

CASIO

QUICK START GUIDE **fx-991EX**



The **fx-991EX** "ClassWiz" features a high-resolution display, making it easier to view formulas and symbols.

This remarkable screen can display between 2-6 times as many characters as other scientific calculators, yet still runs on solar power.

Use the **ON** key to turn the calculator on, and press **SHIFT AC** (OFF) to power the unit down.

The icon-based menu, accessible via the **MENU** key, allows easy navigation of features using the arrow keys and the number keys or the **ALPHA** shortcuts.

The **DEL** key can be used like Backspace in a word processor to delete the character(s) left of the cursor.

The symbols printed on the keys use Natural Textbook Display™ notation, similar to that found in textbooks. This makes input of expressions fast and easy.

The **S_{DN}D** key toggles your calculation results between Standard (exact) and Decimal forms.

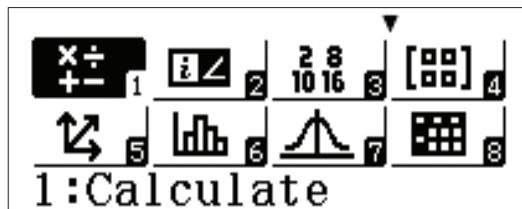
The following explains the meaning of each icon on the fx-991EX icon menu

Icon	Menu Name	Description
	CALCULATE	Perform general computations using Natural Textbook Display™ notation, including absolute value, logs of any base, summation, derivatives, and integrals.
	COMPLEX	Perform computations with complex numbers, including $a + bi$ form, polar ($r\angle\theta$) form, and conversions between the two.
	BASE-N	Perform binary, octal, and hexadecimal computations, and convert among those number bases and base-10.
	MATRIX	Perform operations on matrices up to 4x4, including matrix arithmetic, determinants, transpositions, and identity matrices.
	VECTOR	Perform operations on 2- and 3-dimensional vectors, including vector arithmetic, dot products, angles, and unit vectors.
	STATISTICS	Calculate 13 different one-variable statistics, and apply linear, quadratic, logarithmic, exponential, and geometric (power) regressions.
	DISTRIBUTION	Investigate Normal, Inverse Normal, Binomial, and Poisson probability and cumulative distributions.
	SPREADSHEET	Create spreadsheets with up to 5 columns and 45 rows. Spreadsheet supports Fill, Cut/Copy/Paste, recursive formulas, Mean, and Sum commands.
	TABLE	Create tables of values to compare up to 2 functions simultaneously.
	EQUATION/ FUNCTION	Solve simultaneous (systems of) equations with up to 4 unknowns, and polynomials of up to degree 4.
	INEQUALITY	Solve polynomial inequalities of up to degree 4, with the solution set expressed as a compound inequality.
	RATIO	Solve proportions of the form $A : B = X : D$ and $A : B = C : X$.

CALCULATE

Below are some examples of the Natural Textbook Display™ input/output notation, as found by selecting the Calculate icon from the Main Menu of the **fx-991EX**.

From the Main Menu, use the arrow keys to highlight the Calculate icon, then press **=** or press **1**.



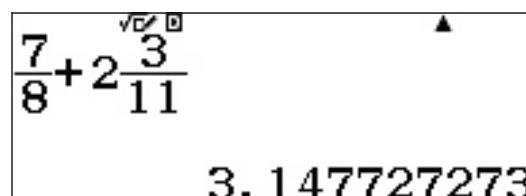
Fractions and mixed numbers can be entered using **1** and **SHIFT 1** (**-****1****2**), respectively.

To enter the calculation to the left, press **1** **7** **▶** **8** **▶** **+** **SHIFT 1** **1** (**-****1****2**) **2** **▶** **3** **▶** **1** **1** **=**.

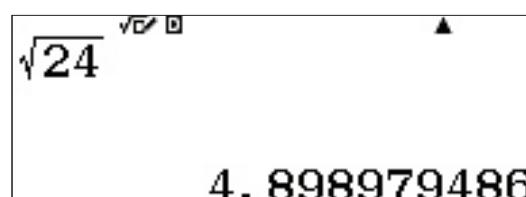
To change the solution to a decimal format, press **S+D**.

Press **SHIFT S+D** ($a\frac{b}{c} \leftrightarrow d$) to convert the result into a mixed-number format.

When inputting radical expressions, the radical bar automatically extends as additional characters are typed.
Press **√** **2** **4** **=**.



The output will be displayed in simplest radical form, but can be converted into a decimal approximation by pressing **S+D**.



CALCULATE

ClassWiz is capable of recognizing and combining like radicals.
Press **✓ 2 4 ➤ + ✓ 1 5 0 =**.

$$\sqrt{24} + \sqrt{150}$$

$$7\sqrt{6}$$

It can also calculate unlike radicals. Press
✓ 2 4 ➤ - ✓ 9 8 =.

$$\sqrt{24} - \sqrt{98}$$

$$2\sqrt{6} - 7\sqrt{2}$$

Higher-order radicals can be beautifully expressed using Natural Textbook Display™ input.

Press **SHIFT x^a (✓) 5 ➤ 6 4 =**.

$$\sqrt[5]{64}$$

$$2.29739671$$

Natural Textbook Display™ templates can be stacked inside one another to allow input of complicated expressions such as this quotient of rational exponentials.

Press **3 x 1 ➤ 2 ➤ ➤ ➤ ➤ 3 x - 2 =**.

$$\frac{1}{3^2}$$

$$\frac{1}{3^{-2}}$$

$$15.58845727$$

(Note: the calculator does *not* generate a Syntax Error when the **-** key is used to create a negative sign. Both **-** and **(-)** are acceptable for use.)

