10010979 -113.2545876i
2nd F SET UP 0 (DRG)	N1 DEG <<ANGLE>> 0DEG 1RAD xy 2GRAD
1 (RAD) (Angle units: RAD)	
2nd F →rθ (Polar coordinates)	N1 RAD 1÷((1÷250)+2π×50 ×20E -6i)= rθ 134.257318 ∠-1.003884822

Complex Calculation MODE →xy →rθ i ∠

(This example is for EL-W506T only.)

<Example 2>

Operation	Display
MODE 3 (COMPLEX) <Complex mode> 2ndF →xy (Rectangular coordinates)	N1 DEG COMPLEX MODE xy 0.
2ndF abs (1 + 2 i) =	N1 DEG abs(1+2i)= xy 2.236067977
MATH 0 2 + 5 i) =	N1 DEG conj(2+5i)= xy 2. -5.i
MATH 1 1 + i √ 3) =	N1 DEG arg(1+i√3)= xy 60.
MATH 2 2 2ndF ∠ 30) =	N1 DEG real(2∠30)= xy 1.732050808
MATH 3 2 2ndF ∠ 30) =	N1 DEG img(2∠30)= xy 1.

Complex Calculation MODE →xy →rθ i ∠

(This example is for EL-W506T only.)

<Example 3>

An AC sine wave voltage of 100V, 60Hz is applied to a circuit consisting of a resistor (R = 120Ω), coil (L = 4 H), and capacitor ($C = 3 \times 10^{-6}$F) connected in series.

(1) Find the impedance of the circuit.
(2) Find the phase difference φ between the current and the voltage.

Circuit impedance = Value of polar coordinate r
Phase difference = Polar coordinate θ

Let R = 120, L = 4, $C = 3 \times 10^{-6}$, and f = 60. If the complex number $Z = R + 2\pi fLi + 1 \div (2\pi fCi)$, find the value of the complex number Z and the values of r and θ.

Operation	Display
MODE 3 (COMPLEX)	
<Complex mode>	
ON/C 2ndF →xy (rectangular coordinates)	
120 + 2 π × 60 × 4 × i + 1 ÷ (2 π × 60 × 3 Exp (−)[NEG] 6 i) =	N1 RAD 120+2π×60×4×i+1÷(2π×60×3E-6i)= xy 120. +623.7703454i
2ndF SET UP 0 (DRG)	
0 (DEG) (Angle units: DEG)	
2ndF →rθ (Polar coordinates)	N1 DEG 120+2π×60×4×i+1÷(2π×60×3E-6i)= rθ 635.2081894 ∠79.110561

Simultaneous Equation MODE

(This example is for EL-W506T only.)

<Example 1>

To produce one unit of product *X*, 3 kg of material *A* and 1 kg of material *B* are required.
To product one unit of product *Y*, 1 kg of material *A* and 2 kg of material *B* are required.
There are 9 kg of *A* and 8 kg of *B* in stock.
If the selling price of product *X* is 300 dollars/unit and the selling price of product *Y* is 200 dollars/unit, how many units of product *X* and how many units of product *Y* should be produced in order to maximize sales *K*?
(Do not include the cost of materials and production or other expenses)

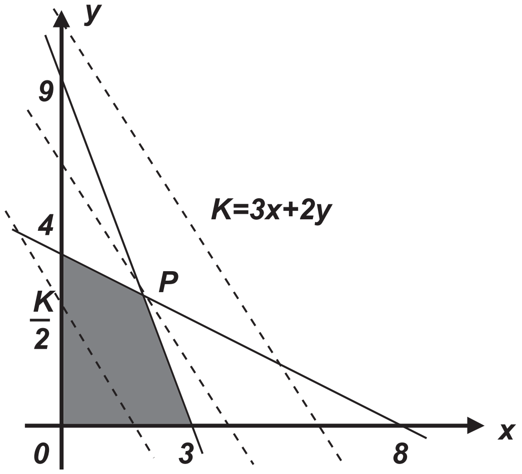
If the quantities produced of each product are *x* and *y*, the sales *K* can be expressed as

$$K = 3x + 2y$$

The following relations hold for the quantities in stock:

$$3x + y \leq 9$$
$$x + 2y \leq 8$$
$$x \geq 0,\ y \geq 0$$

Based on these conditions, find the values of *x* and *y* that maximize sales *K*.



