

## General Guide

### ■ Turning on or off

To turn the calculator on, press [ ON ] ; To turn the calculator off, press [ 2nd ] [ OFF ].

### ■ Battery replacement

SR-310 is powered by two alkaline batteries (GP76A). If the display becomes dim and difficult to read, the batteries should be replaced as soon as possible.

To replace batteries :

- 1) Remove the screws and the back cover.
- 2) Replace the old batteries and install new ones with polarity in correct directions, then secure the screws in place and press [ ON ] to turn the power on.

### ■ Auto power-off function

This calculator automatically turns it off when not operated for approximately 9~15 minutes. It can be reactivated by pressing [ ON ] key and the display, memory, settings are retained.

### ■ Reset operation

If the calculator is on but you get unexpected results, press [ 2nd ] [ RESET ] in sequence. A message appears on the display to confirm whether you want to reset the calculator and clear memory contents.

RESET : N Y

Move the cursor to “ Y ” by [ ▶ ], then press [ ENTER ] to clear all variables, pending operations, statistical data, answers, all previous entries, and memory; To abort the reset operation without clearing the calculator, please choose “ N ” .

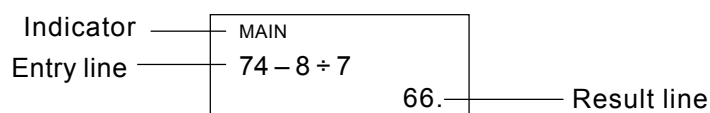
If the calculator is lock and further key operations becomes impossible, please press [ 0 ] [ DMS ] at the same time to release the condition. It will return all settings to default settings.

### ■ Contrast adjustment

Pressing the [ ▼ ] or [ ▲ ] following [ MODE ] key can make the contrast of the screen lighter or darker. Holding either key down will make the display become respectively lighter or darker.

### ■ Display readout

The display comprises the entry line, the result line, and indicators.



**Entry line** SR-310 displays an entry of up to 76 digits. Entries begin on the left ; those with more than 11 digits scroll to the left. Press [ ▶ ] or [ ◀ ] to move the cursor through an entry. Press [ 2nd ] [ ◀ ] or [ 2nd ] [ ▶ ] to move the cursor immediately to the beginning or end of the entry.

**Result line** It displays a result of up to 10 digits, as well as a decimal, a negative sign, a “**x10**” indicator, and a 2-digits positive or negative exponent. Results that exceed the digit limit are displayed in scientific notation.

**Indicators** The following indicators appear on the display to indicate you the current status of the calculator.

<b>Indicator</b>	<b>Meaning</b>
<b>M</b>	Independent memory
<b>-</b>	Result is negative, or the entry line is full
<b>2nd</b>	2nd set of function keys is active.
<b>MODE</b>	Mode selection is active
<b>MAIN</b>	Main mode is active
<b>STAT</b>	Statistics mode is active
<b>Base-n</b>	Base-n mode is active
<b>VLE</b>	Variable linear equation mode is active
<b>QE</b>	Quadratic equation mode is active
<b>CPLX</b>	Complex number mode is active
<b>DEGRAD</b>	Angle mode : <b>DEG</b> rees, <b>GRAD</b> s, or <b>RAD</b> s
<b>ENG SCI</b>	<b>ENG</b> ineering or <b>SCI</b> entific notation.
<b>FIX</b>	Number of decimal places displayed is fixed
<b>HYP</b>	Hyperbolic-trig function will be calculated
<b>BUSY</b>	While an operation is executing
<b>← →</b>	There are digits to the left or right of the display
<b>↑ ↓</b>	There are data above or below the current screen.

## Before starting calculation

### ■ Changing a mode

Pressing [ MODE ] can enter mode menus. You can choose one of six operating modes, including “**0)MAIN**”, “**1)STAT**”, “**2)Base-n**”, “**3)CPLX**”, “**4)VLE**”, “**5)QE**”.

Give “**2)Base-n**” as an example :

Method 1 : Scroll through the menus using [ ◀ ] or [ ▶ ] until “**2)Base-n**” is shown, then enter the desired mode by pressing [ ENTER ].

Method 2 : Key in directly the number of the mode, [ 2 ], to enter the desired mode immediately.

### ■ Selecting an item from display menus

Many functions and settings are available on menus. A menu is a list of options

displayed across the entry line.

Give “ Pressing [ DRG ] key displays the menu for choosing the angle setting under MAIN mode ” as an example :

Method : Press [ DRG ] to display the menu, and then move the cursor [ ◀ ] or [ ▶ ] to an item you want. Press [ ENTER ] while the item is underlined.

For menu items followed by an argument value, you can press [ ENTER ] while the item is underlined or enter directly the corresponding argument value.

## ■ Using “ 2nd ” keys

To execute the functions marked in yellow, please press [ 2nd ] and then the corresponding key. When you press [ 2nd ], the “ 2nd ” indicator shown in the display is to tell you that you will be selecting the second function of the next key you press. If you press [ 2nd ] by mistake, simply press [ 2nd ] again to remove the “ 2nd ” indicator.

## ■ Cursor

Pressing [ ◀ ] or [ ▶ ] key can move the cursor to the left or the right. Hold down any of those keys to move the cursor at high speed.

Pressing [ ▲ ] or [ ▼ ] can scroll the display up or down while there are data above or below the current screen.

## ■ Making corrections during input

To delete a character at the cursor, make the character underlined by using [ ◀ ] or [ ▶ ] to move the cursor, and then press [ DEL ] to delete the character. Delete 1 character to the left of the cursor each time you press [ DEL ].

To replace a character, make the character underlined by using [ ◀ ] or [ ▶ ] to move the cursor, and then enter a new entry to replace the character.

To insert a character, move the cursor to the position of the character where you want to insert, it will be inserted in the front of the character after pressing [ 2nd ] [ INS ] and entering a new character.

(Note): The blinking cursor “ ◀ ” means the calculator is in insert mode. On the contrary, the blinking cursor is displayed as “ \_ ” and it means the calculator is in overwrite mode.

To clear all characters, clear all input character by [ CL ] key.

## ■ Replay function

- This function stores the latest operation executed. After execution is completed, pressing [ ▶ ] or [ ◀ ] key will previous input steps. Pressing [ ▶ ] will display the operation from the beginning, with the cursor located under the first character. Pressing [ ◀ ] will display the operation from the end, with the cursor located at the space following the last character. You can continue moving the cursor by [ ▶ ] or [ ◀ ] and editing values or commands for subse-



- 5) Fractions
- 6) Abbreviated multiplication format in front of variables,  $\pi$ , RAND, RANDI.
- 7) ( - )
- 8) Abbreviated multiplication format in front of Type B functions  
 $2\sqrt{3}$ , Alog2, etc.
- 9) nPr, nCr
- 10)  $x, \div$
- 11) +, -
- 12) AND, NAND
- 13) OR, XOR, XNOR
- 14) Conversion (A  $\leftrightarrow$  B,  $\leftrightarrow$  C,  $\leftrightarrow$  D,  $\leftrightarrow$  E)  
  - When functions with the same priority are used in series, execution is performed from right to left.  
 $e^x \ln 120 \rightarrow e^{x \{ \ln(120) \}}$   
otherwise, execution is from left to right.
  - Compound functions are executed from right to left.
  - Anything contained within parentheses receives the highest priority.

## ■ Accuracy and Capacity

Output digits : Up to 10 digits.

Calculating digits : Up to 24 digits

In general, every reasonable calculation is displayed up to 10 digits mantissa, or 10-digits mantissa plus 2-digits exponent up to  $10^{\pm 99}$ .

Numbers used as input must be within the range of the given function as follow :

Functions	Input range
$\sin x, \cos x, \tan x$	Deg : $ x  < 4.5 \times 10^{10} \text{ deg}$ Rad : $ x  < 2.5 \times 10^8 \pi \text{ rad}$ Grad : $ x  < 5 \times 10^{10} \text{ grad}$ however, for $\tan x$ Deg : $ x  \neq 90 (2n+1)$ Rad : $ x  \neq \frac{\pi}{2} (2n+1)$ Grad : $ x  \neq 90 (2n+1)$ ( n is an integer)
$\sin^{-1} x, \cos^{-1} x$	$ x  \leq 1$
$\tan^{-1} x$	$ x  < 1 \times 10^{100}$
$\sinh x, \cosh x$	$ x  \leq 230.2585092$
$\tanh x$	$ x  < 1 \times 10^{100}$
$\sinh^{-1} x$	$ x  < 5 \times 10^{99}$
$\cosh^{-1} x$	$1 \leq x < 5 \times 10^{99}$
$\tanh^{-1} x$	$ x  < 1$