In a trigonometry setting, arithmetic can be performed in terms of π . Press **3 SHIFT x10^x (π) ➤ 4 ➤ + 2 SHIFT x10^x (π) =**.

$$\frac{3\pi}{4} + 2\pi$$

$$\frac{11}{4}\pi$$

Other useful Natural Textbook Display™ templates that help overcome typical calculator input frustrations include:
logarithms of any base,

log₂ 1 6 =

$$\log_{\frac{1}{2}}(16)$$

$$-4$$

CALCULATE

...summation (sigma) notation,

SHIFT **x** (**Σ-**) **x** **x²** **+** **1** **▶** **-** **3** **▶** **7** **=**

$$\sum_{x=-3}^7 (x^2 + 1)$$

165

...derivatives of a function at a specific point (value),

SHIFT **f(x)** (**d/dx**) **4** **x** **x²** **-** **5** **x** **▶** **0** **•** **2** **=**

$$\frac{d}{dx}(4x^2 - 5x) \Big|_{x=0.2}$$

$-\frac{17}{5}$

...and definite integrals.

∫ **1** **▶** **x** **▶** **2** **▶** **5** **=**.

$$\int_2^5 \frac{1}{x} dx$$

0.9162907319

Settings for the “Calculate” mode can be accessed by pressing

SHIFT **MENU** (SET UP).

Press **▼** one or more times to reveal additional Setup options.

- 1: Input/Output**
- 2: Angle Unit**
- 3: Number Format**
- 4: Engineer Symbol**

1:Fraction Result
2:Complex
3:Statistics
4:Spreadsheet

1:Equation/Func
2:Table
3:Decimal Mark
4:Digit Separator

1:MultiLine Font
2:QR Code
3:Contrast

SOLVE

The **fx-991EX** can elegantly solve an equation for any unknown using Newton’s method with the SOLVE command. To use SOLVE, first input the equation to be solved, then press **SHIFT** **CALC** (SOLVE).

Solve $x^2 + Ax + Bx = 0$ for x when $A = 5$ and $B = 6$.

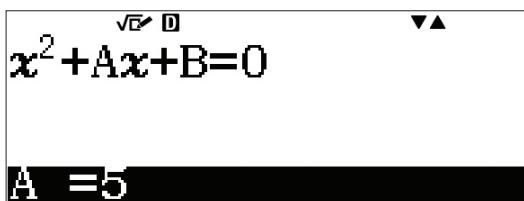
Enter the equation by pressing, **x** **x²** **+** **ALPHA** **(A)** **x** **+** **ALPHA** **(B)** **ALPHA** **CALC** (=) **0**.

$$x^2 + Ax + Bx = 0$$

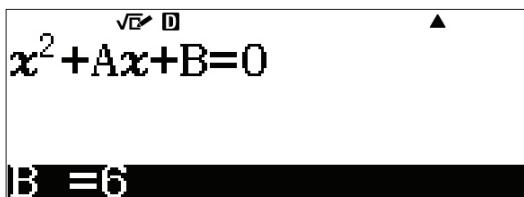
$$x = -5$$

CALCULATE

Input an initial guess for x followed by the values of A and B.
Press **SHIFT** **CALC** (SOLVE) **2** **5** **=** **5** **=** **6** **=**.

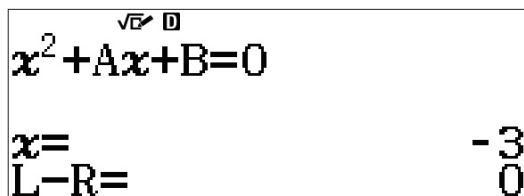


Arrow back up to **x=** and SOLVE the equation by pressing **=**.

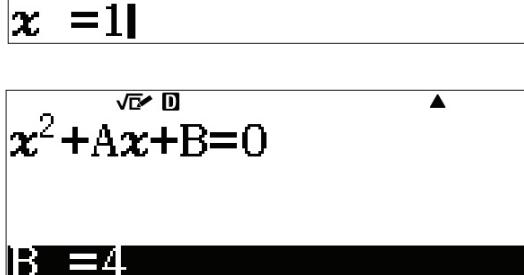


To accomplish the same task and solve for A or B, enter a value for x and a value for one of the other unknowns.

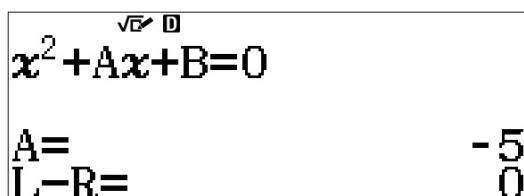
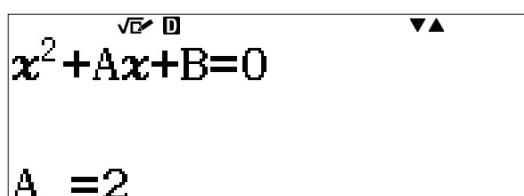
For example, to solve for A when $x = 1$ and $B = 4$, press **SHIFT** **CALC** (SOLVE) **1** **=** **2** **=** **4** **=**.



Arrow back up to **A=** and SOLVE the equation by pressing **=**.



The solution also displays $L - R = 0$. This means that Newton's method of approximation is directly on -5. If $L - R$ is not 0, simply recalculate to get a better approximation.

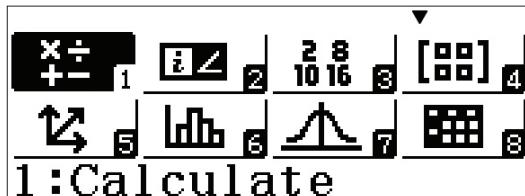


CALCULATE

ENGINEERING CALCULATIONS

There are many menus in the **fx-991EX** that can handle engineering calculations. The **fx-991EX** has the power to handle vectors, matrices, complex numbers and numerically calculates summation and even definite integrals.

From the Main Menu, use the arrow keys to highlight the Calculate icon and press **EX** or press **1**.



