SHARP

SCIENTIFIC CALCULATOR OPERATION GUIDE



< EL-W531TL/W531TH/W531TG/W506T >

CONTENTS

HOW	TO OPERATE				
Read	d Before Using 1. KEY LAYOUT		4		
	2. RESET SWITCH		5		
	3. DISPLAY PATTERN		5		
	4. EXPRESSION INPUT FORMAT ANI	D CALCULATION RESULT	6		
	5. CHANGE RESULT DISPLAY		7		
	6. DISPLAY FORMAT AND DECIMAL SETTING FUNCTION				
	7. EXPONENT DISPLAY		9		
	8. ANGULAR UNIT		10		
	9. RECURRING DECIMAL		11		
	10. DECIMAL POINT OF CALCULATION	ON RESULT	12		
Fund	ctions and Key Operations				
	ON/OFF, Entry Correction Keys	on/c OFF CA ▲ ▼ ■ BS DEL	13		
	Numerical Value Entry Keys	• (-) T Exp	14		
	Random Function	RANDOM	15		
	Modify Key	MDF	16		
	Basic Arithmetic Keys, Parentheses	+ - × ÷ = ()	17		
	Percent	%	18		
	Inverse, Square, Cube, xth Power of y, Square Root, Cube Root, xth Root	x-1	19		
	Power and Radical Root	3v yx xv	20-22		
	10 to the Power of x, Common Logarith Logarithm of x to Base a	IM, 10 ^x log log _a x	23		
	Exponential, Logarithmic	10x log ln log,x	24-26		
	e to the Power of x, Natural Logarithm		27		
	Factorials	<u>n!</u>	28		
	Permutations, Combinations	nPr nCr	29-31		
	Quotient Remainder Calculation, Prime Factorization	int÷ P.FACT	32		
	Greatest Common Divisor, Least Common Multiple	GCD LCM	33		
	Sexagesimal Calculation (Time)	D°M'S	34		
	Fractional Calculations	a/b ab/6	35		
	Memory Calculations	STO RCL M+ M- A ~ F X Y M	36-37		
	Last Answer Memory	ANS	38		

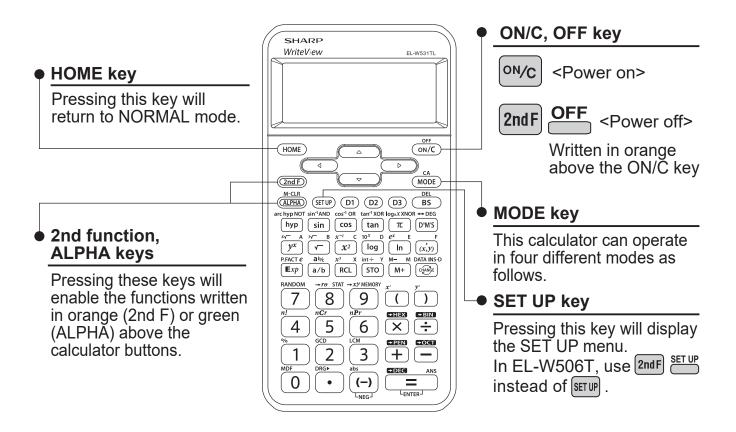
Simultaneous Equation Mode 79-81 Polynomial Equation Mode 82-85 Matrix Calculation Mode MATH 86-88 Vector Calculations Mode MATH 89-91	User-Defined Memories	D1 ~ D3	39	
Arc Trigonometric Functions 10	Absolute Value	abs	40	
Hyperbolic Functions	Trigonometric Functions	sin cos tan	41-45	
Coordinate Conversion 10	Arc Trigonometric Functions	sin ⁻¹ cos ⁻¹ tan ⁻¹	46	
Binary, Pental, Octal, Decimal, an Hexadecimal Operations (N-Base) Statistics Functions DATA INPUT FOR 1-VARIABLE STATISTICS ANALYSIS RESULTS FOR 1-VARIABLE STATISTICS DATA CORRECTION DATA INPUT FOR 2-VARIABLE STATISTICS ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode	Hyperbolic Functions	hyp arc hyp sin cos tan	47-50	
Hexadecimal Operations (N-Base) Statistics Functions DATA INPUT FOR 1-VARIABLE STATISTICS ANALYSIS RESULTS FOR 1-VARIABLE STATISTICS DATA INPUT FOR 2-VARIABLE STATISTICS DATA INPUT FOR 2-VARIABLE STATISTICS TANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode Table Mode Total Independent of the thick of	Coordinate Conversion	+re +xy (x,y)	51	
DATA INPUT FOR 1-VARIABLE STATISTICS ANALYSIS RESULTS FOR 1-VARIABLE STATISTICS DATA CORRECTION DATA INPUT FOR 2-VARIABLE STATISTICS ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode Tabl		→BIN →PEN →OCT →DEC →HEX	52	
ANALYSIS RESULTS FOR 1-VARIABLE STATISTICS DATA CORRECTION DATA INPUT FOR 2-VARIABLE STATISTICS ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode Table	Statistics Functions	MODE (x,y) DATA INS-D STAT	53	
DATA CORRECTION DATA INPUT FOR 2-VARIABLE STATISTICS ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode Table Mode Drill Mode Total Mode To	DATA INPUT FOR 1-VARIABLE S	53		
DATA INPUT FOR 2-VARIABLE STATISTICS ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode Table Mode Total M	ANALYSIS RESULTS FOR 1-VAR	RIABLE STATISTICS	54-55	
ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS Table Mode Drill Mode Functions and Key Operations for EL-W506T only Σ Calculations, Π Calculations S Calculations, Π Calculations S Calculations	DATA CORRECTION		56	
Table Mode Drill Mode Functions and Key Operations for EL-W506T only Σ Calculations, Π Calculations Integer Part, Fraction Part, Closest Integer Engineering Prefixes Differentiation Calculation Integration Calculation Integration Calculation Jdx x 71-73 Simulation Calculation Solver Function Complex Calculation Formulation Formulation Calculation Formul	DATA INPUT FOR 2-VARIABLE S	DATA INPUT FOR 2-VARIABLE STATISTICS		
Drill Mode MODE MODE G5 Functions and Key Operations for EL-W506T only Σ Calculations, Π Calculations Σ Π	ANALYSIS RESULTS FOR 2-VAR	RIABLE STATISTICS	58-60	
Functions and Key Operations for EL-W506T only Σ Calculations, Π Calculations Δ	Table Mode	MODE X	61-64	
Σ Calculations, Π CalculationsΣ Π66Integer Part, Fraction Part, Closest Integer67Engineering PrefixesMATH 068Differentiation Calculationd/dx x69-70Integration Calculationi/dx x71-73Simulation Calculation (ALGB)ALGB74Solver Function500VER75Complex CalculationMODE +xy +ro → ∠76-78Simultaneous EquationMODE +xy +ro → ∠76-78Polynomial EquationMODE MATH82-85Matrix CalculationMODE MATH86-88Vector CalculationsMODE MATH89-91	Drill Mode	MODE	65	
Integer Part, Fraction Part, Closest Integer Engineering Prefixes MATH 0 68 Differentiation Calculation Integration C				
Closest Integer Engineering Prefixes MATH 0 68 Differentiation Calculation MATH 0 69-70 Integration Calculation Integration Calculation Integration Calculation Simulation Calculation (ALGB) Solver Function Complex Calculation Formulation Calculation MODE **XY **P***	<u> </u>		00	
Differentiation Calculation Integration Calculation Simulation Calculation (ALGB) Solver Function Complex Calculation Simultaneous Equation Polynomial Equation Mode Mode Matrix Calculations		MATH 3 ~ 5	67	
Integration Calculation Integration Calculation Simulation Calculation (ALGB) Solver Function Complex Calculation Simultaneous Equation Polynomial Equation Mode Mode Mode Mode Matrix Calculation Mode Mode Mode Matrix Calculation Mode Mode MATH Mode Mode Mode Math Mode M	Engineering Prefixes	MATH 0	68	
Simulation Calculation (ALGB) Solver Function Complex Calculation Simultaneous Equation Polynomial Equation Mode Mode Matrix Calculation Mode Mode MATH Mode Mode Math Mode	Differentiation Calculation		69-70	
Solver Function Solver Function Complex Calculation Mode + xy + re	Integration Calculation	$\int dx = \mathbf{X}$	71-73	
Complex Calculation Simultaneous Equation Polynomial Equation Mode M	Simulation Calculation (ALGB)	ALGB	74	
Simultaneous Equation MODE 79-81 Polynomial Equation MODE 82-85 Matrix Calculation MODE MATH 86-88 Vector Calculations MODE MATH 89-91	Solver Function	SOLVER	75	
Polynomial Equation Mode 82-85 Matrix Calculation Mode MATH 86-88 Vector Calculations Mode MATH 89-91	Complex Calculation	MODE *xy *re	76-78	
Matrix CalculationMODE MATH86-88Vector CalculationsMODE MATH89-91	Simultaneous Equation	MODE	79-81	
Vector Calculations MoDE MATH 89-91	Polynomial Equation	MODE	82-85	
	Matrix Calculation	MODE MATH	86-88	
Distribution Functions 92	Vector Calculations	MODE MATH	89-91	
	Distribution Functions	MODE	92	