$\log x, \ln x$	$1 \times 10^{-99} \leq x < 1 \times 10^{100}$
$10^x$	$-1 \times 10^{100} < x < 100$
$e^x$	$-1 \times 10^{100} < x \leq 230.2585092$
$\sqrt{x}$	$0 \leq x < 1 \times 10^{100}$
$x^2$	$ x  < 1 \times 10^{50}$
$x^3$	$ x  < 2.15443469 \times 10^{33}$
$x^{-1}$	$ x  < 1 \times 10^{100}, x \neq 0$
$\sqrt[3]{x}$	$ x  < 1 \times 10^{100}$
$x!$	$0 \leq x \leq 69, x$ is an integer.
$P(x, y)$	$\sqrt{x^2 + y^2} < 1 \times 10^{100}$
$R(r, \theta)$	$ r  < 1 \times 10^{100}$ Deg : $ \theta  < 4.5 \times 10^{10}$ deg Rad : $ \theta  < 2.5 \times 10^8 \pi$ rad Grad : $ \theta  < 5 \times 10^{10}$ grad however, for tan x Deg : $ \theta  \neq 90 (2n+1)$ Rad : $ \theta  \neq \frac{\pi}{2} (2n+1)$ Grad : $ \theta  \neq 100 (2n+1)$ (n is an integer)
► DMS	$ DD , MM, SS.SS < 1 \times 10^{100},$ $0 \leq MM, SS.SS,  x  < 10^{100}$
$x^y$	$x > 0 : -1 \times 10^{100} < y \log x < 100$ $x = 0 : y > 0$ $x < 0 : y = n, 1/(2n+1), n$ is an integer. but $-1 \times 10^{100} < \frac{1}{y} \log  x  < 100$
$\sqrt[x]{y}$	$y > 0 : x \neq 0, -1 \times 10^{100} < \frac{1}{x} \log y < 100$ $y = 0 : x > 0$ $y < 0 : x = 2n+1, 1/n, n$ is an integer. (n ≠ 0) but $-1 \times 10^{100} < \frac{1}{x} \log  y  < 100$
$nPr, nCr$	$0 \leq r \leq n, n < 10^{100}, n, r$ are integers.
STAT	$ x  < 1 \times 10^{100},  y  < 1 \times 10^{100}$ 1-VAR : $n \leq 50, 2-VAR : n \leq 50$ FREQ. = n, $0 \leq n < 10^{100}$ : n is an integer in 1-VAR mode. $\sigma x, \sigma y, \bar{x}, \bar{y}, a, b, r : n \neq 0$ $Sx, Sy : n \neq 0, 1$
Base-n	<b>DEC :</b> $-2147483648 \leq x \leq 2147483647$

	<p><b>BIN :</b>  <math>10000000000000000000000000000000 \leq x</math>  <math>\leq 11111111111111111111111111111111</math>  (for negative)  <math>0 \leq x \leq 01111111111111111111111111111111</math>  (for zero, positive)</p> <p><b>OCT :</b>  <math>20000000000 \leq x \leq 37777777777</math>  (for negative)  <math>0 \leq x \leq 17777777777</math> (for zero or positive)</p> <p><b>HEX :</b>  <math>80000000 \leq x \leq FFFFFFFF</math> (for negative)  <math>0 \leq x \leq 7FFFFFFF</math> (for zero or positive)</p>
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■ **Error conditions**

Error message will appear on the display and further calculation becomes impossible when any of the following conditions occur.

- DOMAIN Er** (1) When specifying an argument to a function outside the valid range.  
(2) **FREQ** value ( in 1-VAR stats) < 0 or non-integer.  
(3) When USL value < LSL value
- DIVIDE BY 0** (1) You attempted to divide by 0.  
(2) Integration interval [ a, b ] is unavailable or interrupted for the integrated function.
- OVERFLOW Er** When result of function calculations exceeds the range specified.
- STAT Er** When in MAIN,CPLX,VLE,or QE mode, press [ DATA ] or [ STATVAR ].
- SYNTAX Er** (1) Input errors are made.  
(2) When improper arguments are used in commands or functions that require arguments.
- NO SOL** There is no solution or infinite to the simultaneous equation under VLE mode.
- MULTI SOLS**
- NO REAL SOL** There is no real solution to quadratic equation under QE mode.
- LENGTH Er** An entry exceeds 84 digits after implied multiplication with auto-correction.
- OUT OF SPEC** You input a negative  $C_{PU}$  or  $C_{PL}$  value , where  

$$C_{PL} = \frac{\bar{x} - LSL}{3\sigma} , C_{PU} = \frac{USL - \bar{x}}{3\sigma}$$

To release the above errors, please press [ CL ] key.

## Mode 0 - MAIN

### ■ Arithmetic calculation

- Arithmetic operations are performed by pressing the keys in the same sequence as in the expression. See Example 6.
- For negative values, press [(-)] before entering the value. See Example 7.
- For mixed arithmetic operations, multiplication and division are given priority over addition and subtraction. See Example 8
- Results greater than  $10^{10}$  or less than  $10^{-9}$  are displayed in exponential form. See Example 9.

### ■ Display formats

- Decimal places formats are selected by pressing [2nd][FIX] to display the menu. To set decimal places to **n** ( **F0123456789** ), enter a **n** value directly or press [ENTER] key while the item is underlined. ( The default setting is floating point notation **F** and the **n** value is **•** ). See Example 10.
- Even if the number of decimal places is specified, internal calculation for a mantissa is performed up to 24 digits, and the display value is stored in 10 digits. To round off those values to the specified number of decimal places, press [2nd][RND]. See Example 11~12.
- Number display formats are selected by pressing [2nd][SCI/ENG] to display the menu. The items on the menu are **FLO** (for floating point), **SCI** (for scientific), and **ENG** (for engineering). Press [◀] or [▶] until the desired format is underlined, and then press [ENTER]. See Example 13.

(Note): Each time you specify the ENG mode, a displayed value is automatically shown with the corresponding engineering symbol.

- You can enter a number in mantissa and exponent form by [EXP] key. See Example 14.

### ■ Engineering symbol calculations

- This calculator also provides a list of symbols for input of value using engineering notation by pressing [2nd][ENG SYM]. There are sixteen symbols in the menu. See Example 15.

kilo      mega      giga      tera      peta      exa  
 $K = 10^3$ ,  $M = 10^6$ ,  $G = 10^9$ ,  $T = 10^{12}$ ,  $P = 10^{15}$ ,  $E = 10^{18}$  ,

zetta      yotta      milli      micro      nano  
 $Z = 10^{21}$  ,  $Y = 10^{24}$  ,  $m = 10^{-3}$  ,  $\mu = 10^{-6}$  ,  $n = 10^{-9}$  ,

pico      femto      atto      zepto      yopct  
 $p = 10^{-12}$  ,  $f = 10^{-15}$  ,  $a = 10^{-18}$  ,  $z = 10^{-21}$  ,  $y = 10^{-24}$

## ■ Parentheses calculations

- Operation inside parentheses are always executed first. SR-310 can use up to 13 levels of consecutive parentheses in a single calculation. See Example 16.
- Closed parentheses occurring immediately before operation of the [ENTER] key may be omitted, no matter how many are required. See Example 17.
- A multiplication sign “x” occurring immediately before an open parenthesis can omitted. See Example 18.

(Note): The calculator can auto-correct abbreviated multiplication in front of all functions, except memory variables, left parenthesis, type B functions.

- Henceforth, abbreviated type will not be used in this manual. See Example 19.
- The correct result cannot be derived by entering [ ( ) 2 [ + ] 3 [ ) ] [ EXP ] 2. Be sure to enter [ x ] 1 between the [ ) ] and [ EXP ] in the below example. See Example 20.

## ■ Percentage calculation

- [ 2nd ] [ % ] divides the number in the display by 100. You can use this key sequence to calculate percentages, add-ons, discounts, and percentages ratios. See Example 21~22.

## ■ Continuous calculation function

- The calculator enables you to repeat the last operation executed by pressing [ENTER] key for further calculation. See Example 23.
- Even if calculations are concluded with the [ENTER] key, the result obtained can be used for further calculation. See Example 24.

## ■ Answer function

- Answer function stores the most recently calculated result. It is retained even after the power is turned off. Once a numeric value or numeric expression is entered and [ENTER] is pressed, the result is stored by this function. See Example 25.

(Note): Even if execution of a calculation results in an error, however, Answer memory retains its current value.

## ■ Logarithms and Antilogarithms

- The calculator can calculate common and natural logarithms and anti-logarithms using [LOG], [LN], [2nd][10<sup>x</sup>], and [2nd][e<sup>x</sup>]. See Example 26~28.

## ■ Fraction calculation

Fraction value display is as follow :

5 / 12
--------

     Display of  $\frac{5}{12}$

56 $\cup$ 5 / 12
------------------

     Display of  $56 \frac{5}{12}$

- To enter a mixed number, enter the integer part, press [A<sup>b/c</sup>], enter the numerator, press [A<sup>b/c</sup>], and enter the denominator ; To enter an improper fraction, enter the numerator, press [A<sup>b/c</sup>], and enter the denominator. See Example 29.
- During a fraction calculation, if the figure is reducible, a figure is reduced to the lowest terms after pressing a function command key ([+], [−], [×] or [÷]) or the [ENTER] key. By pressing [2nd][A<sup>b/c</sup>↔d/e], the displayed value will be converted to the improper fraction and vice versa. See Example 30.
- To convert between a decimal and fractional result, press [2nd][F↔D] and [ENTER]. See Example 31.
- Calculations containing both fractions and decimals are calculated in decimal format. See Example 32.