There are many different types of unit conversions that can be accomplished on this menu. To view the options, press **SHIFT 8** (CONV). Use the down arrow key (**▼**) to see all the possibilities.

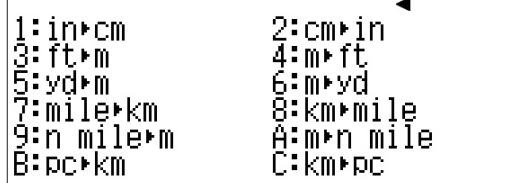
Each one of the choices has a wide range of conversion options for many different types of unit conversion.



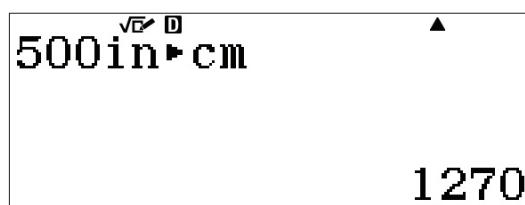
Use the arrow keys to locate the Length conversion and press **1**.

1 :Temperature

To convert 500 inches (in) into centimeters (cm), press **AC** to return to the initial Calculate screen.



Press **5 0 0 SHIFT 8** (CONV) **1** (Length)
1 (in ► cm) **EX**.



CALCULATE

To find the difference between one US Gallon and one UK Gallon, first, convert to a common unit, like a liter (L).

Press **1 SHIFT 8** (CONV) **3** (Volume)
1 (gal(US) ▶ L) **=**.

One US gallon is approximately 3.785 L.

Now, convert the solution to gallons UK.

Press **SHIFT 8** (CONV) **3** (Volume) **4**
(L ▶ gal(UK)) **=**.

It looks like a US gallon is smaller.

1 US gallon = 0.8326742321 UK gallons.

The same calculation can be accomplished using a string of conversions.

Press **1 SHIFT 8** (CONV) **3** (Volume)
1 (gal(US) ▶ L) **SHIFT 8** (CONV)
3 (Volume) **4** (L ▶ gal(UK)) **=**.

ENGINEERING NOTATION

Converting large numbers into scientific and engineering notations can be accomplished through a short series of keystrokes.

Start with a large number like 2.5×10^9 .

Press **2 . 5 x10^x 9** **=**.

The gap between digits at place value separation can be viewed by entering Set Up. Press **SHIFT MENU** (SET UP) and use the arrow keys to navigate to the third menu.

1:gal(US)▶L 2:L▶gal(US)
3:gal(UK)▶L 4:L▶gal(UK)

1gal^{√E 0}▶L

3. 785412

AnsL▶gal(UK)

0. 8326742321

1gal^{√E 0}▶LL▶gal[↑](I>

0. 8326742321

2. 5^{√E 0}

2500000000

1 :Equation/Func
2 :Table
3 :Decimal Mark
4 :Digit Separator

CALCULATE

Press **4** (Digit Separator) **1** (On) to turn on the Digit Separator to show separation between place values.

Press **=** to recalculate the result and display clear place value separation.

To convert this solution into engineering notation, use the **ENG** key to change the solution into scientific notation. To move the decimal to the right, press **ENG**.

2.5_{x10}⁹
2 500_{x10}⁶

2.5_{x10}⁹
2 500 000_{x10}³

2.5_{x10}⁹
2 500 000 000_{x10}⁰

To move the decimal to the left, press **SHIFT ENG** (**←**).

2.5_{x10}⁹
2 500 000_{x10}³

Calculating with engineering symbols has never been easier.

To turn on the engineering symbols in setup, press **SHIFT MODE** (SET UP).

Select **4** (Engineer Symbol) **1** (On) to turn on the Engineering Symbols.

Digit Separator?
1:On
2:Off

2.5_{x10}⁹
2 500 000 000

2.5_{x10}⁹
2.5_{x10}⁹

2.5_{x10}⁹
2 500 000 000_{x10}⁰

1:Input/Output
2:Angle Unit
3:Number Format
4:Engineer Symbol

Engineer Symbol?
1:On
2:Off

CALCULATE

To calculate 500k (kilo) + 10M (Mega), press
5 **0** **0** **OPTN** **3** (Engineering Symbols)
6 (K) **+** **1** **0** **OPTN** **3** (Engineering Symbols)
7 (M) **=**.

500k+10M ▲
10 500 000

The solution is displayed using the appropriate units.

500k+10M E ▲
10.5M

Now, use the **ENG** key to convert between units.

500k+10M E ▲
10 500k

COMPLEX

Complex Number calculations can be executed in the Complex Mode.

From the Main Menu, use the arrow keys to highlight the Complex icon, then press **[EXE]** or press **[2]**.

In Complex Mode, operations can be carried out using the imaginary unit (*i*). To add complex numbers, press **[2] [+]** **[3] [ENG] (i)** **[5] [-]** **[7] [ENG] (i)** **[EXE]**.

Complex numbers that are multiplied are displayed in complex format. Press **[()** **[3]** **[–]** **[2]** **[ENG] (i)** **[)]** **[()** **[5]** **[+]** **[6]** **[ENG] (i)** **[)]** **[EXE]**.

The argument of the complex number $1+2i$, can be found by taking the arctan (y/x) = 63.4349° or by using the Argument command.

Press **[OPTN]** **[1]** (Argument) **[1]** **[+]** **[2]** **[ENG] (i)** **[)]** **[EXE]**.



$$2+3i + 5-7i = 7-4i$$

$$(3-2i)(5+6i) = 27+8i$$

- 1 : Argument
- 2 : Conjugate
- 3 : Real Part
- 4 : Imaginary Part

$$\text{Arg}(1+2i) = 63.43494882$$

COMPLEX

COMPLEX FORM AND POLAR FORM

To convert a complex number into polar form, press
2 **+** **5** **ENG** (*i*) **OPTN** **▼** **1** ($\blacktriangleright r\angle\theta$) **=**.