How to Operate

≈Read Before Using≈

This operation guide has been written mainly based on the EL-W531TL/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-W531TL)



[NORMAL mode]

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

[STAT mode]

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

O Single variable statistic

Quadratic regression

4 Logarithmic regression

5 Power regression

Inverse regression

7 Exponential regression

[TABLE mode]

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

[DRILL mode]

Mode for performing drill calculations.

To select the drill sub-mode, press the corresponding number key after [MODE] 3.

(Math): Math drill (Table): Multiplication table drill

NOTE:

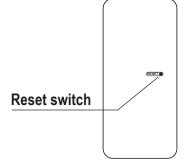
The EL-W506T model has another modes (Complex, Equation, Matrix, Vector and Distribution modes).

2. RESET SWITCH

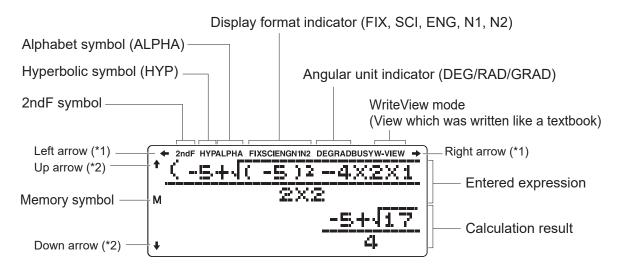
If the calculator fails to operate normally, press the reset switch on the back to reinitialize the unit. The display format and calculation mode will return to their initial settings.

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 key to switch between decimal format, fraction format, and a if possible

fraction format, $\sqrt{}$ and π , if possible.

SET UP 2 0 1 (APPROX.)

Displays the calculation result in decimal format (without $\sqrt{}$ or π) except for fractional calculation.

Use the key to switch between decimal and fraction formats, if possible.

 $\frac{1}{2} = \frac{1}{2} = \frac{1}$

2) LINE editor

Displays the calculation result in decimal format (without $\sqrt{}$ or π) except for fractional calculation.

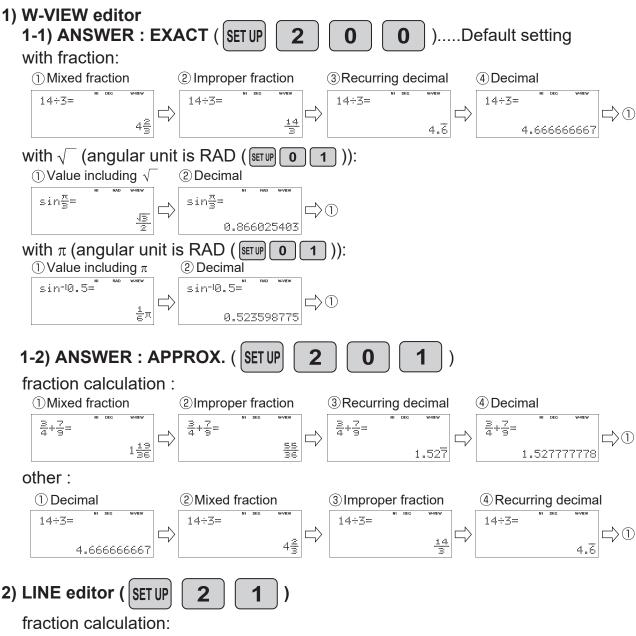
Use the key to switch between decimal and fraction formats (line fraction notation).

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 key (arrow mark position).

In the following examples of this section, the recurring decimal setting is ON ((SETUP) 5 1).



- ① Mixed fraction \rightarrow ② Improper fraction \rightarrow ③ Recurring decimal \rightarrow ④ Decimal \rightarrow ① other ·
- ① Recurring decimal \rightarrow ② Decimal \rightarrow ③ Mixed fraction \rightarrow ④ Improper fraction \rightarrow 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 instead of SET UP.

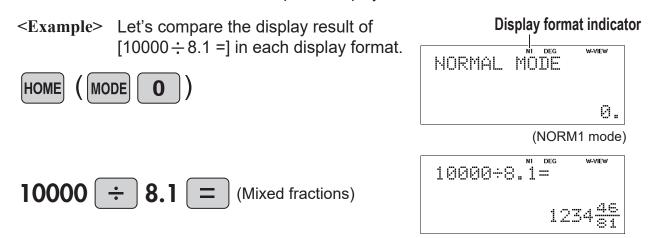
6. DISPLAY FORMAT AND DECIMAL SETTING FUNCTION

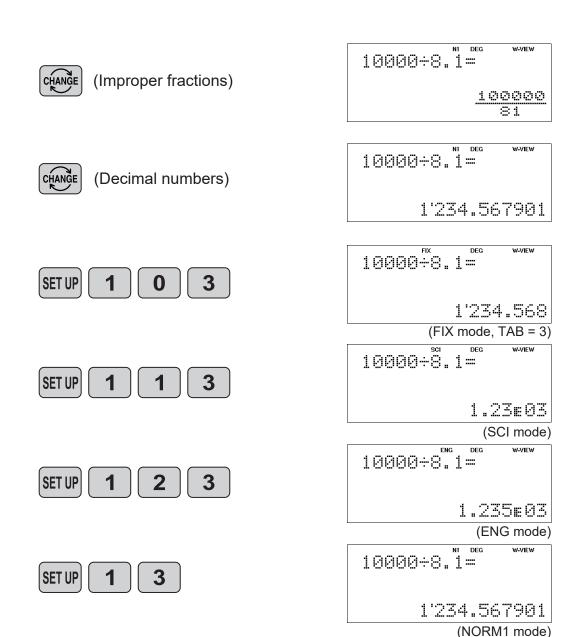
For convenient and easy operation, this model can be used in one of five display format (decimal setting).

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
- 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 once key is pressed, check whether or not the calculator is set to a Special Display Format.





7. EXPONENT DISPLAY

NOTE:

The distance from the earth to the sun is approx. 150,000,000 (1.5 x 108) 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.

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

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 x 10⁻¹⁹ coulombs).