## ■ Angle units conversion

- The angle units (**DEG**, **RAD**, **GRAD**) is set by pressing [DRG] to display the angle menu. The relation among the three angle units is :

$$180^\circ = \pi \text{ rad} = 200 \text{ grad}$$

Angle conversions ( See Example 33.):

1. Change the default angle settings to the units you want to convert to.
2. Enter the value of the unit to convert.
3. Press [DMS] to display the menu. The units you can select are ° (degree), ‘ (minute), “ (second), r (radian), g (gradian) or ► **DMS** (Degree-Minute-Second).
4. Choose the units you are converting from.
5. Press [ENTER] twice.

- To convert an angle to DMS notation, select “► **DMS**”, which converts an entry to DMS notations, i.e., where  $1^{\circ}30'0''$  represents 1 degree, 30 minute, 0 second. See Example 34.
- To convert a DMS notation to decimal, select  $^{\circ}$  (degree),  $'$  (minute),  $''$  (second). See Example 35.

## ■ Trigonometric / Inverse-Tri. functions

- SR-310 provides standard trigonometric functions and inverse trigonometric functions -  $\sin$ ,  $\cos$ ,  $\tan$ ,  $\sin^{-1}$ ,  $\cos^{-1}$  and  $\tan^{-1}$ . See Example 36~38.

(Note): When using those keys, make sure the calculator is set for the angle unit you want.

## ■ Hyperbolic / Inverse-Hyp. functions

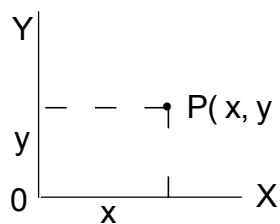
- SR-310 uses [2nd][HYP] to calculate the hyperbolic functions and inverse-hyperbolic functions -  $\sinh$ ,  $\cosh$ ,  $\tanh$ ,  $\sinh^{-1}$ ,  $\cosh^{-1}$  and  $\tanh^{-1}$ . See Example 39~40.

(Note): When using those keys, make sure the calculator is set for the angle unit you want.

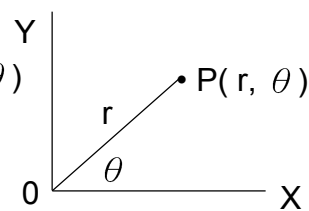
## ■ Coordinates transformation

- Pressing [2nd][R↔P] displays a menu to convert rectangular coordinates to polar coordinates or vice versa. See Example 41~42.

Rectangular Coordinates



Polar Coordinates



$$x + yi = r(\cos \theta + i \sin \theta)$$

(Note): When using those key, make sure the calculator is set for the angle unit you want.

## ■ Probability

- Pressing [PRB] displays the probability menu. See Example 43~47. With the following functions :

**nPr**      Calculates the number of possible permutations of  $n$  item taken  $r$  at a time.

**nCr**      Calculates the number of possible combinations of  $n$  items taken  $r$  at a time.

**!**          Calculates the factorial of a specified positive integer  $n$ , where  $n \leq 69$ .

**RANDM** Generates a random number between 0 and 1.

**RANDMI** Generates a random integer value between two specified integers, A and B, where  $A \leq \text{random value} \leq B$ .

## ■ Other functions ( $x^{-1}$ , $\sqrt{\quad}$ , $\sqrt[x]{\quad}$ , $\sqrt[3]{\quad}$ , $x^2$ , $x^3$ , $\wedge$ )

- The calculator also provides reciprocal ( [  $x^{-1}$  ] ), square root ( [  $\sqrt{\quad}$  ] ), universal root [ 2nd ] [  $\sqrt[x]{\quad}$  ], cubic root ( [ 2nd ] [  $\sqrt[3]{\quad}$  ] ), square ( [  $x^2$  ] ), cubic ( [ 2nd ] [  $x^3$  ] ) and exponentiation ( [  $\wedge$  ] ) functions. See Example 48~51.

## ■ Unit Conversion

- The calculator has a built-in unit conversion feature that enables you to convert numbers from metric to English units and vice versa. See Example 52.

- Enter the number you want to convert.
- Press [ 2nd ] [ CONV ] to display the menu. There are 7 menus, covering distance, area, temperature, capacity, weight, energy, and pressure.
- Use the [  $\blacktriangledown$  ] [  $\blacktriangle$  ] to scroll through the list of units until a appropriate units menu is shown, then [ ENTER ].
- Pressing [  $\blacktriangleright$  ] or [  $\blacktriangleleft$  ] can convert the number to another unit.

## ■ Physics constants

- You can use a number physics constants in your calculations. With the following constants :

Symbol	Meaning	Value
<b>c</b>	Speed of light	299792458 m/s
<b>g</b>	Acceleration of gravity	9.80665 m.s <sup>-2</sup>
<b>G</b>	Gravitational constant	6.6725985 x 10 <sup>-11</sup> N.m <sup>2</sup> kg <sup>-2</sup>
<b>V<sub>m</sub></b>	molar volume of ideal gas	0.0224141 m <sup>3</sup> mol <sup>-1</sup>
<b>N<sub>A</sub></b>	Avagadro's number	6.022136736 x 10 <sup>23</sup> mol <sup>-1</sup>
<b>e</b>	Elementary charge	1.6021773349 x 10 <sup>-19</sup> C
<b>m<sub>e</sub></b>	Electron mass	9.109389754 x 10 <sup>-31</sup> kg
<b>m<sub>p</sub></b>	Proton mass	1.67262311 x 10 <sup>-27</sup> kg
<b>h</b>	Plank's constant	6.62607554 x 10 <sup>-34</sup> J.s
<b>k</b>	Boltzmann's constant	1.38065812 x 10 <sup>-23</sup> J.K <sup>-1</sup>
<b>R</b>	Gas constant	8.3145107 J / mol • k
<b>F</b>	Faraday constant	96485.30929 C / mol
<b>m<sub>n</sub></b>	Neutron constant	1.67492861 x 10 <sup>-27</sup> kg
<b>μ</b>	Atomic mass constant	1.66054021 x 10 <sup>-27</sup> kg
<b>ε<sub>0</sub></b>	Dielectric permittivity	8.854187818 x 10 <sup>-12</sup> F / m
<b>μ<sub>0</sub></b>	Magnetic permittivity	0.000001257 x 10 <sup>-06</sup> H / m
<b>Φ<sub>0</sub></b>	Flux quantum	2.0678346161 x 10 <sup>-15</sup> Vs
<b>a<sub>0</sub></b>	Bohr radius	5.2917724924 x 10 <sup>-11</sup> m

$\mu_B$	Bohr magneton	$9.274015431 \times 10^{-24} \text{ A} \cdot \text{m}^2$
$\mu_N$	Neutron magnetic moment	$5.050786617 \times 10^{-27} \text{ J/T}$

To insert a constant at the cursor position ( See Example 53.):

1. Press [ 2nd ] [ CONST ] to display the physics constants menu.
2. Press [ ▶ ] [ ◀ ] until the constant you want is underlined.
3. Press [ ENTER ].

## ■ Integration and Differentiation

SR-310 can perform numerical integration and differentiation by [ 2nd ] [ ∫dx ] and [ 2nd ] [ d/dx ].

### Integration

The calculator uses Simpson's rule to perform integration calculations as shown in the below :

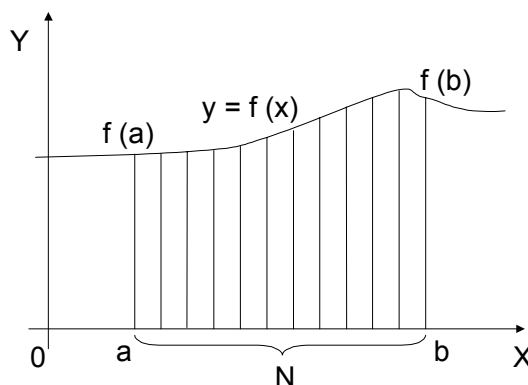
$$\int_a^b f(x) dx, N = 2^n$$

where [ a, b ] is integration interval and N is the number of division. ( n is an integer from 1 to 9 )

#### Simpson's Rule

$$\text{Area} = \frac{h}{3} \{ f(a) + 4\{ f(a+h) + f(a+3h) + \dots + f(a+(N-1)h) + 2\{ f(a+2h) + f(a+4h) + \dots + f(a+(N-2)h) \} + f(b) \},$$

$$\text{Where } h = \frac{b-a}{N},$$



In general, the larger n is, the more calculation time is required and the higher precision for the result is. In some case, the results of your integration may be erroneous even if the larger n is used. In particular, when significant digits are less than 1, an error message sometimes will be shown.

Step : (See Example 54)

1. Select integration mode by pressing [ 2nd ] [ ∫dx ].
2. Enter the function you want to integrate. You can use [ 2nd ] [ x ] key to enter the variable x into the function.
3. Press [ ▼ ]. Enter the lower and upper limits of integration ( a and b ).
4. Press [ ▼ ]. Give the number of division to specify  $2^n = N$ , where the value of n is an integer from 1 to 9 and the default value is 5.
5. Press [ ENTER ].

(Note): The calculator always perform trigonometric integration using radians as the unit of angular measurement.

(Note): Integration involving certain types of functions or ranges can result in relatively large errors being generated in the values produced.