The conditions can be graphed as shown above.
The sales *K* is a maximum where the line $K = 3x + 2y$ passes through the intersection point *P* of lines $3x + y = 9$ and $x + 2y = 8$.

The intersection point P can be obtained from the following simultaneous equations:

$$3x + y = 9$$
$$x + 2y = 8$$

Solving these gives

$x = 2,\ y = 3$

and thus the maximum value of the sales *K* is

$K = 3 \times 2 + 2 \times 3 = 12$ (x 100) dollars (when $x = 2$ units and $y = 3$ units)

Simultaneous Equation MODE

(1) Solve the following simultaneous equations.

$3x + y = 9$
$x + 2y = 8$

(2) Use the result of (1) to find the following value.

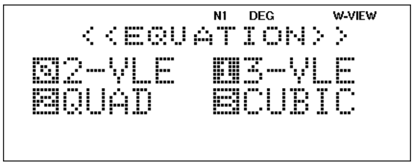
$K = 3x + 2y$

Operation | **Display**

(1)

Set the mode to Equation.

MODE 4 (EQUATION)



<Equation mode>

(2-VLE)

<Simultaneous linear equations in two unknowns>

Enter the coefficients.

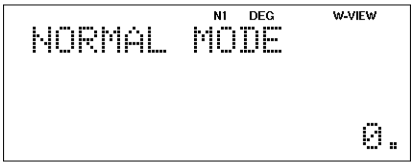
a1 = 3 , b1 = 1 , c1 = 9
a2 = 1 , b2 = 2 , c2 = 8

3 ENTER 1 ENTER 9 ENTER
1 ENTER 2 ENTER 8 ENTER

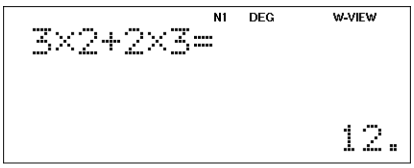
(2)

Set the mode to Normal.

HOME (MODE 0)



3 × 2 + 2 × 3
=



Simultaneous Equation MODE

(This example is for EL-W506T only.)

<Example 2>

When ethanol C_2H_5OH is completely combusted, carbon dioxide CO_2 and water H_2O are created.
The chemical reaction formula of this reaction is expressed as follows:

$$x\ C_2H_5OH + 3O_2 \rightarrow y\ CO_2 + z\ H_2O$$

Find the values of x, y, and z to complete the chemical reaction formula.

The numbers of C, H, and O before and after the reaction are equal, hence

Number of C: $2x = y$
Number of H: $5x + x = 2z$
Number of O: $x + 6 = 2y + z$

As such, the following simultaneous equations are obtained:

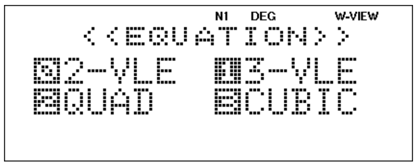
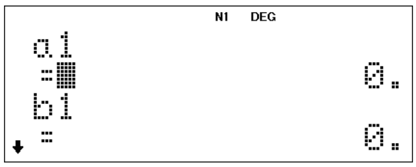
$$\begin{aligned} 2x - y \quad &= 0 \\ 6x \quad - 2z &= 0 \\ x - 2y - z &= -6 \end{aligned}$$