W-VIEW

2.1-20

8. ANGULAR UNIT

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

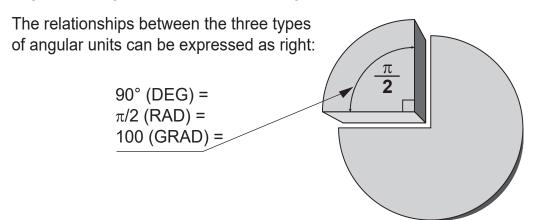
Degrees (DEG is shown at the top of the display)

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

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

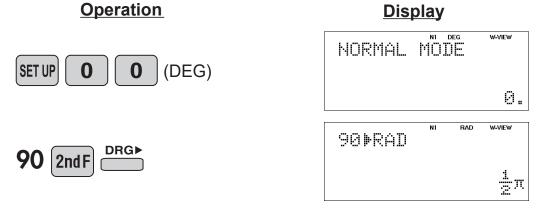
Radians are different from degrees and express angles based on the circumference of a circle. 180° is equivalent to π radians. Therefore, the angular measure of a circle is 2π radians. Press π 0 1.

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



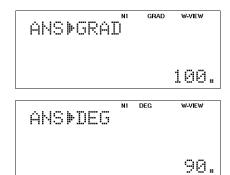
Angular values are converted from DEG to RAD to GRAD with each push of the key (2nd function of). This function is used when doing calculations related to trigonometric functions or coordinate geometry conversions.

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





DRG▶



2nd F

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.

5 Recurring decimal is ON. SET UP

Recurring decimal is OFF. **SET UP**

NOTE:

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

<Example>

Operation

Display

ON/C SET UP 5

(Recurring decimal: ON)

CHANGE **56**

(The recurring part is indicated by "-".)

N1 DEG W-VIEW 56÷99= 0.56

CHANGE

(Floating point)

N1 DEG W-VIEW 56+99= 0.565656565



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

ON/C SET UP 6 1

1 ÷ 2 = CHANGE

Display

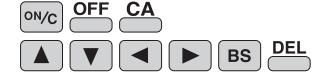
ni dec w-view 1÷2≕ 0;5

NOTE:

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

≈Functions and Key Operations≈

ON/OFF, Entry Correction Keys



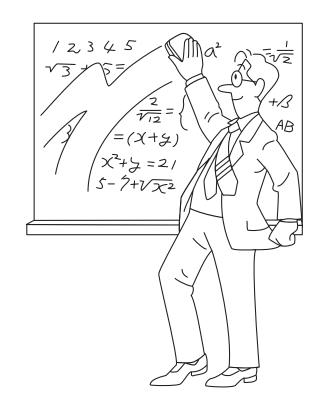
Turns the calculator on or clears the data. It also clears the contents of the calculator display and voids any calculator command; however, statistics, as well as values stored in the memory, are not erased.

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.

These keys are useful for editing equations. The <a> key moves the cursor to the left, and the <a> key moves the cursor to the right. The <a> key deletes the symbol/number at the left of the cursor, and the <a> key deletes the symbol/number at the cursor.



Numerical Value Entry Keys



0 to 9 Numeric keys for entering data values.

- Decimal point key. Enters a decimal point.
- Enters the minus symbol.

 The subtraction key is not used for entering negative numbers.
- 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. $(1.23x10^{12} \rightarrow 1.23E12)$
 - **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 x 108 km.

Circumference equals diameter x π ; therefore, 1.496 x 10⁸ x 2 x π

Operation Display 1.496 Εχρ 8 × 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 to convert it to decimal form.

[Random Dice]

To simulate a die-rolling, a random integer between 1 and 6 can be generated by pressing [2ndf] [2nd

[Random Coin]

To simulate a coin flip, 0 (heads) or 1 (tails) can be randomly generated by pressing [201] To generate the next random coin number, press [201].

[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 [2ndf] RANDOM 3 1 (2ndf) 99 [1] a random integer from 1 to 99 will be generated. To generate the next random integer, press [2ndf].

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 it 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...)

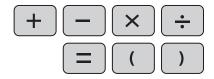
2ndF MDF (internally, 0.6)

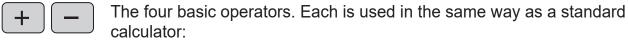
× 9 = 5.4

I APPLICATIONS:

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

Basic Arithmetic Keys, Parentheses







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

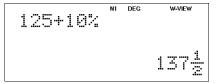




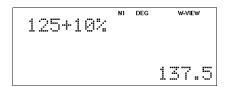
For calculating percentages. Four methods of calculating percentages are presented as follows.

1) \$125 increased by 10%...137.5







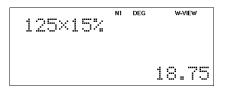


2) \$125 reduced by 20%...100



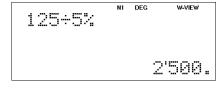
3) 15% of \$125...18.75





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

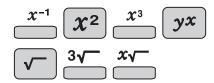


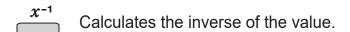


NOTE:

In EL-W506T, when "(%)" is specified immediately after a value, the value is treated as a percentage. "(%)" is specified by [MITH] 6 in normal mode.

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





 x^2 Squares the value.

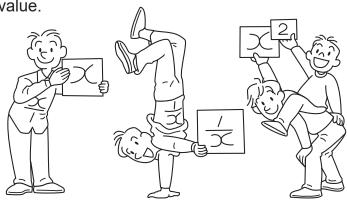
 x^3 Cubes the value.

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

Calculates the square root of the value.

Calculates the cube root of the value.

Calculates the x^{th} root of the value.



<Example>

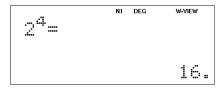
Operation

Display





2 yx 4 =



4 2nd F 7 16 =



Power and Radical root



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 $\tau = 20 \text{ N/mm}^2$.

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

Operation









9550 ▶









Power and Radical root

yx

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)

$$400000 \left(1 + \frac{5}{100}\right)^{\frac{1}{3}} = 463.050.$$

(2)

$$\begin{array}{c|c}
100 & \begin{array}{c}
 & \text{NI DEC} & \text{WYIEW} \\
 & 339422 \\
 & 300000 & -1 \end{array} = \\
2.499971984$$

Power and Radical root

yx

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 \flat), B, C 440 x $(\sqrt[12]{2})^3$
- (2) "C" of A, G, F, E, D, C $\frac{440 \times (\sqrt[12]{2})^{3}}{2}$
- (3) "A" one octave higher **440** x $(\sqrt[12]{2})^{12}$

Operation

Display



(2) ON/C a/b 440 \times (2ndF $x_{\sqrt{}}$

(3) ON/C 440 \times (2ndF $x\sqrt{}$

$$12 \triangleright 2 \triangleright 0 \qquad yx \qquad 12 =$$

440×(12,12) 12 = 880.

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



- **10** x Calculates the value of 10 raised to the x^{th} power.
- Calculates the logarithm, the exponent of the power to which 10 must be raised to equal the given value.
- $\log_{\mathbf{a}} x$ Calculates the logarithm of x to power a.

<Example>

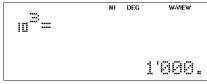






$$2ndF \stackrel{\log_a x}{\longrightarrow} 3 \blacktriangleright 45 =$$

Display





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,

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

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 x 10¹³ joules. When this energy is converted to a magnitude,

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

holds. Find the magnitude M.