## Differentiation

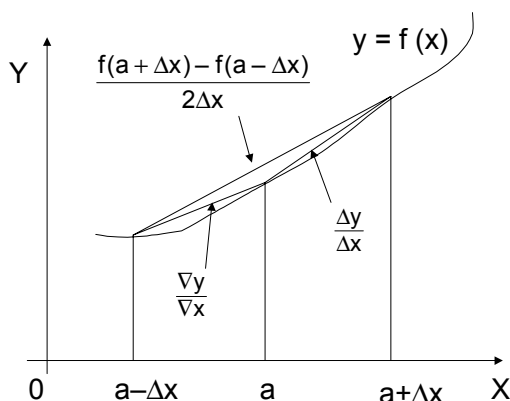
The calculator uses Central difference to perform differential calculations as shown in the below :

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

where  $a$  is the point you want to determine the derivative and  $\Delta x$  is increase/ decrease of  $x$ .

### Central difference

$$\begin{aligned} f'(a) &= \frac{1}{2} \left( \frac{\Delta Y}{\Delta X} + \frac{\nabla Y}{\nabla X} \right) \\ &= \frac{1}{2} \left( \frac{f(a + \Delta x) - f(a)}{\Delta x} + \frac{f(a) - f(a - \Delta x)}{\Delta x} \right) \\ &= \frac{f(a + \Delta x) - f(a - \Delta x)}{2\Delta x} \end{aligned}$$



The smaller  $\Delta x$  is, the more calculation time is required and the higher precision for the derivative is. In general, the precision is  $\pm 1$  at the least significant digit of the result. However, you needn't input a value of  $\Delta x$  and just press [ ENTER ] to skip it. The calculator automatically assigns the default value of  $10^{-8}$ .

Step : (See Example 55)

1. Select differentiation mode by pressing [ 2nd ] [ d/dx ].
2. Enter the differential function. You can use [ 2nd ] [  $\chi$  ] key to enter the variable  $x$  into the function.
3. Press [  $\nabla$  ]. Input point  $x = a$  to determinate the derivative.
4. Press [  $\nabla$  ]. Enter the increase / decrease of  $x$  (  $\Delta x$  )
5. Press [ ENTER ].

## Application of integration and differentiation

- Integrals and differentials can be added, subtracted, multiplied and divided with each other. For example,  $\int_a^b f(x) dx + \int_c^d g(x) dx$  ,  $\int_a^b f(x) dx \times \int_c^d g(x) dx$  ,  $f'(a) \div \int_a^b g(x) dx$  .... See Example 56.
- Integrated or differential results can be used in addition, multiplication, and division, and in function. For example,  $5 \times \int_a^b f(x) dx$  ,  $\ln(\int_a^b f(x) dx)$  ... See Example 57.
- After you perform an integration, you can integrate the same  $f(x)$  again, with different limits of integration ,  $a$  and  $b$ , or a different number of divisions,  $n$ . Differentiation also provides the feature. See Example 58.
- When integration interval  $[ a, b ]$  is unavailable or interrupted for the integrated function, an error message will appear on the display. It means you need to

change the lower and upper limits of integration ( a, b ) for the integrated function. See Example 59.

(Note): If the result for integration or differentiation takes a long time to calculate and you want to interrupt (while it is executing and the word **BUSY** appears on the display), please press [ CL ]. A message appears on the display to confirm whether you want to interrupt.

STOP : N Y

Move the cursor to “ Y ” to interrupt or “ N ” to return.

## Mode 1 - STAT

There are three menu operation in statistics menu : **1-VAR** ( for analyzing data in a single dataset), **2-VAR** ( for analyzing paired data from two datasets ) and **D-CL** ( for clearing all datasets).

### ■ Single-variable / Two-variable statistics

Step :

1. From the statistics menu, choose **1-VAR** or **2-VAR** and press [ ENTER ].
2. Press [ DATA ] and there are three menu : **DATA-INPUT**, **LIMIT-SET**, **DISTR**. Please choose **DATA-INPUT** and press [ ENTER ].
3. Enter an x - value and press [ ▼ ].
4. Enter the frequency ( **FREQ** ) of the x - value ( in **1-VAR** mode ) or the corresponding y - value ( in **2-VAR** mode ) and press [ ▼ ].
5. To enter more data, repeat from step 3.
6. Press [ STATVAR ] and scroll through the statistical results menu by [ ▶ ] or [ ◀ ] to find out statistical variables you want. (See table below)

Variable	Meaning
<b>n</b>	Number of the x values or x-y pairs entered.
<b><math>\bar{x}</math> or <math>\bar{y}</math></b>	Mean of the x values or y values
<b>Xmax or Ymax</b>	Maximum of the x values or y values
<b>Xmin or Ymin</b>	Minimum of the x values or y values
<b>Sx or Sy</b>	Sample standard deviation of x values or y values.
$S_x = \sqrt{\frac{\sum(x - \bar{x})^2}{n-1}} \quad , \quad S_y = \sqrt{\frac{\sum(y - \bar{y})^2}{n-1}}$	
<b><math>\sigma_x</math> or <math>\sigma_y</math></b>	Population standard deviation of x values or y values
$\sigma_x = \sqrt{\frac{\sum(x - \bar{x})^2}{n}} \quad , \quad \sigma_y = \sqrt{\frac{\sum(y - \bar{y})^2}{n}}$	
<b><math>\sum x</math> or <math>\sum y</math></b>	Sum of all x values or y values
<b><math>\sum x^2</math> or <math>\sum y^2</math></b>	Sum of all $x^2$ values or $y^2$ values
<b><math>\sum xy</math></b>	Sum of ( x y ) for all x-y pairs

## ■ Process capability

Step : (See Example 60~61)

1. Press [ DATA ] and there are three menu : **DATA-INPUT**, **LIMIT-SET**, **DISTR**. Please choose **LIMIT-SET** and press [  $\overline{\text{ENTER}}$  ].
2. Enter a upper spec. limit value ( **X USL** or **Y USL** ), then press [  $\blacktriangledown$  ].
3. Enter a lower spec. limit value ( **X LSL** or **Y LSL** ), then press [  $\blacktriangledown$  ].
4. Enter the datasets you want under **DATA-INPUT** mode.
5. Press [ STATVAR ] and scroll through the statistical results menu by [  $\blacktriangleright$  ] or [  $\blacktriangleleft$  ] to find out process capability variables you want. (See table below)

Variable	Meaning
<b>Cax</b> or <b>Cay</b>	Capability accuracy of the x values or y values

$$C_{ax} = \frac{\left| \left( \frac{X_{USL} + X_{LSL}}{2} \right) - \bar{x} \right|}{\frac{X_{USL} - X_{LSL}}{2}}, \quad C_{ay} = \frac{\left| \left( \frac{Y_{USL} + Y_{LSL}}{2} \right) - \bar{y} \right|}{\frac{Y_{USL} - Y_{LSL}}{2}}$$

**Cpx** or **Cpy** Potential capability precision of the x values or y

$$\text{values } C_{px} = \frac{X_{USL} - X_{LSL}}{6\sigma}, \quad C_{py} = \frac{Y_{USL} - Y_{LSL}}{6\sigma}$$

**Cpkx** or **Cpky** Minimum ( $C_{PU}$ ,  $C_{PL}$ ) of the x values or y values  
, where  $C_{PU}$  is upper spec. limit of capability precision  
and  $C_{PL}$  is lower spec. limit of capability precision

$$C_{pkx} = \text{Min} ( C_{PUX}, C_{PLX} ) = C_{px} ( 1 - C_{ax} )$$

$$C_{pky} = \text{Min} ( C_{PUY}, C_{PLY} ) = C_{py} ( 1 - C_{ay} )$$

(Note): When calculating process capability in **2 – VAR** mode, the  $x_n$  and  $y_n$  are independent with each other.

## ■ Probability distribution

Step : (See Example 62)

1. Based on the datasets in 1-VAR mode, press [ DATA ] and there are three menu : **DATA-INPUT**, **LIMIT-SET**, **DISTR**. Please choose **DISTR** and press [  $\overline{\text{ENTER}}$  ].
2. Enter a  $a_x$  value, then press [  $\overline{\text{ENTER}}$  ].
3. Press [ STATVAR ] and scroll through the statistical results menu by [  $\blacktriangleright$  ] or [  $\blacktriangleleft$  ] to find out probability distribution variables you want. (See table below)

Variable	Meaning
t	Test value $t = \frac{a_x - \bar{x}}{\sigma}$
P ( t )	Represent the cumulative fraction of the standard normal distribution that is less than the value t
R ( t )	Represent the cumulative fraction of the standard normal distribution that lies between the value t and 0. $R ( t ) = 1 - P ( t )$
Q ( t )	Represent the cumulative fraction of the standard normal distribution that is greater than the value t $Q ( t ) =   0.5 - R ( t )  $

## ■ Linear regression

Step : (See Example 63)

1. Based on the datasets in **2-VAR** mode, press [ STATVAR ] and scroll through the statistical results menu by [ ▶ ] or [ ◀ ] to find out **a**, **b**, or **r**.
2. To predict a value for x ( or y ) given a value for y (or x), select the **x'** (or **y'**) variable, press [ ENTER ], enter the given value, and press [ ENTER ] again. (See table below)

Variable	Meaning
a	Linear regression y-intercept $a = \frac{\sum y - b \sum x}{n}$
b	Linear regression slope $b = \frac{(n \sum x y - \sum x \sum y)}{(n \sum x^2 - (\sum x)^2)}$
r	Correlation coefficient $r = \frac{(n \sum x y - \sum x \sum y)}{\sqrt{(n \sum x^2 - (\sum x)^2)(n \sum y^2 - (\sum y)^2)}}$
x'	Predicted x values given a, b, and y vales $x' = \frac{y - a}{b}$
y'	Predicted y value given a, b, and x value. $y' = a + bx$

## ■ Correcting data

Step : (See Example 64)

1. Press [ DATA ].
2. To change x - values or the frequency of the x - value in **1-VAR** mode ( or the corresponding y - value in **2-VAR** mode ), please choose **DATA-INPUT**. To change upper spec. limit value, or lower spec. limit value, please choose **LIMIT-SET**. To change  $a_x$ , please choose **DISTR**.
3. Press [ ▼ ] to scroll through the data you have entered.
4. To change an entry, display it and enter the new data. The new data you enter overwrites the old entry. Press [ ▼ ] or [ ENTER ] to save the change.