1 : $\blacktriangleright r\angle\theta$
2 : $\blacktriangleright a+bi$

To convert any polar form of a complex number, use the r theta command or type in the angle in polar form.

Press **AC** **2** **SHIFT** **ENG** (\angle) **3** **3** **0** **OPTN** **▼**
2 ($\blacktriangleright a+bi$) **=**.

Alternately, simply type in the angle in polar form by pressing
2 **SHIFT** **ENG** (\angle) **3** **3** **0** **=**.

These calculations can also be accomplished in radian mode.
To change to radian mode, press **SHIFT** **MENU** (SET UP) **2** (Angle Unit) **2** (Radian).

$2+5i \blacktriangleright r\angle\theta$

$\sqrt{29} \angle 68.19859051$

$2\angle 330 \blacktriangleright a+bi$

$\sqrt{3}-i$

$2\angle 330$

$\sqrt{3}-i$

$2\angle \frac{11}{6}\pi \blacktriangleright a+bi$

$\sqrt{3}-i$

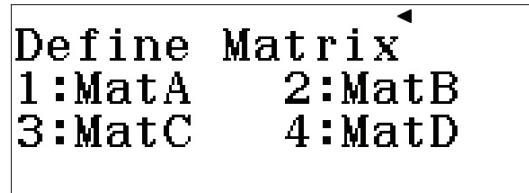
MATRIX

Operations with matrices and matrix related calculations are all located in the Matrix Menu.

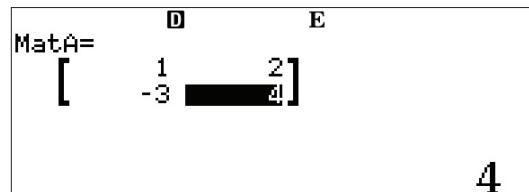
From the Main Menu, use the arrow keys to highlight the Matrix icon and press **E** or press **4**.



To enter matrices, first, define the matrix.



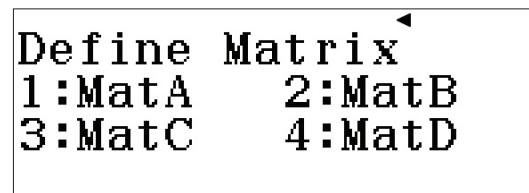
Press **1** (MatA) **2** (Rows) **2** (Columns)
1 **E** **2** **E** **(** **3** **E** **4** **E**.



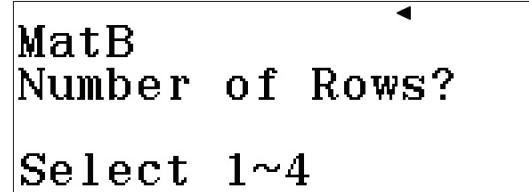
To enter a second matrix, press **OPTN**.



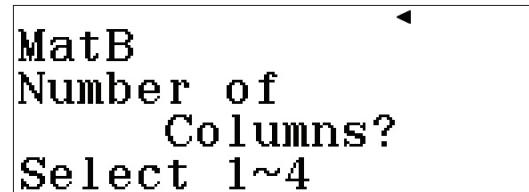
From the resulting popup window, press **1** (Define Matrix) **2** (MatB).



Select the number of rows, **2** (Rows).



Select the number of columns, **2** (Columns).



MATRIX

Enter the matrix values by pressing
3 $\boxed{=}$ $\boxed{-}$ **6** $\boxed{=}$ **8** $\boxed{=}$ **2** $\boxed{=}$.

MatB=
$$\begin{bmatrix} \textcolor{blue}{4} \\ 3 & -6 \\ 8 & \textcolor{red}{2} \end{bmatrix}$$

2

To perform matrix calculations, like addition, subtraction, and multiplication, follow these simple commands.

To enter Matrix calculation, press **AC**.

To recall the name of a matrix, press **OPTN**.

To add A + B, press **3** (MatA) **+** **OPTN** **4** (MatB) $\boxed{=}$.

1:Define Matrix
2>Edit Matrix
3:MatA 4:MatB
5:MatC 6:MatD

MatA+MatB

The solution matrix is displayed in the window and can be viewed without scrolling.

MatAns=
$$\begin{bmatrix} \textcolor{blue}{4} & \textcolor{red}{E} \\ \frac{4}{5} & -4 \end{bmatrix}$$

4

To calculate the determinant of the matrix, press **OPTN** **▼** **2** (Determinant) **OPTN** **3** (MatA) **D** $\boxed{=}$.

1:MatAns
2:Determinant
3:Transposition
4:Identity

Det(MatA)

10

Matrices can be used to solve a system of equations.

Take the following equation with 3 unknowns:

$$\begin{cases} x + y = 3 \\ -x + 3y + 4z = -3 \\ 4y + 3z = 2 \end{cases}$$

Enter the coefficient matrix as Matrix A and the solution matrix as Matrix B.

MATRIX

Redefine the matrices by pressing **OPTN** **1** (Define Matrix).

Press **1** (MatA) to define Matrix A and enter the 3 x 3 coefficient matrix.

Select the number of rows, **3** (Rows).

Select the number of columns, **3** (Columns).

Enter the values of the coefficients, pressing **=** after each one to move to the next value.

Now, enter the 3 x 1 solution matrix as Matrix B.

Press **OPTN** **1** (Define Matrix).

Define Matrix B **2** (MatB) as a 3 x 1, so select **3** (Rows) and **1** (Columns) from the next two windows.