Operation

Display

(2) ON/C 2ndF 10^x 1.5 \times 2 =

(3)





Exponential, Logarithmic



log

<Example 2> Air is held inside a cylinder of volume V_1 (= 0.01 m³) 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

1000000 × 0.01 ON/C

1000000 🕨 101000

<u>1000000</u> 101000 0×0.011n-

10000000×0.011n 10 22'926.34762

 $ig(extsf{a/b} ig) 1000000 ig(imes ig) 0.01 ig(ig)$

log a/b 1000000 0.434

101000

10000000X0.01 22'941.90383

Exponential, Logarithmic



< 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)

$$pH = -\log_{10}(a + \frac{\sqrt{a^2 + 4x10^{-14}} - a}{2})$$

Operation

Display

Enter the value of a

ON/C 1.0 \times 2ndF $\stackrel{10^x}{\longrightarrow}$ $\stackrel{(-)}{\longrightarrow}$

STO A

ni dec waiew 1.0×io ⁻⁸≑A 0.0000001

Calculate the pH

 $\begin{array}{c|c} \hline \text{(-)} & 2ndF & \log_a x \\ \hline \end{array} 10 \quad \begin{array}{c|c} \hline \\ \hline \end{array} \text{ALPHA} \quad \begin{array}{c|c} A \\ \hline \end{array}$

+ a/b $\sqrt{}$ ALPHA $\stackrel{A}{\longrightarrow}$ x^2 +

4 \times 2ndF $\stackrel{10^x}{\longrightarrow}$ (-) 14 \blacktriangleright

ALPHA A D

e to the Power of x, Natural Logarithm

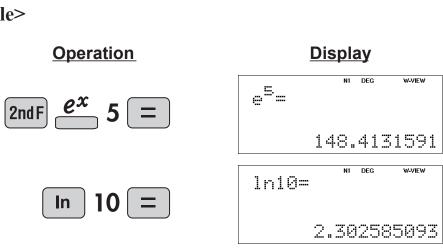


ex Calculates powers based on the constant e (2.718281828).

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

<Example>

In



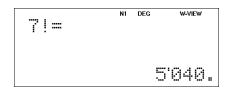
Factorials $\stackrel{n}{=}$

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

7 $2 \operatorname{ndF} =$

Display



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

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

$$3! = 3 \times 2 \times 1 = 6$$

Operation

Display



3 (2n



NI DEG W-VIEW

□ 1 ==

APPLICATIONS:

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

Permutations, Combinations



nPr

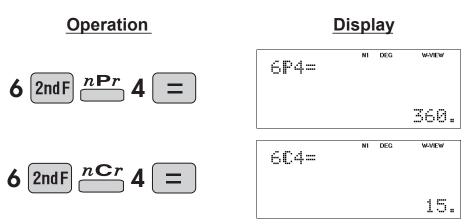
This function finds the number of different possible orderings in selecting r objects from a set of n objects. For example, there are six different ways of ordering the letters ABC in groups of three letters—ABC, ACB, BAC, BCA, CAB, and CBA.

The calculation equation is $_{3}P_{3} = 3 \times 2 \times 1 = 6$ (ways).



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 ${}_{3}C_{2}$.

<Example 1>



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



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?

$$_{5}P_{3} = 5 \times 4 \times 3$$

(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

$$C \times 3! = {}_{5}P_{3}$$

Therefore C is

$$C = {}_{5}P_{3} \div 3!$$

*This is written as 5C3.

Operation

Display

(1)

ON/C 5 2ndF nPr 3 =

5P3=	NI	DEG	W-VIEW
			60.

(2)

ON/C 5 2ndF $\stackrel{nPr}{=}$ 3 \div

3 2ndF n! =

ON/C 5 2ndF nCr 3 =

NI DEG W-VIEW
503=
10.

Permutations, Combinations



<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, 4C2

Hence 13 x 4C2

Ways of selecting remaining three cards

Ways of selecting the number: Three types are selected from (13 - 1) types (13-1)C₃

Ways of selecting the suit: For each number on the three cards, there are 4 types of suit 4³

Hence

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

Ways of selecting five cards

The probability of drawing one pair is $(13 \times {}_{4}C_{2}) \times ({}_{12}C_{3} \times {}_{4}^{3}) \div {}_{52}C_{5}$

Operation

Display

2nd F

2nd F

(1203×48)+5205



(13×4C2)×(12C3×4

0.422569027

Quotient Remainder Calculation, Prime Factorization



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



Greatest Common Divisor, Least Common Multiple



Calculates the greatest common divisor.

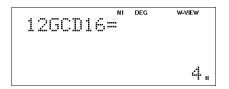
LCM Calculates the least common multiple.

<Example>

Operation

ON/C 12 2ndF GCD 16 =

Display



Sexagesimal Calculation (Time)







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

2 D°M'S 35 D°M'S 45 +

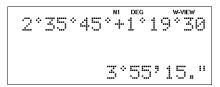
1 D°M'S 19 D°M'S 30 =







Display



APPLICATIONS:

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

Fractional Calculations







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



Inputs a mixed fraction.

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

Operation

3 2nd F ab/c





Display



Convert to an improper fraction



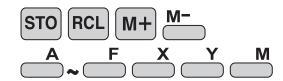
Convert to decimal notation



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 Stores displayed values in memories A~F, X, Y, M.

Recalls values stored in A~F, X, Y, M.

M+ Adds the displayed value to the value in the independent memory M.

Subtracts the displayed value from the value in the independent memory M.

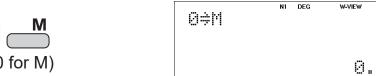
A F X Y Temporary memories

Independent memory

<Example 1>

Operation

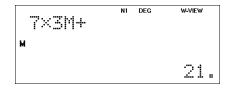
O STO M (Enter 0 for M)





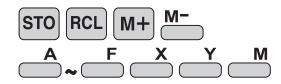
Display







Memory Calculations



<Example 2>

Calculates \$/¥ at the designated exchange rate.

$$$1 = $110 \implies $26,510 = $? $2,750 = $?$$

Operation

Last Answer Memory

ANS

Recalls the last answer calculated by pressing =

 $\langle Example \rangle$ Solve for x first and then solve for y using x.

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

Operation











User-Defined Memories

D1 ~ D3

D3

Recall a function that was defined by the user.

<Example>



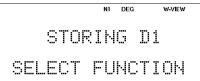














APPLICATIONS:

■ 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>

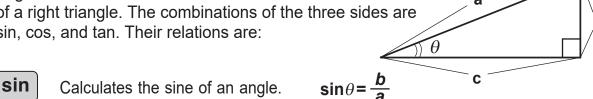


Trigonometric Functions

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:

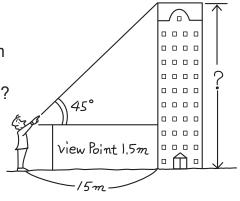


Cos Calculates the cosine of an angle.
$$\cos \theta = \frac{c}{a}$$

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

<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?



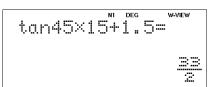
[DEG mode]

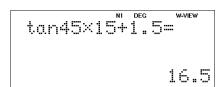
Operation



Display

tan45×15+1.5= 16‡









APPLICATIONS:

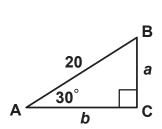
Trigonometric functions are useful in mathematics and various engineering calculations. They are often used in astronomical observations, civil engineering and in calculations involving electrical circuits, as well as in calculations for physics such as parabolic motion and wave motion.

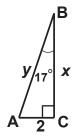
Trigonometric Functions

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

(DRG)

ERAD

(DEG)

<Angle setting "o" (DEG)>

NOTE:

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

Trigonometric Functions sin cos tan



ON/C

20 sin 30 =

W-VIEW 20sin30= 10.