(Note): Even you exit STAT mode, all data in **1 -VAR** and **2 -VAR** mode are still retained unless you clear all data by selecting **D-CL** mode.

## Mode 2 - Base-n

### ■ Bases conversions

- The number system (10, 16, 2, 8) is set by pressing [2nd][dhbo] to display the menu, making one of the items underlined followed [ENTER]. A corresponding symbol - “**d**”, “**h**”, “**b**”, “**o**” appears on the display. (The default setting is **d**: decimal base). See Example 65.

(Note): The total range of numbers handled in this mode is 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. If values not valid for the particular number system are used, attach the corresponding designator (**d**, **h**, **b**, **o**), or an error message will appear.

Binary base (**b**): 0, 1

Octal base (**o**): 0, 1, 2, 3, 4, 5, 6, 7

Decimal base (**d**): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Hexadecimal base (**h**): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

- Pressing [↻] can use block function to display a result in octal or binary base which exceeds 8 digits. The system is designed to display up to 4 blocks. See Example 66.

### ■ Negative expressions

- In binary, octal, and hexadecimal bases, the calculator represents negative numbers using complement notation. The complement is the result of subtracting that number from 10000000000 in that number's base by pressing [NEG] key in non-decimal bases. See Example 67.

### ■ Basic arithmetic operations for bases

- The unit enables you to calculate in number base other than decimal. The calculator can add, subtract, multiply, and divide binary, octal, and hexadecimal numbers. See Example 68.

### ■ Logical operation

- Logical operations are performed through logical products (AND), negative logical (NAND), logical sums (OR), exclusive logical sums (XOR), negation (NOT), and negation of exclusive logical sums (XNOR). See Example 69.

## Mode 3 - CPLX

- Complex mode enables you to add, subtract, multiply, and divide complex numbers. See Example 70. The results of a complex operation are displayed as follow :

**Re** Real value

**Im** Imaginary value

**ab** Absolute value

**ar** Argument value

## Mode 4 - VLE

Variable linear equations (**VLE**) mode can solve a set of simultaneous equations with two unknowns as follows :

$$a x + b y = c$$

$$d x + e y = f, \text{ where } x \text{ and } y \text{ are unknown.}$$

- In VLE mode, you just enter each coefficient ( **a**, **b**, **c**, **d**, **e**, **f** ) in the correct order, and the calculator automatically solves for **x**, **y**. See Example 71.

## Mode 5 - QE

Quadratic equations (**QE**) mode can solve a equations as follows :

$$a x^2 + b x + c = 0, \text{ where } x \text{ is unknown.}$$

- In QE mode, you just enter each coefficient ( **a**, **b**, **c** ) in the correct order, and the calculator automatically solves for all **x** values. See Example 72.

## Example

### Example 1

- Change  $123 \times 45$  as  $12 \times 47$

123 [x] 45 [ENTER]

MAIN	DEG
123 * 45	
	5 535.

[▶][▶][▶][DEL]

MAIN	DEG
12 * 45	

[▶][▶] 7 [ENTER]

MAIN	DEG
12 * 47	
	564.

### Example 2

- $14 \div 0 \times 2.3$  mistakenly input instead of  $14 \div 10 \times 2.3$

14 [÷] 0 [x] 2.3 [ENTER]

MAIN	DEG
DIVIDE BY 0	
	.

After 5 Sec

MAIN	DEG
14 / 0 * 2.3	

[◀][2nd][INS] 1 [ENTER]

MAIN	DEG
14 / 10 * 2.3	
	3.22

### Example 3

$$[(3 \times 5) + (56 \div 7) - (74 - 8 \times 7)] = 5$$

3 [x] 5 [M+]

MAIN	DEG
3 * 5	
M	15.

56 [÷] 7 [M+]

MAIN	DEG
56 / 7	
M	8.

[MRC] [ENTER]

MAIN	DEG
M	
M	23.

74 [-] 8 [x] 7 [2nd] [M-]

MAIN	DEG
74 - 8 * 7	
M	18.

[MRC] [ENTER]

MAIN	DEG
M	
M	5.

[MRC] [MRC] [CL]

MAIN	DEG
-	

## Example 4

① ■ Put the value 30 into variable A

① [2nd][CL-VAR]30[SAVE]

MAIN DEG  
→ A B C D E →

[ENTER]

MAIN DEG  
30 → A  
30.

② ■ Multiple 5 to variable A, then put the result into variable B

② 5[x][2nd][RECALL]

MAIN DEG  
A B C D E X →  
30.

[ENTER][ENTER]

MAIN DEG  
5 \* 30  
150.

[SAVE][▶][ENTER]

MAIN DEG  
Ans → B  
150.

③ ■ Add 3 to variable B

③ [VRCL][▶]

MAIN DEG  
A B C D E X →  
150.

[ENTER][+]  
3

MAIN DEG  
B + 3

[ENTER]

MAIN DEG  
B + 3  
153.

④ ■ To clear the contents of all variables

④ [2nd][CL-VAR][VRCL]

MAIN DEG  
A B C D E X →

## Example 5

① ■ To resume a character which is just deleted by [DEL]

① 543[DEL]

MAIN DEG  
54\_

[2nd][↶]

MAIN DEG  
543\_

② ■ To resume running memory which is just cleared by [MRC]

② 25[M+]

MAIN DEG  
25  
M 25.

[MRC][MRC]

MAIN DEG  
M

[2nd][↶][ENTER]

MAIN DEG  
M  
M 25.

③ ■ To resume an operation which is just cleared by [CL]

③ 1 [+ ] 2 [= ] [CL]

MAIN DEG  
—

[2nd][↶]

MAIN DEG  
1 + 2 \_

### Example 6

1 + 2 x 3 = 7

1 [+ ] 2 [x ] 3 [ENTER]

MAIN DEG  
1 + 2 \* 3  
7.

### Example 7

-3.5 + 8 ÷ 2 = 0.5

[(-)] 3.5 [+ ] 8 [ ÷ ] 2 [ENTER]

MAIN DEG  
- 3.5 + 8 / 2  
0.5

### Example 8

7 + 10 x 8 ÷ 2 = 47

7 [+ ] 10 [x ] 8 [ ÷ ] 2 [ENTER]

MAIN DEG  
7 + 10 \* 8 / 2  
47.

### Example 9

12369 x 7532 x 74103 = 6903680613000

12369 [x ] 7532 [x ] 74103 [ENTER]

MAIN DEG  
12369 \* 7532 \* →  
6.903680613 x 10<sup>12</sup>

### Example 10

6 ÷ 7 = 0.857142857

6 [ ÷ ] 7 [ENTER]

MAIN DEG  
6 / 7  
0 . 857142857

[2nd][FIX][▶][▶][▶]

MAIN DEG  
F 0 1 2 3 4 5 6 7 8 9

[ENTER]

MAIN	DEG	FIX
6 / 7		
		0.86

[2nd][FIX]4

MAIN	DEG	FIX
6 / 7		
		0.8571

[2nd][FIX][•]

MAIN	DEG	
6 / 7		
		0.857142857

### Example 11

$$1 \div 6 \times 6 = 1$$

[2nd][FIX][▶][▶][▶][▶]

MAIN	DEG	
F 0 1 2 3 4 5 6 7 8 9		

[ENTER]1[÷]6[ENTER]

MAIN	DEG	FIX
1 / 6		
		0.167

[x]6[ENTER]

MAIN	DEG	FIX
Ans * 6		
		1.000

### Example 12

$$\text{RND}(1 \div 6) \times 6 = 1.002$$

[2nd][RND]1[÷]6[ENTER]

MAIN	DEG	FIX
RND(1 / 6)		
		0.167

[x]6[ENTER]

MAIN	DEG	FIX
Ans * 6		
		1.002

### Example 13

$$1 \div 6000 = 0.0001666\dots$$

1[÷]6000[ENTER]

MAIN	DEG	
1 / 6000		
		0.000166667

[2nd][SCI/ENG][▶]

MAIN	DEG	
FLO SCI ENG		

[ENTER]

MAIN	DEG	SCI
1 / 6000		
		1.666666667 <sub>x10<sup>-04</sup></sub>

[2nd][SCI/ENG][▶]

MAIN	DEG	SCI
FLO SCI ENG		

[ENTER]

MAIN	DEG	ENG
1 / 6000		μ
		166.6666667

### Example 14

$$0.0015 = 1.5 \times 10^{-3}$$

1.5 [EXP] [(-)] 3 [ENTER]

MAIN	DEG
1.5 E- 3	
	0. 0015

### Example 15

$$20 \text{G byte} + 0.1 \text{K byte} = 2.00000001 \times 10^{10}$$

20 [2nd] [ENG SYM] [▶] [▶] [▶]

MAIN	DEG
→ K M G T P →	

[ENTER] [+] 0.1 [2nd] [ENG SYM] [▶] [ENTER]  
[ENTER]

MAIN	DEG
20 G + 0.1 K	
2.00000001 x10 <sup>10</sup>	

### Example 16

$$(5 - 2 \times 1.5) \times 3 = 6$$

[ ( ] 5 [ - ] 2 [ x ] 1.5 [ ) ] [ x ] 3 [ENTER]

MAIN	DEG
( 5 - 2 * 1.5 ) * 3 →	
6 .	