1:Define Matrix
2>Edit Matrix
3:MatA 4:MatB
5:MatC 6:MatD

Define Matrix
1:MatA 2:MatB
3:MatC 4:MatD

MatA
Number of Rows?
Select 1~4

MatA
Number of Columns?
Select 1~4

MatA= [1 -1 0] [1 3 4] [0 4]

3

1:Define Matrix
2>Edit Matrix
3:Matrix Calc

Define Matrix
1:MatA 2:MatB
3:MatC 4:MatD

MATRIX

Enter the values of the coefficients, pressing **[** after each one to move to the next value.

MatB= **[** **]**
[**3**]
[-3]
[**2**]

2

Press **[AC]** to return to the Matrix Calculation screen.

[

Matrix

The solution can be found by calculating $A^{-1} \times B$.

Press **[OPTN]** **3** (MatA) **[x]** **[X]** **[OPTN]** **4** (MatB) **[** **]**.

MatA⁻¹ **[** MatB **]**

1

The solution represents the following:

$$\begin{cases} x = 1 \\ y = 2 \\ z = -2 \end{cases}$$

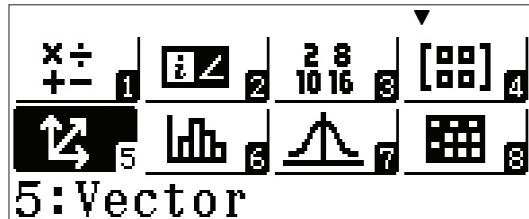
MatAns= **[** **]**
[**1**]
[**2**]
[-2]

This same system can also be solved using the Equation icon.

VECTOR

The **fx-991EX** is capable of handling vector calculations with vectors in 2 or 3 dimensions.

From the Main Menu, use the arrow keys to highlight the Vector icon and press **[EX]** or press **[5]**.



Let vectors **u** and **v** be defined in the 3-dimensional plane by the following: $\mathbf{u} = 2\mathbf{i} + 3\mathbf{j} - 2\mathbf{k}$ and $\mathbf{v} = 3\mathbf{i} - 4\mathbf{j} + 5\mathbf{k}$

Define **u** as Vector **A** with dimension 3.

Press **[1]** (VctA) **[3]** (Dimension).

Define Vector
1:VctA 2:VctB
3:VctC 4:VctD

Enter the components of the vector and press **[EX]** after each one to move to the next value.

VctA
Dimension?
Select 2~3

VctA= [2
[3]

-2

Define **v** as Vector **B** with dimension 3.

Press **[OPTN]** **[1]** (Define Vector).

1:Define Vector
2>Edit Vector
3:Vector Calc

Press **[2]** (VctB) **[3]** (Dimension).

VctB
Dimension?
Select 2~3

VECTOR

Enter the components of the vector and press **[EX]** after each one to move to the next value.

VctB= **D**
[3
-4
5]

5

To execute basic vector operations, press **[AC]** to enter Vector calculation.

Recall the names of the vectors and execute the desired operation by pressing **[OPTN]**.

Vector addition, subtraction, and multiplication are all available.

For subtraction, press **[3]** (VctA) **[OPTN]** **[4]** (VctB) **[EX]**.

VctA-VctB **D**

Vector

VctAns= **D**
[-1
7
-7]

-1

For multiplication, press **[OPTN]** **[3]** (VctA) **[OPTN]** **[4]** (VctB) **[EX]**.

VctAns= **R**
[0
-16
-17]

7

The sums of the product of the components of a vector are known as the vector's dot product. So,
 $u \cdot v = (2 * 3) + (3 * -4) + (-2 * 5) = -16$.

Press **[OPTN]** **[3]** (VctA) **[OPTN]** **[2]** (Dot Product) **[OPTN]** **[4]** (VctB) **[EX]**.

VctA • VctB **D**

-16

VECTOR

Even some very complex vector operations like the angle between vectors, which is defined as $\cos^{-1} \frac{\mathbf{u} \cdot \mathbf{v}}{\|\mathbf{u}\| \|\mathbf{v}\|} = \theta$ in which $\|\mathbf{v}\| = \sqrt{2^2 + 3^2 + (-2)^2} = |\mathbf{v}|$ are easily accomplished on the **fx-991EX**.

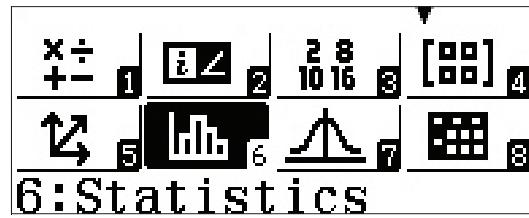
To calculate vector cross product (not vector multiplication),
press **OPTN** **▼** **3** (Angle) **OPTN** **3** (VctA) **SHIFT** **)** (,) **OPTN**
4 (VctB) **)** **=**.

Angle^D(VctA, VctB)
123.2844165

STATISTICS

The **fx-991EX** can calculate several one-variable statistics, and also analyze relationships between two data sets using various regression models.

From the Main Menu, use the arrow keys to highlight the Statistics icon, then press **[EX]** or press **[6]**.



On the resulting menu, select **[1]** for “1-Variable” statistics.

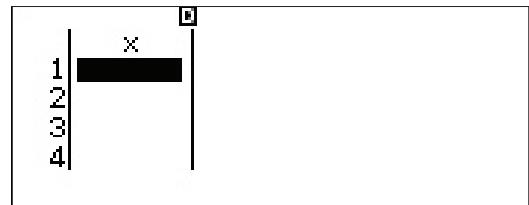
- 1 : 1-Variable**
- 2 : $y=a+bx$**
- 3 : $y=a+bx+cx^2$**
- 4 : $y=a+b \cdot \ln(x)$**

A data entry screen appears.

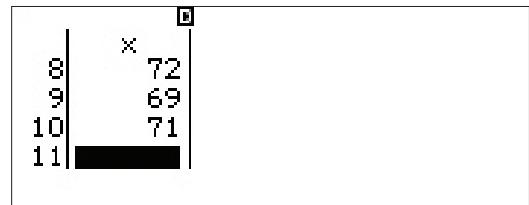
This example uses the following list of some students' heights, given in inches: 70.5, 74, 67, 71, 71, 72, 73.5, 72, 69, 71.