20 cos 30 =

20cos30= 10/3

tan

17 =

N1 DEG 6.541705237

sin

N1 DEG W-VIEW 6.84060724

Trigonometric Functions

<Example 3>

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

sin

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

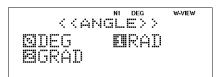
Root mean square value $V_e = 100 \text{ [V]}$ Frequency f = 60 [Hz]

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





1 (RAD)

<Angle setting "rad" (RAD)>

NOTE:

In EL-W506T, use 2nd F SET UP instead of SET UP.



sin (2
$$\times$$
 π \times





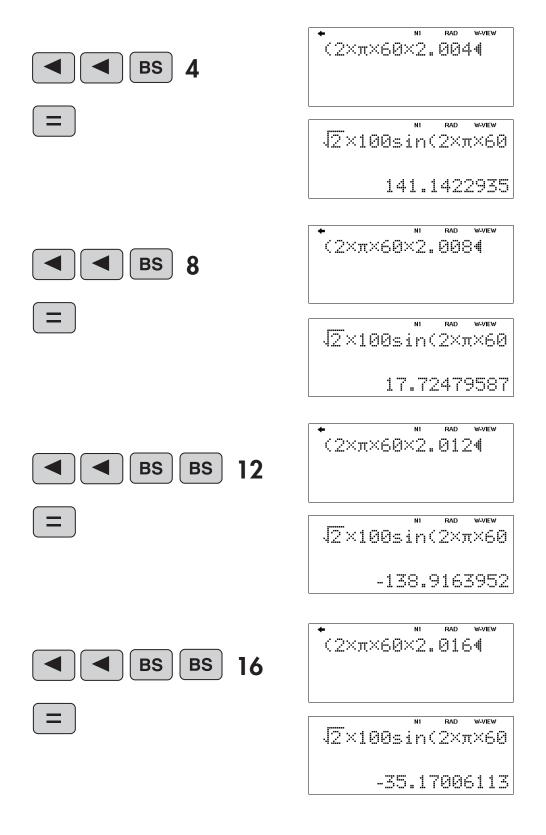


(2×π×60×2.0024





Trigonometric Functions



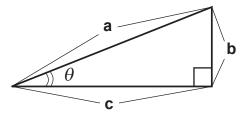
sin

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.

$$\theta = \cos^{-1} \frac{c}{a}$$

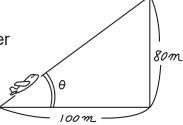
tan-1

(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









0 (DEG)

<Angle setting "o" (DEG)>

NOTE:

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

2ndF tan^{-1} ($80 \div$ 100) =

tan-1(80+100)= wyiew
38.65980825

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.

arc hyp

hyp

hyp cos sin

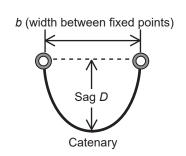
<Example 1>

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







$$6sinh(\frac{2}{2x0.846})$$

$$2 \times 9.846 \sinh \left(\frac{\text{w-view}}{2 \times 9.} \right)$$

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:

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

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

Х	V
0	0
1	6.0950185
2	6.777153851
5	6.819992397
10	6.82
15	6.82

NOTE:

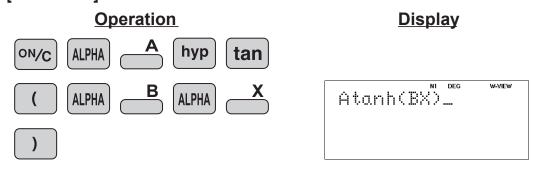
This example is solved by the Simulation calculation (ALGB).

EL-W506T has the Simulation calculation (ALGB).

This function is convenient for repeated calculations using varying values of X.

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

[DEG mode]

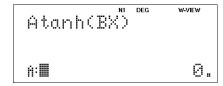




2. Enter the Simulation calculation.



<Simulation calculation>



3. Enter the value of A.

6.82 =



(If 6.82 appears, press only the = key)

4. Enter the value of B.

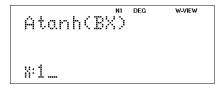
1.44 =



(If 1.44 appears, press only the = key)

5. Enter the value of *X*. For example,

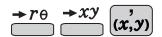




6. The answer is obtained.

Repeat 2 to 6

Coordinate Conversion $\stackrel{\bullet}{=}$



→rθ

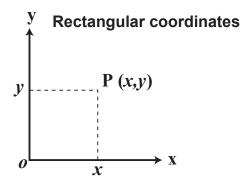
Converts rectangular coordinates to polar coordinates $(x, y \rightarrow r, \theta)$

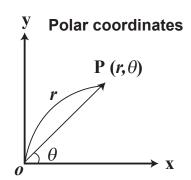
→xy

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 $2ndF$ $\rightarrow r\theta$

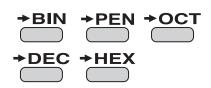
	N1	DEG	W-VIEW
195	tre		
۲:	7.61	571	310
A:	ウまごす	äġe	;āāĒ

7.6
$$(x',y)$$
 23.2 2nd F $\xrightarrow{\rightarrow} xy$

APPLICATIONS:

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

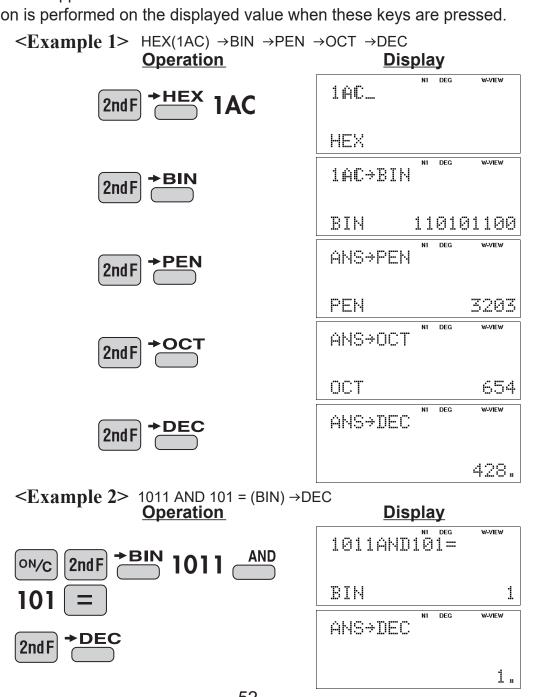
Binary, Pental, Octal, Decimal, and Hexadecimal **Operations (N-Base)**



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.

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

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



Statistics Functions



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.



Splits data used for X and FRQ data input (or X, Y, and FRQ data input).



Close/display the input table.



Insert a line in the input table for data insertion.



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

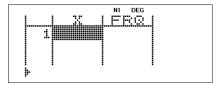
Operation







Select single-variable statistics mode (The input table is displayed.)

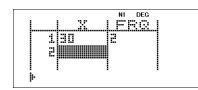


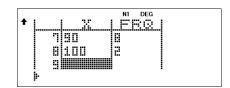
30











ANALYSIS RESULTS FOR 1-VARIABLE STATISTICS

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

Operation

Display

DATA

(Close the input table.)







Calculates Statistical values.







Statistics:

n Number of samples

 \overline{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)

 $\sigma^2 x$ 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_{I} 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

0.

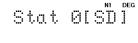












DATA

(Display the input table.)

97.27

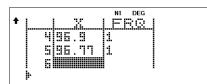


96.83



96.77





DATA

(Close the input table.)