### Example 17

$$2 + 3 \times (5 + 4) = 29$$

2 [ + ] 3 [ x ] [ ( ] 5 [ + ] 4 [ ) ] [ENTER]

MAIN	DEG
2 + 3 * ( 5 + 4	
29 .	

### Example 18

$$(7 - 2) \times (8 + 5) = 65$$

[ ( ] 7 [ - ] 2 [ ) ] [ ( ] 8 [ + ] 5 [ ) ] [ENTER]

MAIN	DEG
( 7 - 2 ) ( 8 + 5	
65 .	

### Example 19

$$2 \times \{ 7 + 6 \times (5 + 4) \} = 122$$

2 [ x ] [ ( ] 7 [ + ] 6 [ x ] [ ( ] 5 [ + ] 4 [ ) ] [ ) ] [ENTER]

MAIN	DEG
2 * ( 7 + 6 * ( 5 + 4	→
122 .	

### Example 20

$$(2 + 3) \times 10^2 = 500$$

[ ( ] 2 [ + ] 3 [ ) ] [ x ] 1 [ EXP ] 2 [ENTER]

MAIN	DEG
( 2 + 3 ) * 1 E2	
500 .	

## Example 21

$$120 \times 30\% = 36$$

120 [x] 30 [2nd] [%] [=]

MAIN	DEG
120 * 30 %	
	36 .

## Example 22

$$88 \div 55\% = 160$$

88 [÷] 55 [2nd] [%] [=]

MAIN	DEG
88 / 55 %	
	160 .

## Example 23

$$3 \times 3 \times 3 \times 3 = 81$$

3 [x] 3 [=]

MAIN	DEG
3 * 3	
	9 .

[x] 3 [=]

MAIN	DEG
Ans * 3	
	27 .

[=]

MAIN	DEG
Ans * 3	
	81 .

## Example 24

- To calculate  $\div 6$  after  $3 \times 4 = 12$

3 [x] 4 [=]

MAIN	DEG
3 * 4	
	12 .

[÷] 6 [=]

MAIN	DEG
Ans / 6	
	2 .

## Example 25

$$123 + 456 = 579 \rightarrow 789 - 579 = 210$$

123 [+] 456 [=]

MAIN	DEG
123 + 456	
	579 .

789 [-] [2nd] [ANS] [=]

MAIN	DEG
789 - Ans	
	210 .

## Example 26

$$\ln 7 + \log 100 = 3.945910149$$

[LN] 7 [▶] [+] [LOG] 100 [=]

MAIN	DEG
ln (7) + log (1 →	
	3.945910149

### Example 27

$$10^2 = 100$$

[2nd][10][x]2[ENTER]

MAIN	DEG
10 ^ ( 2 )	
	100 .

### Example 28

$$e^{-5} = 0.006737947$$

[2nd][e^x][(-)]5[ENTER]

MAIN	DEG
e ^ (-5)	
	0.006737947

### Example 29

$$7\frac{2}{3} + 14\frac{5}{7} = 22\frac{8}{21}$$

7[A b/c]2[A b/c]3[+]14[A b/c]5[A b/c]7[ENTER]

MAIN	DEG
7 2 3 + 14 5 7	→
	22 8 / 21

### Example 30

$$4\frac{2}{4} = 4\frac{1}{2}$$

4[A b/c]2[A b/c]4[ENTER]

MAIN	DEG
4 2 4	
	4 1 / 2

[2nd][A b/c]↔d/e[ENTER]

MAIN	DEG
Ans ▶ A b/c ↔ d/e	
	9 / 2

[2nd][A b/c]↔d/e[ENTER]

MAIN	DEG
Ans ▶ A b/c ↔ d/e	
	4 1 / 2

### Example 31

$$4\frac{1}{2} = 4.5$$

4[A b/c]1[A b/c]2[2nd][F↔D][ENTER]

MAIN	DEG
4 1 2 ▶ F ↔ D	
	4.5

### Example 32

$$8\frac{4}{5} + 3.75 = 12.55$$

8[A b/c]4[A b/c]5[+]3.75[ENTER]

MAIN	DEG
8 4 5 + 3.75	
	12.55

### Example 33

$$2 \pi \text{ rad.} = 360 \text{ deg.}$$

[DRG]

MAIN DEG  
DEG RAD GRD

[ENTER] 2 [2nd] [π] [DMS] [▶] [▶] [▶]

MAIN DEG  
° ' " r g →

[ENTER] [ENTER]

MAIN DEG  
2 π r  
360 .

### Example 34

$$1.5 = 1^{\circ}30'10'' \text{ (DMS)}$$

1.5 [DMS] [◀]

MAIN DEG  
← ▶ DMS

[ENTER] [ENTER]

MAIN DEG  
1.5 → DMS  
1°30'10''

### Example 35

$$2^{\circ}45'10.5'' = 2.752916667$$

2 [DMS]

MAIN DEG  
° ' " r g →

[ENTER] 45 [DMS] [▶]

MAIN DEG  
° ' " r g →

[ENTER] 10.5 [DMS] [▶] [▶]

MAIN DEG  
° ' " r g →

[ENTER] [ENTER]

MAIN DEG  
2° 45' 10.5''  
2.752916667

### Example 36

$$\sin 30 \text{ Deg.} = 0.5$$

[DRG]

MAIN DEG  
DEG RAD GRD

[ENTER] [SIN] 30 [ENTER]

MAIN DEG  
sin ( 30 )  
0.5

### Example 37

$\sin 30 \text{ Rad.} = -0.988031624$

[DRG][▶]

MAIN DEG  
DEG RAD GRD

[ENTER][SIN]30 [ENTER]

MAIN RAD  
sin ( 30 )  
- 0.988031624

### Example 38

$\sin^{-1} 0.5 = 33.33333333 \text{ Grad.}$

[DRG][▶]

MAIN RAD  
DEG RAD GRD

[ENTER][2nd][SIN<sup>-1</sup>]0.5 [ENTER]

MAIN GRAD  
sin<sup>-1</sup> ( 0.5 )  
33.33333333

### Example 39

$\cosh 1.5 + 2 = 4.352409615$

[2nd][HYP][COS]1.5[▶][+]<sup>2</sup> [ENTER]

MAIN DEG  
cosh ( 1.5 ) + 2 →  
4.352409615

### Example 40

$\sinh^{-1} 7 = 2.644120761$

[2nd][HYP][2nd][SIN<sup>-1</sup>]7 [ENTER]

MAIN DEG  
sinh<sup>-1</sup> ( 7 )  
2.644120761

### Example 41

■ If  $x=5, y=30$ , what are  $r, \theta$ ? Ans:  $r = 30.41381265 \theta = 80.53767779^\circ$

[2nd][R↔P]

MAIN DEG  
R↔Pr R↔P  $\theta$  →

[ENTER]5 [2nd][↵]30

MAIN DEG  
R↔Pr ( 5, 30 )

[ENTER]

MAIN DEG  
R↔Pr ( 5, 30 )  
30.41381265

[2nd][R↔P][▶]

MAIN DEG  
R↔Pr R↔P  $\theta$  →

[ENTER]5[2nd][ $\rightarrow$ ]30

MAIN DEG  
R>P  $\theta$  ( 5, 30 )

[ENTER]

MAIN DEG  
R>P  $\theta$  ( 5, 30 )  
80.53767779

### Example 42

- If  $r=25$ ,  $\theta = 56^\circ$ , what are  $x, y$ ? Ans:  $x = 13.97982259$   $y = 20.72593931$

[2nd][R $\leftrightarrow$ P][ $\leftarrow$ ][ $\leftarrow$ ]

MAIN DEG  
 $\leftarrow$  P>Rx P>Ry

[ENTER]25[2nd][ $\rightarrow$ ]56

MAIN DEG  
P>Rx ( 25, 56 )  $\rightarrow$

[ENTER]

MAIN DEG  
P>Rx ( 25, 56 )  $\rightarrow$   
13.97982259

[2nd][R $\leftrightarrow$ P][ $\leftarrow$ ]

MAIN DEG  
 $\leftarrow$  P>Rx P>Ry

[ENTER]25[2nd][ $\rightarrow$ ]56

MAIN DEG  
P>Ry ( 25, 56 )  $\rightarrow$

[ENTER]

MAIN DEG  
P>Ry ( 25, 56 )  $\rightarrow$   
20.72593931

### Example 43

$$7! \div [(7-4)!] = 840$$

7[PRB]

MAIN DEG  
nPr nCr !  $\rightarrow$

[ENTER]4[ENTER]

MAIN DEG  
7 nPr 4  
840 .