Solving these gives

$x = 1$, $y = 2$, $z = 3$

and the chemical reaction formula is

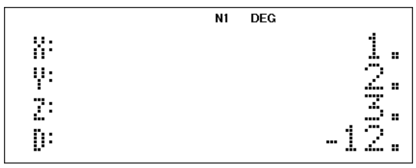
$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Operation	Display
Set the mode to Equation MODE 4 (EQUATION)	
<Equation mode> 1 (3-VLE) <Simultaneous linear equations in three unknowns>	

Enter the coefficients.

a1 = 2 , b1 = -1 , c1 = 0 , d1 = 0
a2 = 6 , b2 = 0 , c2 = -2 , d2 = 0
a3 = 1 , b3 = -2 , c3 = -1 , d3 = -6

2 ENTER (−) NEG 1 ENTER 0 ENTER 0 ENTER
6 ENTER 0 ENTER (−) NEG 2 ENTER 0 ENTER
1 ENTER (−) NEG 2 ENTER (−) NEG 1 ENTER (−) NEG 6
ENTER



Polynomial Equation [MODE]

(This example is for EL-W506T only.)

<Example 1>

Let the hydrochloric acid concentration be c (= 1.0×10^{-8} mol / ℓ), and the hydrogen ion concentration be x.

(1) Solve the following quadratic equation to find the hydrogen ion concentration x:

$$x^2 - cx - K_W = 0$$

where

$K_W = 1.0 \times 10^{-14}$ [mol / ℓ] (ionic product of water)

(2) Use the result of (1) to find the pH (= - log x) of hydrochloric acid.

$$\mathbf{pH = -\log x \ (x>0)}$$

Operation	Display
(1)	
Set the mode to Equation.	
[MODE] [4] (EQUATION) [2] (QUAD)	N1 DEG a: 0. b: 0. c: 0.
Solve the equation (enter coefficients a, b, c).	
1 [ENTER]	
[(−) NEG] 1.0 [Exp] [(−) NEG] 8 [ENTER]	N1 DEG a: 1. b: -0.00000001 c: -1.0E -14_
[(−) NEG] 1.0 [Exp] [(−) NEG] 14	
[ENTER]	N1 DEG X= ↓ 1: 0.000000105 2: -0.000000095

(2)

Set the mode to Normal

HOME (MODE 0)

(−) NEG log 0.000000105

=

N1 DEG W-VIEW
NORMAL MODE
0.

N1 DEG W-VIEW
-log0.000000105=
6.978810701

NOTE:
Make sure the FSE (decimal settings) in the SETUP menu when manually entering the results of the previous calculation and using it for subsequent calculations. The accuracy of the calculation results may vary as follows.
If the absolute value of the previous result is much less than 1, it is recommended to use the SCI format.

	Answer of (1) (Previous result)	Answer of (2) (Subsequent result)
NORM1 format (default) 2nd F SET UP 1 3	N1 DEG X= ↓ 1: 0.000000105 2: -0.000000095	N1 DEG W-VIEW -log0.000000105= 6.978810701
SCI format. Tab=5. 2nd F SET UP 1 1 5	SCI DEG X= ↓ 1: 1.0512E-07 2: -9.5125E-08	SCI DEG W-VIEW -log1.0512E -7= 6.9783E00
NORM2 format 2nd F SET UP 1 4	N2 DEG X= ↓ 1: 1.05124922E-07 2: -9.512492197E-08	N2 DEG W-VIEW -log1.05124922E - 6.978294313

Polynomial Equation [MODE]

(This example is for EL-W506T only.)

<Example 2>

Let the acetic acid concentration be c (= 0.1 mol / ℓ), and the hydrogen ion concentration be x.

(1) Solve the following quadratic equation to find the hydrogen ion concentration x:

$$x^3 + K_a x^2 - (cK_a + K_w)x - K_a K_w = 0$$

where

K_a = 2.75 x 10^{-5} [mol / ℓ] (ionization equilibrium constant of acetic acid)
K_w = 1.0 x 10^{-14} [mol / ℓ] (ionic product of water)

(2) Use the result of (1) to find the pH (= - log x) of acetic acid.

$$\text{pH} = -\log x \ (x>0)$$

Operation	Display

(1)

Save constants.