		N1 DEG
m I sx •s²x	=======================================	96.884 96.884 0.234478144 0.05498



fr = 0.209723627 fr = 0.209723627 fr = 0.043984 \text{2} = 484.42 \text{2} \text{2} = 46932.7672

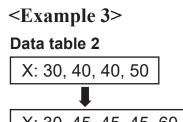
Average = 96.884

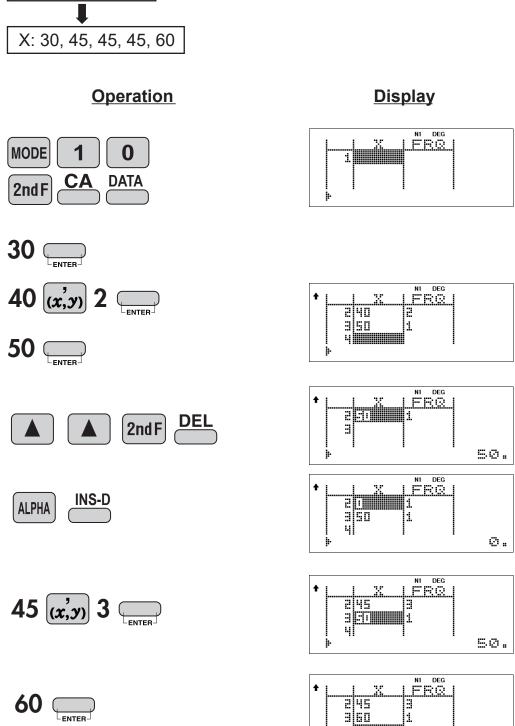
Standard deviation = 0.209723627

DATA CORRECTION

Move the cursor () to the data that you want to correct, enter the numeric value, and press .

- 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.





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.

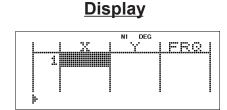
Data table 3

	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
У	Date blossoms bloom	13	9	11	5	7	12	15	7

Operation

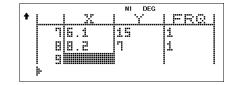


Select two-variable statistics mode and linear regression calculation in sub-mode. (The input table is displayed.)



6.2	(x,y)	13	ENTER
		ı	

8.2 (x',y) 7



ANALYSIS RESULTS FOR 2-VARIABLE STATISTICS

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

Operation

Display



(Close the input table.)







Calculates Statistical values.











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

Statistics:

- \overline{y} Mean (average) of samples (y data)
- sy Standard deviation of samples (y data)
- s^2y Variance of samples (y data)
- σv Standard deviation of the population (y data)
- $\sigma^2 v$ Variance of the population (y data)
- Σy Sum of samples (y data)
- Σv^2 Sum of squares of samples (y data)
- Σxy Sum of products of samples (x,y)
- Σx^2y Sum of products of samples (x²,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	
0.16	
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 2nd F 0.028 0.20 (x,y)0.073 40.16 s|a.zan (x,y)0.207 1.00 DATA (Close the input table.) N1 DEG a+bx **ALPHA**

<Example 6>

The hot water inside an electric pot is maintained at 92 °C.

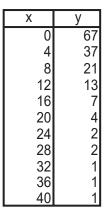
When a thermometer is placed in this hot water, the values indicated by the thermometer at times x and the differences y between these values and the temperature of the hot water are shown below. Using Euler's exponential regression, find the formula that expresses the relation between each time x and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

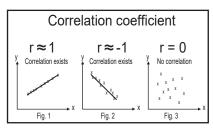
(Room temperature 25°C, hot water temperature 92°C)

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 2
28	90	2
20 24 28 32 36	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.





Display

1

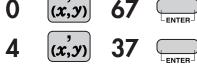
FRO

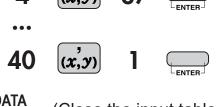
Operation

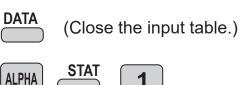
<u>pperation</u>

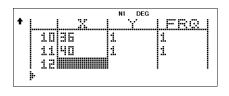


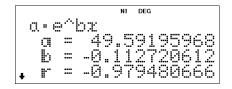














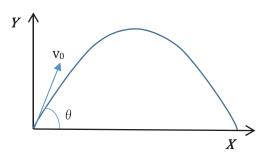


You can see the changes in values of one or two functions.

<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.

$$\begin{aligned} & ditance \ \textit{\textbf{X}} = \mathbf{v}_0 \cdot cos\theta \cdot t \\ & height \ \textit{\textbf{Y}} = \mathbf{v}_0 \cdot sin\theta \cdot t - \frac{1}{2} \cdot g \cdot t^2 \end{aligned}$$



(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)

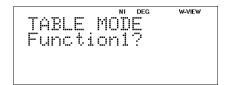
$$distance = 20 \cdot (cos40)x$$

$$height = 20 \cdot (sin40)x - 4.9x^{2}$$

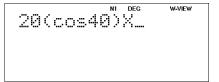
Operation

Display

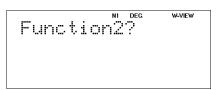
MODE 2 (TABLE)



Enter expression of distance.

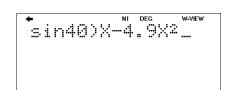






Enter expression of height.

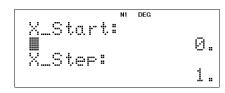
20 (
$$\sin 40$$
) ALPHA $\frac{x}{x^2}$







ENTED

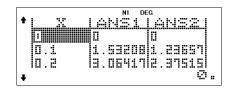


Enter start value and step value.



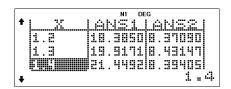






Check distance (ANS1) and height (ANS2) at x second.









(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.

$$\begin{split} Y &= \mathbf{V}_0 \cdot \sin\theta \cdot \frac{X}{\mathbf{V}_0 \cdot \cos\theta} - \frac{1}{2}g \left(\frac{X}{\mathbf{V}_0 \cdot \cos\theta}\right)^2 \\ &= \tan\theta \cdot X - \frac{g}{2{\mathbf{V}_0}^2 \cdot \cos^2\theta} X^2 \qquad * \tan\theta = \frac{\sin\theta}{\cos\theta} \\ &= X \left(\tan\theta - \frac{g}{2{\mathbf{V}_0}^2 \cdot \cos^2\theta} X\right) \end{split}$$

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

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

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

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

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

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

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

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

Operation

Display

Enter the expression.

 $\begin{array}{c|c} \text{MODE} & \textbf{2} & \text{(TABLE)} \\ \textbf{20} & \textbf{x}^2 & \text{sin} & \textbf{2} & \text{ALPHA} & \textbf{x} \end{array}$

202sin2X÷9.8_

÷ 9.8



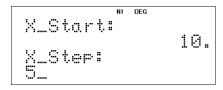
Skip next expression.





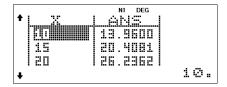
Enter start value 10 and step value 5.

10 ___ 5



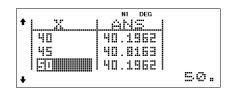


Check the distance(ANS) with ▼ key.



Press key until the value of ANS decreases.

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



Operation

MODE 3

(In EL-W506T, use MODE 8 instead of MODE 3.)

Display

Select type.

1 (Table)

Select row & order.



(row:3, order:Serial)



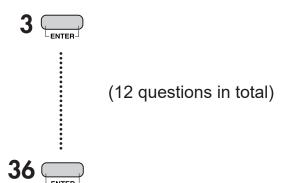
× Table 1~12? **III**‡ 4**21311001** Random⊁ SELECT & [ENTER]



× Table Multiply by:03 Type:Serial READY



Enter the answer.



× Table

3× 1=_

12

11

× Table

√ 3× 1=3 → 3× 2=

Display the correct answer rate.

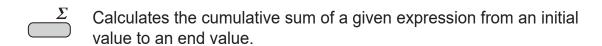


X Table
Multiply by:03
Type:Serial
y : 10(83%)

≈Functions and Key Operations for EL-W506T only≈

Σ Calculations, Π Calculations



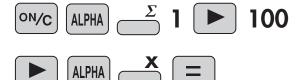


Calculates the product of a given expression from an initial value to an end value.

(This example is for EL-W506T only.)