### Example 44

$$7! \div [(7-4)! \times 3!] = 35$$

7[PRB][ $\blacktriangleright$ ]

MAIN DEG  
nPr nCr !  $\rightarrow$

[ENTER]4[ENTER]

MAIN DEG  
7 nCr 4  
35 .

## Example 45

$$5! = 120$$

5 [PRB] [▶] [▶]

MAIN DEG  
nPr nCr ! →

[ENTER] [ENTER]

MAIN DEG  
5 !  
120 .

## Example 46

- Generates a random number between 0 and 1

[PRB] [◀] [◀]

MAIN DEG  
← RANDM →

[ENTER] [ENTER]

MAIN DEG  
RANDM  
0.80895996

## Example 47

- Generates a random number between 7 and 9

[PRB] [◀]

MAIN DEG  
← RANDMI

[ENTER] 7 [2nd] [◀] 9 [ENTER]

MAIN DEG  
RANDMI (7, 9) →  
8 .

## Example 48

$$\frac{1}{1.25} = 0.8$$

1.25 [2nd] [X<sup>-1</sup>] [ENTER]

MAIN DEG  
1.25<sup>-1</sup>  
0.8

## Example 49

$$2^2 + \sqrt{4 + 21} = 9$$

2 [X<sup>2</sup>] [+] [√] 4 [+] 21 [ENTER]

MAIN DEG  
2<sup>2</sup> + √(4+21)  
9 .

## Example 50

$$\sqrt[3]{27} = 3$$

3 [2nd] [√] 27 [ENTER]

MAIN DEG  
3 × √(27)  
3 .

## Example 51

$$7^4 = 2401$$

7 [ ^ ] 4 [ ENTER ]

MAIN	DEG
7 ^ 4	
	2401.

## Example 52

$$1 \text{ yd}^2 = 9 \text{ ft}^2 = 0.000000836 \text{ km}^2$$

1 [ 2nd ] [ CONV ] [  $\nabla$  ] [  $\blacktriangleright$  ]

MAIN	DEG
$\rightarrow$ ft <sup>2</sup> yd <sup>2</sup> m <sup>2</sup>	$\rightarrow \uparrow$ $\downarrow$

[ ENTER ]

MAIN	DEG
ft <sup>2</sup> yd <sup>2</sup> m <sup>2</sup>	$\rightarrow$
	1.

[  $\blacktriangleleft$  ]

MAIN	DEG
ft <sup>2</sup> yd <sup>2</sup> m <sup>2</sup>	$\rightarrow$
	9.

[  $\blacktriangleright$  ] [  $\blacktriangleright$  ] [  $\blacktriangleright$  ]

MAIN	DEG
$\leftarrow$ km <sup>2</sup> hectares	$\rightarrow$
	0.000000836

## Example 53

$$3 \times G = 2.00177955 \times 10^{-10}$$

3 [ x ] [ CONST ] [  $\blacktriangleright$  ] [  $\blacktriangleright$  ]

MAIN	DEG
c g G Vm N <sub>A</sub>	$\rightarrow$
	6.6725985 x10 <sup>-11</sup>

[ ENTER ] [ ENTER ]

MAIN	DEG
3 * 6.6725985	$\rightarrow$
	2.00177955 x10 <sup>-10</sup>

## Example 54

$$\int_1^5 (x+1)^3 dx = 320$$

[ 2nd ] [  $\int dx$  ]

MAIN	DEG
$\int ( ) dx$	

[ ( ] [ 2nd ] [ X ] [ + ] 1 [ ) ] [ ^ ] 3

MAIN	DEG
$\int ((X+1)^3) dx$	$\rightarrow$

[ ENTER ] 1

MAIN	DEG
a <sub>1</sub> = 1	$\uparrow$ $\downarrow$

[  $\nabla$  ] 5

MAIN	DEG
b <sub>1</sub> = 5	$\uparrow$ $\downarrow$

[▼]

MAIN DEG  
2 n | n<sub>1</sub> = 5 (1~9) ↑  
↓

[ENTER]

MAIN DEG  
∫ (X+1)^3 dx →  
320.

### Example 55

$$f(x) = x^3 + 4x^2 + x - 6 \Rightarrow f'(3) = (3x^2 + 8x + 1) \Big|_{x=3} = 52$$

[2nd][d/dx]

MAIN DEG  
d/dx(

[2nd][X][^]3[+]  
4[2nd][X][X^2][+]  
[2nd][X][-]6

MAIN DEG  
← ^3 + 4X^2 + X - 6 →

[ENTER]3

MAIN DEG  
x<sub>1</sub> = 3 ↑  
↓

[▼]

MAIN DEG  
Δ x<sub>1</sub> = 1 E - 08 ↑  
↓

[ENTER]

MAIN DEG  
d/dx(X^3+4X →  
52.

### Example 56

$$\begin{cases} f_1(x) = \sin(3x + 30) \\ f_2(x) = \cos^3(x) \end{cases}$$

$$\Rightarrow f_1'(10) - f_2'(30) = [3\cos(3x + 30)] \Big|_{x=10} - \left\{ - [3\cos(x)^2 \times \sin(x)] \Big|_{x=30} \right\}$$

$$= 0.045814893 \text{ (Rad)} = 2.625 \text{ (Deg.)}$$

[2nd][d/dx][SIN]3[2nd][X][+]  
30

MAIN DEG  
← n (3X + 30) - →

[2nd][d/dx][COS][2nd][X][^]  
3

MAIN DEG  
← ((cos(X)^3) →

[ENTER]10

MAIN DEG  
x<sub>1</sub> = 10 ↑  
↓

[▼]

MAIN DEG  
Δ x<sub>1</sub> = 1 E - 08 ↑  
↓

[▼]30

MAIN DEG  
x<sub>2</sub> = 30 ↑  
↓

[▼]

MAIN	DEG
$\Delta x_2 = 1 E - 08$	↑ ↓

[ENTER]

MAIN	DEG
$d/dx(\sin(3X))$	→
0.045814893	

[2nd][ANS][x]180[÷][2nd][π][ENTER]

MAIN	DEG
Ans * 180 / π	↑ ↓
2.625	

### Example 57

$$\cos \left[ \int_1^5 (x+1)^3 dx \right] = \cos(320) = 0.766044443$$

[COS][2nd][∫dx][()][2nd][X][+][1][)][^]3

MAIN	DEG
$\left( \int ((X+1)^3 \right)$	← → ↑ ↓

[ENTER]1

MAIN	DEG
$a_1 = 1$	↑ ↓

[▼]5

MAIN	DEG
$b_1 = 5$	↑ ↓

[▼]

MAIN	DEG
$2^n   n_1 = 5(1 \sim 9)$	↑ ↓

[ENTER]

MAIN	DEG
$\cos \left( \int ((X+1)^3 \right)$	→
0.766044443	

### Example 58

$$\begin{cases} \int_1^5 (x+1)^3 dx = 320 \\ \int_3^8 (x+1)^3 dx = 1576.25 \end{cases}$$

[2nd][∫dx][()][2nd][X][+][1][)][^]3

MAIN	DEG
$\int ((X+1)^3) dx$	→

[ENTER]1[▼]5[▼][ENTER]

MAIN	DEG
$\int ((X+1)^3) dx$	→
320.	

[ENTER]

MAIN	DEG
$a_1 = 1$	↑ ↓

3

MAIN	DEG
$a_1 = 3$	↑ ↓

[▼]8

MAIN	DEG
$b_1 = 8$	↑ ↓

[▼]

MAIN DEG  
2 n | n<sub>1</sub> = 5 (1 ~ 9) ↑  
↓

[ENTER]

MAIN DEG  
∫ (X + 1)^3 dx →  
1576.25

### Example 59

$$\int_{-0.5}^{0.5} \frac{1}{(x^2 - 3x + 2)} dx = 0.58789835$$

[2nd][∫dx]1[÷][()][2nd][X][x^2][-]  
3[2nd][X][+][2][)]

MAIN DEG  
← / (X<sup>2</sup> - 3X + 2) →

[ENTER][(-)]0.5[▼]1.5[▼][ENTER]

MAIN DEG  
DIVIDE BY 0  
.