Enter data by typing in each value one at a time, with each followed by the **[EX]** key.

7 **0** **[EX]** **5** **[EX]**, **7** **4** **[EX]**, etc.



To calculate the 1-Variable statistics for this data set, press **[OPTN]** **[3]** (1-Variable Calc).



- 1 : Select Type**
- 2 : Editor**
- 3 : 1-Variable Calc**
- 4 : Statistics Calc**

STATISTICS

13 different 1-variable statistics have been calculated, 6 of which appear on the first screen. Press \blacktriangledown one or more times to reveal additional statistics:

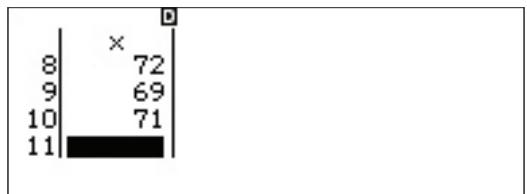
\bar{x} =71.1
 $\sum x$ =711
 $\sum x^2$ =50589.5
 $s^2 x$ =3.74
 $s x$ =1.933907961
 $s^2 x$ =4.155555556

$s x$ =2.03851798
n =10
min(x) =67
 Q_1 =70.5
Med =71
 Q_3 =72

max(x) =74

These statistics have each been stored inside the **fx-991EX** as variables, in case you should wish to use them in further calculations.

Press **[AC]** to return to the data entry screen.



Enter the Option menu by pressing **[OPTN]**.

1:Select Type
2:Editor
3:1-Variable Calc
4:Statistics Calc

Select item **4** (Statistics Calc) to enter the Statistics calculation area.

Statistics
1-Variable

Press **[OPTN]**, and then the down arrow (\blacktriangledown) once to reveal the different categories of statistical variables.

1:Summation
2:Variable
3:Min/Max
4:Norm Dist

For instance, to calculate the interquartile range (IQR), press **[3]** (Min/Max) **[4]** (Q_3) $\boxed{-}$ **[OPTN]** \blacktriangledown **[3]** (Min/Max) **[2]** (Q_1) $\boxed{=}$.

1:min(x) 2: Q_1
3:Med 4: Q_3
5:max(x)

$Q_3 - Q_1$
1.5

STATISTICS

FREQUENCY TABLES

If the data comes from a frequency table, ClassWiz can be set up to input the data values in one column, and the frequencies in another.

To access the set-up menu, press **SHIFT MENU** (SET UP).

1 : Input / Output
2 : Angle Unit
3 : Number Format
4 : Engineer Symbol

Press the down arrow (\blacktriangledown) to reach the second page and **3** to select the Statistics settings.

1 : Fraction Result
2 : Complex
3 : Statistics
4 : Spreadsheet

Press **1** to turn the Frequency option **On**.

Frequency?
1 : On
2 : Off

The Statistics Calculation area appears again. Even though nothing appears to have happened, the setting has indeed changed.

$Q_3 - Q_1$ □
1.5

To access the Data entry area, press **OPTN** **3** (Data).

1 : Select Type
2 : 1-Variable Calc
3 : Data

Notice a second column for frequencies now appears and the previous data set has been erased.

	x	□	Freq	
1	█			
2				
3				
4				

STATISTICS

Enter the same 10 students' height used previously making use of the Frequency column. As each data point is inputted, ClassWiz automatically assigns a default Frequency of 1. Edit a Frequency by using the arrow keys to highlight it, then typing a new Frequency followed by **[EX]**.

Once all of the data points (x) and frequencies (Freq) have been entered, press **OPTN** **3** (1-Variable Calc) again to display the 1-Variable statistics.

	x	Freq
3	67	1
4	71	3
5	72	1
6		

	x	Freq
5	72	2
6	73.5	1
7	69	1
8		

(Notice, the statistics are identical to those previously found.)

\bar{x}	=71.1
$\sum x$	=711
$\sum x^2$	=50589.5
$s^2 x$	=3.74
$s x$	=1.933907961
$s^2 x$	=4.155555556

$s x$	=2.03851798
n	=10
$\min(x)$	=67
Q_1	=70.5
Med	=71
Q_3	=72

$\max(x)$	=74
-----------	-----

REGRESSIONS

To calculate a linear regression, press **OPTN** **OPTN** **1** (Select Type).

- 1 : Select Type
- 2 : Editor
- 3 : 1-Variable Calc
- 4 : Statistics Calc

Select option **2** ($y=a+bx$).

- 1 : 1-Variable
- 2 : $y=a+bx$
- 3 : $y=a+bx+cx^2$
- 4 : $y=a+b \cdot \ln(x)$

A reminder that changing the type of statistics will clear previous data appears.

Press **[EX]** to confirm and Clear memory.

- Clear memory?
- [=] : Yes
- [AC] : Cancel

STATISTICS

Two columns for pairwise data (ordered pairs) now appears.

Note, the Frequency (Freq) column still appears; press

SHIFT MENU (SET UP) ▶ **3** (Statistics) **2** (Off)
to remove it.

Input the ordered pairs (1, 1), (2, 4), (3, 9), and (4, 16). Use the arrow keys to navigate to the "y" column as necessary.

	x	y	Freq
1			
2			
3			
4			

	x	y	Freq
2	2	4	
3	3	9	
4	4	16	
5			

To view 2-Variable statistics or the linear regression results, press **OPTN** **3**.