<Example>

Operation





ALPHA
$$\Box$$
 1 \blacktriangleright 5 \blacktriangleright 3 \bigcirc ALPHA \Box \Box \Box \Box \Box

$$\begin{bmatrix} 1 & (3^{X-1}) = \\ X = 1 & 59'049. \end{bmatrix}$$

Integer Part, Fraction Part, Closest Integer

MATH 3 ~ 5

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

MATH (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>

ON/C

Operation

MATH 3 √ 2 =

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

on/c 40000









Differentiation Calculation



(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.

Price elasticity of demand
$$=$$
 - Rate of demand $=$ - $\frac{dD}{D}$ $=$ - $\frac{D}{D}$ $=$ - $\frac{D}{$

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

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

Operation



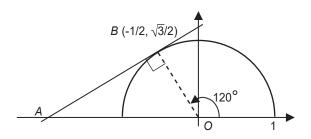


Differentiation Calculation



(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, $\sqrt{3}/2$) on the semicircle.

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

Operation







$$\begin{array}{c|c}
 & \text{AC} & \text{AC} & \text{AC} \\
 & \text{AC} & \text{AC} & \text{AC} \\
 & \text{AC} & \text{AC} & \text{AC} \\
 & \text{Constant of the AC} & \text{AC} & \text{AC} \\
 & \text{Constant of the AC} & \text{AC} & \text{AC} & \text{AC} & \text{AC} \\
 & \text{Constant of the AC} & \text{Constant of the AC} & \text{AC} & \text{AC} & \text{AC} & \text{AC} \\
 & \text{Constant of the AC} & \text{Constant of t$$

Integration Calculation

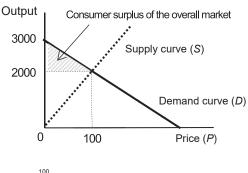


(This example is for EL-W506T only.)

<Example 1>

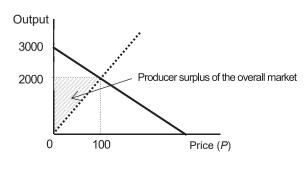
Let the demand curve of the overall market be D = 3000 - 10P, the supply curve be S = 20P, the equilibrium price be 100, and the equilibrium output be 2000.

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



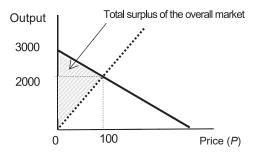
$$\int_{0}^{100} (3000 - 10x - 2000) \ dx$$

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



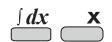
$$\int_{0}^{100} (2000 - 20x) \ dx$$

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



$$\int_{0}^{100} (3000 - 10x - 20x) \ dx$$

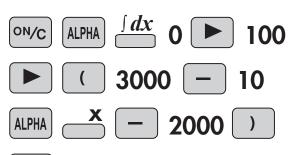
Integration Calculation $\frac{dx}{dx} = x$

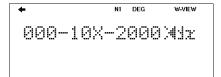


Operation

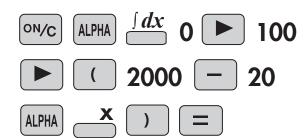
Display

(1)

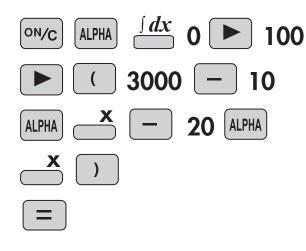


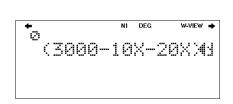


(2)

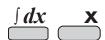


(3)



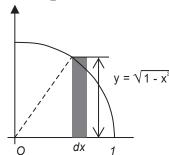


Integration Calculation



(This example is for EL-W506T only.)

<Example 2>



The fan shaped curve at left is given by the equation

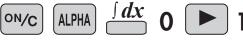
$$y = \sqrt{1 - x^2}$$

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

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

Operation

Display







$$\int_{0}^{1} \sqrt{1-X^{2}} \, dx = 0.785357562$$

Simulation Calculation (ALGB)

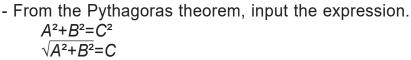


If you have to find values consecutively using the same expression, once you enter the expression, all you have to do is to specify the value for the variable in the equation.

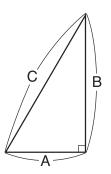
(This example is for EL-W506T only.)

<Example>

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



Operation



Display

Ø.

Ĥ∷∭

-Find C from A and B.

ON/C $\sqrt{}$ (ALPHA $\stackrel{A}{}$ x^2 $\sqrt{}$ $\sqrt{$

Solver Function



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 $10\,m^2$.

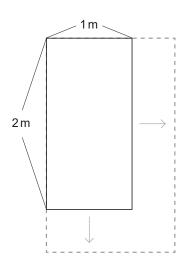
How many meters did you make it longer?

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

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

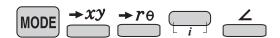
 $(2+x)(1+x)-12=0$

- Perform the solver function. ("start=0" and "dx=0.00001)



Operation Display ON/C (2 + ALPHA) (1 + ALPHA) - 12 2nd F SOLVER 2...

Complex Calculation



(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 ($R = 250\Omega$) and capacitor ($C = 20 \times 10^{-6}$ F) connected in parallel. Find the impedance of this circuit.

Circuit impedance = Value of polar coordinate r

Let R = 250, $C = 20 \times 10^{-6}$, and f = 50. If the complex number $Z = 1 \div ((1 \div R) + 2\pi fCi)$, find the value of the complex number Z and the values of r.

Operation

Display

MODE 3 (COMPLEX)

<Complex mode>

 $2ndF \rightarrow xy$ (Rectangular coordinates)

COMPLEX MODE

1 ÷ (1 ÷ 250

) + 2 π × 50 ×

20 Exp (-) 6 (-) =

1÷((1÷250)+2π×50 ×20μ-6i)= 72.10010979 -113.2545876i

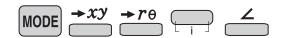
2ndF SET UP (DRG)

1 (RAD) (Angle units: RAD)

2ndF $r\theta$ (Polar coordinates)

1÷((1÷250)+2π×50 ×20ε-6i)= 134.257318 2-1.003884822

Complex Calculation



(This example is for EL-W506T only.)

<Example 2>

Operation

Display

(COMPLEX) MODE

<Complex mode>

(Rectangular coordinates)

COMPLEX MODE

0.

obs(1+2<u>i</u>)≡ 2.236067977

2 + 5 **MATH**

conj(2+5<u>1</u>)=

1 + - 3

ors(1+1/5)= 60.

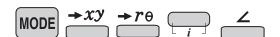
2 2nd F ____ 30 MATH

real(2238)= 1.732050808

2 2ndF ____ 30 MATH

im9(2230)= 1.

Complex Calculation



(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 ($R = 120\Omega$), coil (L = 4 H), and capacitor ($C = 3 \times 10^{-6} \text{F}$) 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 rPhase difference = Polar coordinate θ

Let R = 120, L = 4, $C = 3 \times 10^{-6}$, and f = 60. If the complex number $Z = R + 2 \pi f L i + 1 \div (2\pi f C i)$, 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 $\rightarrow xy$ (rectangular coordinates)

120 + 2 π × 60 ×

4 × _ + 1 ÷ (

2 π × 60 × 3 Exp

(-) 6 (-) 1 (-)

120+2π×60×4×i+1÷ (2π×60×3ε-6i)= 120: +623.7703454i

2ndF SET UP 0 (DRG)

0 (**DEG**) (Angle units: DEG)

2ndF → rθ (Polar coordinates)

120+2π×60×4×i+1÷ (2π×60×3μ-6i)= 635.2081894 279.110561

Simultaneous Equation



(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

$$K = 3x + 2y$$

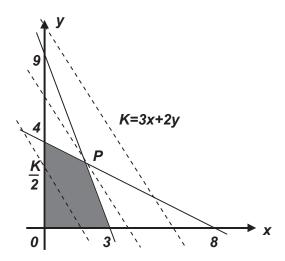
The following relations hold for the quantities in stock:

$$3x + y \le 9$$

$$x + 2y \le 8$$

$$x \ge 0, y \ge 0$$

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

$$K = 3 \times 2 + 2 \times 3 = 12 \times 100 \times 100$$

Simultaneous Equation



(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.