After 5 Sec

MAIN DEG  
← (X<sup>2</sup> - 3X + 2) dx → ↑

[ENTER][▼]0.5

MAIN DEG  
b<sub>1</sub> = 0.5 ↑  
↓

[▼][ENTER]

MAIN DEG  
∫ ( 1 / (X<sup>2</sup> - 3X + 2) ) dx →  
0.58789835

### Example 60

- Enter data : X<sub>USL</sub> = 6, X<sub>LSL</sub> = 2, X<sub>1</sub> = 3, FREQ<sub>1</sub> = 2, X<sub>2</sub> = 5, FREQ<sub>2</sub> = 9, then find out  $\bar{x}$  = 4.636363636, S<sub>x</sub> = 0.809039835, C<sub>ax</sub> = 0.318181818, and C<sub>px</sub> = 0.864241622

[MODE]1

STAT DEG  
1-VAR 2-VAR →

[ENTER][DATA][▶]

STAT DEG  
← LIMIT-SET →

[ENTER]6

STAT DEG  
X USL = 6 ↑  
↓

[▼]2 [ENTER]

STAT DEG  
X LSL = 2 ↑  
2. ↓

[DATA]

STAT DEG  
DATA-INPUT →

[ENTER]3

STAT DEG  
X<sub>1</sub> = 3 ↑  
↓

[▼]2	STAT DEG FREQ <sub>1</sub> = 2    ↑ ↓
[▼]5[▼]9	STAT DEG FREQ <sub>2</sub> = 9    ↑ ↓
[STATVAR]	STAT DEG n $\bar{x}$ Xmax    → 11.
[▶]	STAT DEG n $\bar{x}$ Xmax    → 4.636363636
[▶][▶][▶]	STAT DEG ← Xmin Sx $\sigma$ X    → 0.809039835
[▶][▶][▶][▶]	STAT DEG ← $\Sigma X$ $\Sigma X^2$ Cax    → 0.318181818
[▶]	STAT DEG ← Cpx Cpkx t    → 0.864241622

### Example 61

- Enter data:  $X_{USL} = 6, X_{LSL} = 2, Y_{USL} = 9, Y_{LSL} = 3, X_1 = 3, Y_1 = 4; X_2 = 5, Y_2 = 7$ , then find out  $\bar{x} = 4, S_x = 1.414213562, C_{ax} = 0, C_{ay} = 0.166666667$

[MODE]1[▶]	STAT DEG 1 -VAR 2 -VAR    →
[ <u>ENTER</u> ][DATA][▶]	STAT DEG ← LIMIT-SET    →
[ <u>ENTER</u> ]6[▼]2[▼]9[▼]3 [ <u>ENTER</u> ]	STAT DEG Y LSL = 3    ↑ 3. ↓
[DATA]	STAT DEG DATA-INPUT    →
[ <u>ENTER</u> ]3[▼]4[▼]5[▼]7	STAT DEG Y <sub>2</sub> = 7    ↑ ↓
[STATVAR][▶]	STAT DEG n $\bar{x}$ Xmax    → 4.
[▶][▶][▶]	STAT DEG ← Xmin Sx $\sigma$ X    → 1.414213562

[▶][▶][▶][▶][▶][▶][▶][▶][▶][▶][▶][▶]  
 [▶][▶][▶][▶][▶][▶][▶]

STAT DEG  
 ← x' y' Cax →  
 0.

[▶][▶][▶]

STAT DEG  
 ← Cay Cpy →  
 0.166666667

### Example 62

- Enter data :  $a_x = 2, X_1 = 3, \text{FREQ}_1 = 2, X_2 = 5, \text{FREQ}_2 = 9$ , then find out  $t = -3.417682776, P(t) = 0.0003, Q(t) = 0.4997, R(t) = 0.9997$

[MODE] 1

STAT DEG  
 1-VAR 2-VAR →

[ENTER][DATA][▶][▶]

STAT DEG  
 ← DISTR

[ENTER] 2 [ENTER]

STAT DEG  
 $a_x = 2$   
 2.

[DATA][ENTER] 3 [▼] 2 [▼] 5 [▼] 9

STAT DEG  
 $\text{FREQ}_2 = 9$  ↑  
 ↓

[STATVAR][◀][◀][◀][◀]

STAT DEG  
 ← Cp Cpk t →  
 - 3.417682776

[▶]

STAT DEG  
 ← P(t) Q(t) →  
 0.0003

[▶]

STAT DEG  
 ← P(t) Q(t) →  
 0.4997

[▶]

STAT DEG  
 ← R(t) →  
 0.9997

### Example 63

- Enter data :  $X_1 = 3, Y_1 = 4, X_2 = 5, Y_2 = 7$ , set  $y = 6, x = 5$ , get  $x'(6) = 4.333333333, y'(5) = 7$

[MODE] 1 [▶]

STAT DEG  
 1-VAR 2-VAR →

[ENTER][DATA][ENTER] 3 [▼] 4 [▼] 5 [▼] 7

STAT DEG  
 $Y_2 = 7$  ↑  
 ↓

[STATVAR][◀][◀][◀][◀][◀][◀][◀][◀]

STAT DEG  
 ← x' y' Cax →

[ENTER]6[ENTER]

STAT DEG  
x'(6)  
4.333333333

[STATVAR][◀][◀][◀][◀][◀][◀][◀]

STAT DEG  
← x' y' Cax →

[ENTER]5[ENTER]

STAT DEG  
y'(5)  
7.

### Example 64

- Based on Example 63, change  $Y_1 = 4$  as  $Y_1 = 9$  and  $X_2 = 5$  as  $X_2 = 8$ , then find  $S_x = 3.535533906$

[DATA]

STAT DEG  
DATA-INPUT →

[ENTER][▼]9

STAT DEG  
Y<sub>1</sub> = 9 ↑  
↓

[▼]8

STAT DEG  
X<sub>2</sub> = 8 ↑  
↓

[STATVAR][▶][▶][▶][▶]

STAT DEG  
← Xmin Sx σ X →  
3.535533906

### Example 65

$31_{10} = 1F_{16} = 11111_2 = 37_8$

[MODE]2

Base-n  
d

31 [ENTER]

Base-n  
d31  
31 d

[dhbo]

Base-n  
BASE d h b →  
d

[ENTER]

Base-n  
D H B O  
31 d

[▶]

Base-n  
D H B O  
1F h

[▶]

Base-n  
D H B O  
1111 b

[▶]

Base-n  
D H B O  
37 o

## Example 66

$$4777_{10} = 1001010101001_2$$

[MODE] 2 [dhbo] [ENTER] [▶] [▶]	Base-n D H B O b
[ENTER]	Base-n b
[dhbo] [▶]	Base-n BASE d h b → b
[ENTER] 4777 [ENTER]	Base-n d4777 10101001 1b
[↺]	Base-n d4777 10010 2b
[↺]	Base-n d4777 0 3b
[↺]	Base-n d4777 0 4b

## Example 67

- How is  $3A_{16}$  expressed as a negative? Ans : FFFFFFFC6

[MODE] 2 [dhbo] [ENTER] [▶]	Base-n D H B O h
[ENTER] [NEG] 3 [/A] [ENTER]	Base-n NEG h3A FFFFFFFC6 h

## Example 68

$$1234_{10} + 1EF_{16} \div 24_8 = 2352_8 = 1258_{10}$$

[MODE] 2 [dhbo] [ENTER] [▶] [▶] [▶]	Base-n D H B O o
[ENTER] [dhbo] [▶]	Base-n BASE d h b → o
[ENTER] 1234 [+]	Base-n d1234 + o
[dhbo] [▶] [▶]	Base-n BASE d h b → o

[ENTER] 1 IE IF [÷]

Base-n  
← 1234 + h1EF /  
o

[dhbo] [◀]

Base-n  
← o  
o

[ENTER] 24

Base-n  
← 4 + h1EF / o 24  
o

[ENTER]

Base-n  
d1234 + h1EF/ →  
2352 o

[dhbo] [ENTER] [▶]

Base-n  
D H B O  
1258 d

### Example 69

$$1010_2 \text{ AND } (A_{16} \text{ OR } 7_{16}) = 1010_2$$

[MODE] 2 [dhbo] [ENTER] [▶] [▶]

Base-n  
D H B O  
b

[ENTER] [dhbo] [▶] [▶] [▶] [ENTER] 1010  
[AND] [(

Base-n  
← 1010 AND (  
b

[dhbo] [▶] [▶] [ENTER] / A [OR] [dhbo] [▶]  
[▶] [ENTER] 7 [ENTER]

Base-n  
b1010 AND ( →  
1010 b

### Example 70

$$(7 - 9i) + (15 + 12i) = 22 + 3i \Rightarrow ab = 22.20360331, ar = 7.765166018$$

[MODE] 3

CPLX DEG

7 [+] [(-)] 9 [i] [+] 15 [+] 12 [i] [ENTER]

CPLX DEG  
Re Im ab ar  
22.

[▶]

CPLX DEG  
Re Im ab ar  
3.

[▶]

CPLX DEG  
Re Im ab ar  
22.20360331

[▶]

CPLX DEG  
Re Im ab ar  
7.765166018

## Example 71

$$\begin{cases} 3x+5y=5 \\ x-4y=13 \end{cases} \Rightarrow x=5, y=-2$$

[MODE]4	VLE DEG ax + by = c, dx +	→
[▼]3	VLE DEG a = 3	↑
[▼]5	VLE DEG b = 5	↑
[▼]5	VLE DEG c = 5	↑
[▼]1	VLE DEG d = 1	↑
[▼][(-)]4	VLE DEG e = -4	↑
[▼]13	VLE DEG f = 13	↑
[▼]	VLE DEG X Y	5.
[▶]	VLE DEG X Y	-2.

## Example 72

■  $x^2 - 5x + 6 = 0 \Rightarrow x = 2 \text{ or } 3$

[MODE]5	QE DEG $ax^2 + bx + c = 0$	
[▼]1	QE DEG a = 1	↑
[▼][(-)]5	QE DEG b = -5	↑
[▼]6	QE DEG c = 6	↑

[▼]

QE	DEG
$X_1$	$X_2$
	3.

[▶]

QE	DEG
$X_1$	$X_2$
	2.