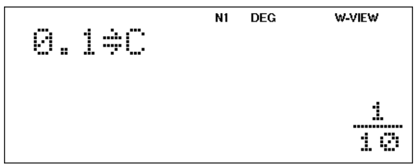
(When using the same number repeatedly, it is convenient to store it in memory.)

[HOME] ([MODE] [0])

2.75 [Exp] [(−)] (NEG) 5 [STO] [A]

1.0 [Exp] [(−)] (NEG) 14 [STO] [B]

0.1 [STO] [C]



Polynomial Equation MODE

Set the mode to Equation

MODE 4 (EQUATION) 3 (CUBIC)

<Cubic equation>

```
        N1  DEG
a:            0.
b:            0.
c:            0.
d:            0.
```

Solve the equation (enter coefficients a, b, c, d).

1 ENTER

ALPHA A ENTER

(−) NEG (ALPHA C ALPHA A

+ ALPHA B) ENTER

(−) NEG ALPHA A ALPHA B

=

```
        N1  DEG
X=
1:   -0.001672119
2:    0.001644619
3:   -9.99413E-14
```

(2)

Set the mode to Normal.

HOME (MODE 0)

ON/C (−) NEG log **0.001644619**

=

```
        N1  DEG      W-VIEW
NORMAL MODE

                  0.
```

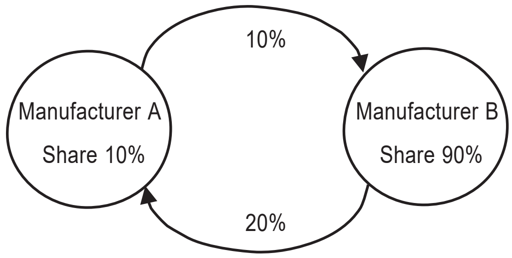
```
        N1  DEG      W-VIEW
-log0.001644619=

        2.783934697
```

Matrix Calculation MODE MATH

(This example is for EL-W506T only.)

<Example>

In a certain year (year 0), the share of manufacturer A is 10% and the share of manufacturer B is 90%. Manufacturer A then releases a new product, and each following year it maintains 90% of the share it had the previous year, and usurps 20% of the share of manufacturer B.
Find the transition matrix for this process and the shares of manufacturers A and B after 2 years.



Answer

Assuming that the share of manufacturer A after k years is a_k and the share of manufacturer B is b_k, the shares of the 0th year and the 1st year and thereafter are as follows.

$$a_1 = 0.9a_0 + 0.2b_0$$
$$b_1 = (1\text{-}0.9)a_0 + (1\text{-}0.2)b_0$$

Thus, a_1 and b_1 are

$$a_1 = 0.9a_0 + 0.2b_0$$
$$b_1 = 0.1a_0 + 0.8b_0$$

Make it into a matrix format.

$$\begin{bmatrix} a_1 \\ b_1 \end{bmatrix} = \begin{bmatrix} 0.9 & 0.2 \\ 0.1 & 0.8 \end{bmatrix} \begin{bmatrix} a_0 \\ b_0 \end{bmatrix}$$

The transition matrix is

$$A = \begin{bmatrix} 0.9 & 0.2 \\ 0.1 & 0.8 \end{bmatrix}$$

The share after 2 years are

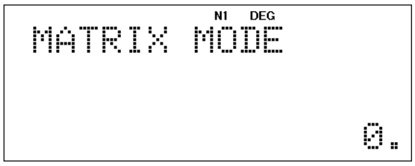
$$\begin{bmatrix} a_2 \\ b_2 \end{bmatrix} = \begin{bmatrix} 0.9 & 0.2 \\ 0.1 & 0.8 \end{bmatrix} \begin{bmatrix} a_1 \\ b_1 \end{bmatrix}$$
$$= \begin{bmatrix} 0.9 & 0.2 \\ 0.1 & 0.8 \end{bmatrix} \begin{bmatrix} 0.9 & 0.2 \\ 0.1 & 0.8 \end{bmatrix} \begin{bmatrix} a_0 \\ b_0 \end{bmatrix}$$

Matrix Calculation MODE MATH

Operation	Display

Set the mode to Matrix.