<Equation mode>

(2-VLE)

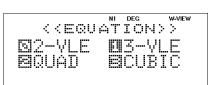
<Simultaneous linear equations in two unknowns>

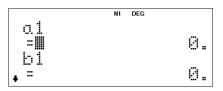
Enter the coefficients.

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

3 ENTER 1 ENTER 9 ENTER







MORMAL MODE

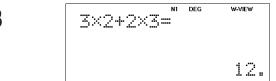
W-VIEW

0.

Set the mode to Normal.







Simultaneous Equation



(This example is for EL-W506T only.)

<Example 2>

When ethanol C₂H₅OH is completely combusted, carbon dioxide CO₂ and water H₂O 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 = yNumber of H: 5x + x = 2zNumber of O: x + 6 = 2y + z

As such, the following simultaneous equations are obtained:

$$2x - y = 0$$

 $6x - 2z = 0$
 $x - 2y - z = -6$

Solving these gives x = 1, y = 2, z = 3

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

and the chemical reaction formula is

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

Operation

Set the mode to Equation





(EQUATION)

<Equation mode>



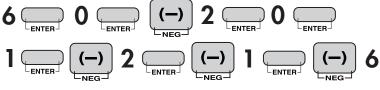
<Simultaneous linear equations in three unknowns>

Enter the coefficients.

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

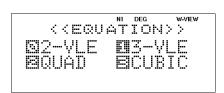


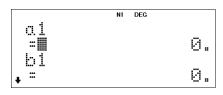


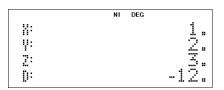




Display









(This example is for EL-W506T only.)

<Example 1>

Let the hydrochloric acid concentration be c (= 1.0 x 10⁻⁸ mol / ℓ), and the hydrogen ion concentration be x.

(1) Solve the following quadratic equation to find the hydrogen ion concentration x: $\mathbf{x}^2 - \mathbf{c}\mathbf{x} - \mathbf{K}_{\mathbf{w}} = \mathbf{0}$

where

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

(2) Use the result of (1) to find the pH (= $-\log x$) of hydrochloric acid. pH = $-\log x$ (x>0)

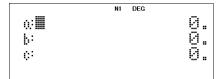
Operation

Display

(1)

Set the mode to Equation.

MODE 4 (EQUATION) 2 (QUAD)



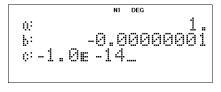
Solve the equation (enter coefficients a, b, c).

1 ENTER









X= 4 1: 0.00000105 2: -0.000000095



(2)

Set the mode to Normal

HOME (MODE

0

(–) log

log 0.000000105



HORMAL MODE W-VIEW

-1090,000000105=

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)



1 3

X= 4 1: 0.000000105 2: -0.000000095 -log0.000000105=

SCI format. Tab=5.



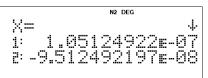
1 1 5

-1091.0512E-7=

NORM2 format



1 4



-log1.05124922E-



(This example is for EL-W506T only.)

<Example 2>

Let the acetic acid concentration be c (= 0.1 mol $/\ell$), 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

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

(2) Use the result of (1) to find the pH (= - $\log x$) of acetic acid. pH = - $\log x (x>0)$

Operation

Display

(1)

Save constants.

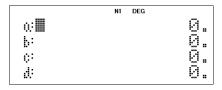
(When using the same number repeatedly, it is convenient to store it in memory.)



Set the mode to Equation

(EQUATION) (CUBIC) **MODE**

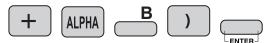
<Cubic equation>



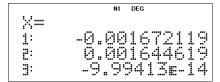
Solve the equation (enter coefficients a, b, c, d).











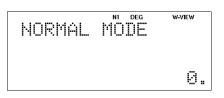
(2)

Set the mode to Normal.









-1090.001644619= 2.783934697

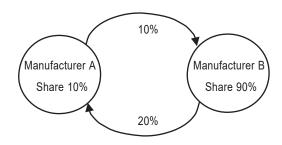
Matrix Calculation



(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.

$$a_1 = 0.9a_0 + 0.2b_0$$

 $b_1 = (1-0.9)a_0 + (1-0.2)b_0$

Thus, a₁ and b₁ 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



Operation

Display

Set the mode to Matrix.





(MATRIX)

MATRIX MODE 0.

Enter transition matrix.

MATH



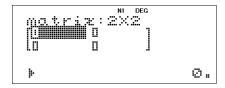
(EDIT)

Set size.





<2 x 2 Matrix>



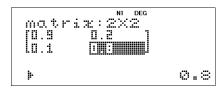
Enter elements.











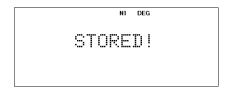
Save to mat A.

ON/C



(STORE)





Enter share of 0 year into matrix.

MATH



(EDIT)

1

Set size.



<2 x 1 Matrix>









Save to mat B.

ON/C



3 (STORE)

STORED!

Matrix Calculation

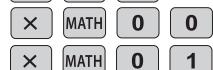


Calculate the shares of manufacturers A and B after 2 years.

mat A x mat A x mat B

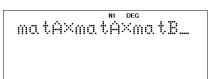


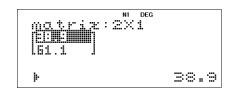






(A: 38.9%, B: 61.1%)





Vector Calculations

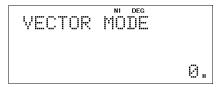


Set the mode to Vector.

MODE



(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

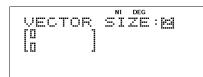
Set the dimension.

MATH

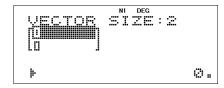


(EDIT)

(2-dimentional)



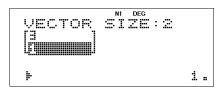




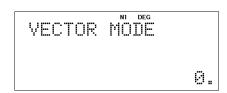
Enter numeric value.











Store to vectA.









Enter next Vector.







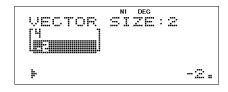












Vector Calculations



Store to vectB.

ON/C

MATH **3 1**

STORED!

Calculate the dot product.

MATH 4

 $\boxed{\mathsf{MATH}} \boxed{\mathbf{0}} \boxed{\mathbf{0}} \boxed{(x,y)}$

MATH 0 1)

DotPro(vectA;vec tB)=

Calculate the angle.

MATH 6

MATH 0 1)

AnglivectAguectB)= 45.

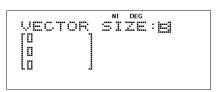
(2) Calculate the cross product of Vector A(1,2,3) and Vector B(4,5,6).

Operation

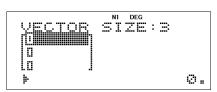
Set the dimension.

MATH **1** (3-dimentional)



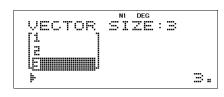






Enter numeric value.

1 ENTER 2 ENTER 3 ENTER



ON/C

Vector Calculations



VECTOR

VECTO [4 [5]

Store to vectA.



3

STORED!

N1 DEG SIZE: S

€.

Enter next Vector.











Store to vectB.



MATH







Calculate the cross product.

5 MATH

MATH







MATH

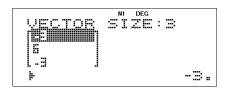






CrossPro(vectA;vectE)





Distribution Functions



(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.



Display





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

Operation

Display