- 1**:Select Type
- 2**:Editor
- 3**:2-Variable Calc
- 4**:Regression Calc

The 2-Variable statistics display calculation results for both x and y:

\bar{x}	=2.5
$\sum x$	=10
$\sum x^2$	=30
s^2x	=1.25
sx	=1.118033989
s^2x	=1.666666667

sx	=1.290994449
n	=4
\bar{y}	=7.5
$\sum y$	=30
$\sum y^2$	=354
s^2y	=32.25

\bar{y}	=5.678908346
s^2y	=43
sy	=6.557438524
$\sum xy$	=100
$\sum x^3$	=100
$\sum x^2y$	=354

$\sum x^4$	=354
$\min(x)$	=1
$\max(x)$	=4
$\min(y)$	=1
$\max(y)$	=16

Press **AC** **OPTN** **4** (Regression Calc) to display the linear regression results.

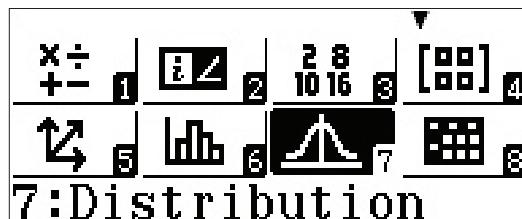
$y=a+bx$	
a	=-5
b	=5
r	=0.9843740387

Other regressions, including quadratic, logarithmic, exponential, and geometric, can be accessed via **OPTN** **1** (Select Type).

DISTRIBUTION

The **fx-991EX** can quickly generate probability distribution tables, covering the Normal, Inverse Normal, Binomial, and Poisson distributions.

From the Main Menu, use the arrow keys to highlight the Distribution icon, then press **[EX]** or press **7**.



Several distribution choices appear. Use **▼** to access the second page.

1:Normal PD
2:Normal CD
3:Inverse Normal
4:Binomial PD

1:Binomial CD
2:Poisson PD
3:Poisson CD

Select **1** (Binomial CD) from the second page to analyze the following Binomial Distribution problem: "A fair 6-sided die is rolled six times. Find P(6 comes up at least twice)."

To enter the values of x (number of successes), N (number of trials), and p (probability of success), press **2** (Variable). Input the values as shown, using **[F3]** to create the fraction separator.

1>List
2:Variable

Binomial CD
X :1
N :6
p :1**[F3]****6**

After pressing **[EX]** to input the value of p , ClassWiz automatically converts the fraction into a decimal for its own purposes.

Press **[EX]** again to calculate the probability.

Binomial CD
X :1
N :6
p :0.1666

DISTRIBUTION

A probability of 73.7% is displayed.

Because $x = 1$ was entered, the calculator calculated $P(\leq 1 \text{ six is rolled})$. This provides a great opportunity to use the **complement** of an event: $P = 1 - 0.737 = 0.263 = 26.3\%$.

To display the probabilities of obtaining *any* number of sixes in 6 rolls, press [OPTN] 1 (Select Type).

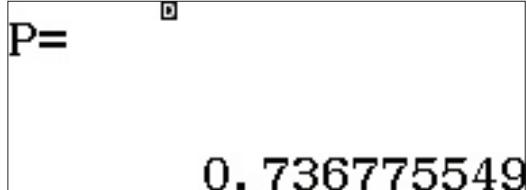
This time, choose 4 (Binomial PD).

Because the calculation is for probabilities for several different numbers of successes, select 1 (List).

Enter the values 0, 1, 2, 3, 4, 5, and 6 into the "x" column (which represents number of successes). Press [EXE] after each input.

Once the final value has been entered, press [EXE] again to end the data entry process.

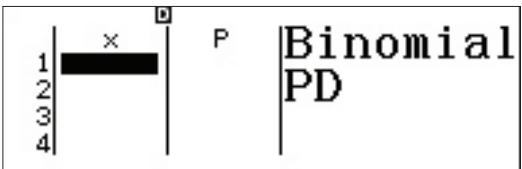
Notice, the values of N and p are preserved from the cumulative probability calculation. (N and p are global calculator variables.)

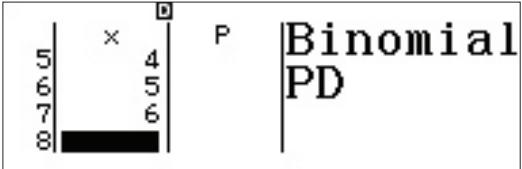
P= 
0.736775549

1 : Select Type

1 : Normal PD
2 : Normal CD
3 : Inverse Normal
4 : Binomial PD

1 : List
2 : Variable


Binomial
PD


Binomial
PD

Binomial PD
N : 6
p : 0.1666

DISTRIBUTION

Press **[EXE]** one more time to calculate the probability distribution table.

	x	P	Binomial
1	0	0.3348	PD
2	1	0.4018	
3	2	0.2009	
4	3	0.0535	
			0

Notice how the small probabilities are expressed in proper scientific notation!

	x	P	Binomial
5	4	8×10 ⁻³	PD
6	5	6.4×10 ⁻⁴	
7	6	2.1×10 ⁻⁵	
8			

INVERSE NORMAL

To calculate an Inverse Normal Distribution, press **[OPTN]** **[1]** (Select Type).

("Editor" edits the previous PD's data list.)

Select **[3]** (Inverse Normal).

Input the values as shown to answer the question: "If the heights of U.S. males are normally distributed with a mean of 70 inches and a standard deviation of 4 inches, what range defines the tallest 10% of U.S. males?"

Press **[EXE]** once more to reveal the result. To be in the top 10% of U.S. males by height, a man must be over 75 inches (6'3") tall.

1:Select Type
2:Editor

1:Normal PD
2:Normal CD
3:Inverse Normal
4:Binomial PD

Inverse Normal
Area :0.9
 σ :4
 μ :70

xInv=

75.12620655

SPREADSHEET

The Spreadsheet mode is useful for studying the statistics of data that require more than two lists. It also supports recursive formulas, sequences, and series.

From the Main Menu, use the arrow keys to highlight the Spreadsheet icon, then press **[EX]** or press **8**.