MODE 5 **(MATRIX)**

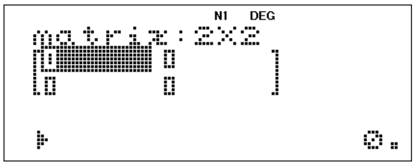


Enter transition matrix.

MATH 1 **(EDIT)**

Set size.

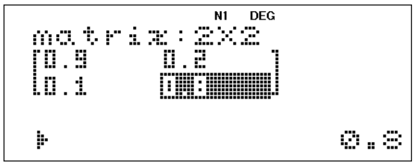
2 2 ENTER <2 x 2 Matrix>



Enter elements.

0.9 ENTER **0.2** ENTER

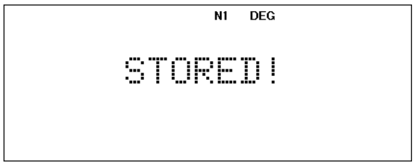
0.1 ENTER **0.8** ENTER



Save to mat A.

ON/C

MATH 3 **(STORE)** 0



Enter share of 0 year into matrix.

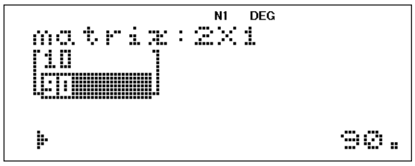
MATH 1 **(EDIT)**

Set size.

2 1 ENTER <2 x 1 Matrix>

Enter elements.

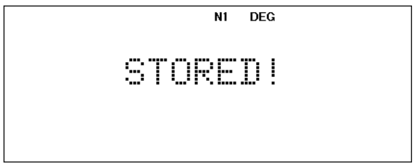
10 ENTER **90** ENTER



Save to mat B.

ON/C

MATH 3 **(STORE)** 1



Matrix Calculation [MODE] [MATH]

Calculate the shares of manufacturers A and B after 2 years.

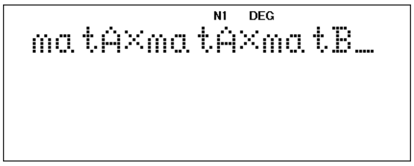
mat A x mat A x mat B

[ON/C]

[MATH] [0] [0]

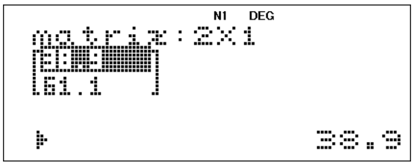
[×] [MATH] [0] [0]

[×] [MATH] [0] [1]



[=]

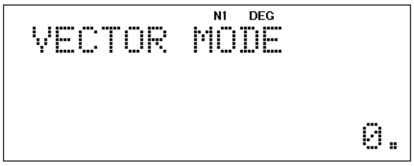
(A: 38.9%, B: 61.1%)



Vector Calculations [MODE] [MATH]

Set the mode to Vector.

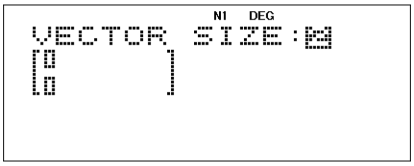
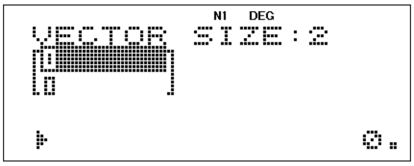
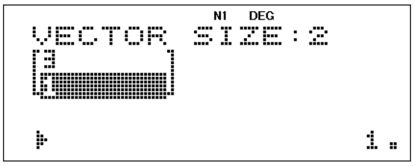
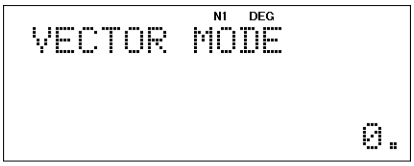
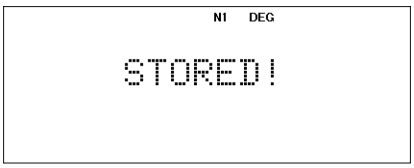
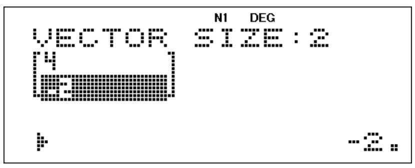
[MODE] [6] (VECTOR)



(This example is for EL-W506T only.)

<Example>

(1) Calculate the dot product of Vector A(3,1) and Vector B(4,-2), and calculate the angle between Vector A and Vector B.

Operation	Display
Set the dimension. [MATH] [1] (EDIT) [2] (2-dimentional)	
[ENTER]	
Enter numeric value. 3 [ENTER] 1 [ENTER]	
[ON/C]	
Store to vectA. [MATH] [3] [0]	
Enter next Vector. [MATH] [1] [2] [ENTER] 4 [ENTER] [(−) NEG] 2 [ENTER]	

Operation	Display
Store to vectB. ON/C MATH 3 1	STORED!
Calculate the dot product. MATH 4 MATH 0 0 (x,y) MATH 0 1) ENTER	DotPro(vectA,vectB)= 10.
Calculate the angle. MATH 6 MATH 0 0 (x,y) MATH 0 1) ENTER	Angl(vectA,vectB)= 45.

(2) Calculate the cross product of Vector A(1,2,3) and Vector B(4,5,6).

Operation	Display
Set the dimension. MATH 1 3 (3-dimentional)	VECTOR SIZE:3
ENTER	VECTOR SIZE:3 0.
Enter numeric value. 1 ENTER 2 ENTER 3 ENTER	VECTOR SIZE:3 1 2 3 3.
ON/C	VECTOR MODE 0.

Vector Calculations MODE MATH

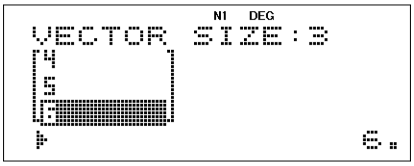
Store to vectA.

MATH 3 0

Enter next Vector.

MATH 1 3 ENTER

4 ENTER 5 ENTER 6 ENTER



Store to vectB.

ON/C

MATH 3 1

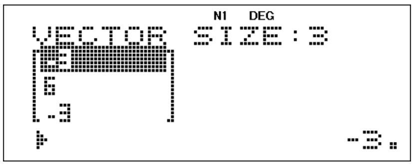
Calculate the cross product.

MATH 5

MATH 0 0 (x,y)

MATH 0 1)

ENTER



Distribution Functions MODE

(This example is for EL-W506T only.)

<Example>

(1) Calculate the probability density for the normal distribution at x = 65 when the test score averages is 60 with a standard deviation of 12.

Operation	Display
MODE 7 0 0 (Normal pdf)	Normal pdf x: 0. μ: 0. σ: 1.
65 ENTER 60 ENTER 12	Normal pdf x: 65. μ: 60. σ: 12
ENTER	Normal pdf ANS= 0.03048103

(2) Calculate the probability of range x = 70 to 80 in the above sample.

Operation	Display
MODE 7 0 1 (Normal cdf)	Normal cdf x1: 0. x2: 0. μ: 0.
70 ENTER 80 ENTER 60 ENTER	Normal cdf x2: 80. μ: 60. σ: 1.
12 ENTER	Normal cdf ANS= 0.154538028

SHARP CORPORATION

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