The ClassWiz spreadsheet looks and acts similarly to many popular software spreadsheet applications.

	A	B	C	D
1				
2				
3				
4				

Investigate the mass of different common sizes of laundry detergent bottles, when the average density of liquid laundry detergent is 0.885 g/mL. Type **0** **•** **8** **8** **5** **[EX]** in cell **A1**.

Use the arrow keys to move over to cell **B1**, and input **4** **0** **[EX]** to represent a 40 fl oz. (1 fl oz. = 29.5735 mL) bottle of laundry detergent.

	A	B	C	D
1				
2				
3				
4				

Move to cell **C1**, and press **[ALPHA] [CALC] (=)** to create an equals sign. Like in other spreadsheet programs, this is the first step necessary when entering a formula.

	A	B	C	D
1	0.885	40		
2				
3				
4				

To "grab" the value within a cell, press **[OPTN] [2]** (Grab).

	A	B	C	D
1	0.885	40		
2				
3				
4				

1 :\$
2 :Grab

SPREADSHEET

Navigate to cell **B1**, and press **=** (Set) to **Grab** the value in that cell.

	A	B	C	D
1	0.885	40		
2				
3				
4				

Set : [=]

This places a reference to cell **B1** within the formula.

	A	B	C	D
1	0.885	40		
2				
3				
4				

=B1|

To create a conversion from fluid ounces (fl oz.) to milliliters (mL), type **X 2 9 • 5 7 3 5 =**.

	A	B	C	D
1	0.885	40		
2				
3				
4				

=B1×29. 5735|

The formula has correctly calculated that a 40 fl oz. bottle of laundry detergent has a volume of 1182.9 mL.

Formulas can also be typed directly, without using the **Grab** command.

Navigate to cell **D1** and input **[ALPHA] [CALC] (=)**
[ALPHA] [(-)] (A) 1 X [ALPHA] [x] (C) 1 =.

A 40 fl oz. (1182.9 mL) bottle of laundry detergent has a mass of 1046.9 grams.

	A	B	C	D
1	0.885	40	1182.9	
2				
3				
4				

	A	B	C	D
1	0.885	40	1182.9	
2				
3				
4				

=A1×C1|

	A	B	C	D
1	0.885	40	1182.9	1046.9
2				
3				
4				

Now, let's use the power of relational formulas to check some other bottle sizes:

To populate many different cells with the same value, press **[OPTN] [2]** (Fill Value).

- 1 :Fill Formula
- 2 :Fill Value
- 3 :Edit Cell
- 4 :Free Space

SPREADSHEET

Input the density of laundry detergent as the **Value** and **A2:A6** as the cell **Range**. Press **ALPHA** **(** (A) **2** **ALPHA** **)** (:) **ALPHA** **(** (A) **6** **=** **=**.

Column **A** is now filled with the density value.

Next populate column **B** with additional bottle sizes.

Navigate to cell **B2**, and input the value 75 by pressing **7** **5** **=**.

To populate many different cells with the same formula, press **OPTN** **1** (Fill Formula).

Input the formula **ALPHA** **„„** (B) **2** **+** **2** **5** **=**.

Notice, the cell **Range** is pre-populated with the currently highlighted cell (**B3**).

Use the right arrow to edit only the end cell by pressing **▷** **▷** **▷** **▷** **▷** **▷** **DEL** **6** **=** **=**.

Scroll down to cell **B6** to make sure that the formula has been adjusted relative to each cell's position, so that cells **B2** to **B6** now display bottle sizes from 75 to 175 fl oz. (1 fl oz. = 29.5735 mL).

Fill Value
Value :0.885
Range :A2:A6

	A	B	C	D
1	0.885	40	1182.9	1046.9
2	0.885	75		
3	0.885			
4	0.885			

	A	B	C	D
1	0.885	40	1182.9	1046.9
2	0.885	75		
3	0.885			
4	0.885			

1:Fill Formula
2:Fill Value
3>Edit Cell
4:Free Space

Fill Formula
Form =B2+25
Range :B3:B3

Fill Formula
Form =B2+25
Range :B3:B6

	A	B	C	D
3	0.885	100		
4	0.885	125		
5	0.885	150		
6	0.885	175		

=B5+25

SPREADSHEET

Navigate to cell **C1**, which still displays the formula used to convert fluid ounces to milliliters.

	A	B	C	D
1	0.885	40	1182.9	1046.9
2	0.885	75		
3	0.885	100		
4	0.885	125		

=B1×29. 5735

The ClassWiz has a “copy and paste” option that can be used instead of retyping the same formula repeatedly.

Press **OPTN** **▼** **2** (Copy & Paste).

The formula from the currently highlighted cell (**C1**) has now been copied.

Scroll down one cell at a time (**▼** **≡**) to **Paste** this formula into cells **C2** through **C6**.

Column **C** now contains the volumes, in milliliters, of the different sizes of laundry detergent bottles.

To exit **Copy & Paste** mode, press **AC**.

- 1 :Cut & Paste
- 2 :Copy & Paste
- 3 :Delete All
- 4 :Recalculate

	A	B	C	D
1	0.885	40	1182.9	1046.9
2	0.885	75		
3	0.885	100		
4	0.885	125		

Paste : [=]

	A	B	C	D
3	0.885	100	2957.3	
4	0.885	125	3696.6	
5	0.885	150	4436	
6	0.885	175	5175.3	

Paste : [=]

Time to practice! Use the same technique to **Copy & Paste** the mass calculation formula from cell **D1** into cells **D2** through **D6**.

If done correctly, Column **D** should show masses (in grams) as shown.

So, for example, a 175 fl oz. (5175.3 mL) bottle of laundry detergent has a mass of about 4.5 kg.

A decent amount of data has been entered now. To check how much free space remains in ClassWiz’s memory, press **OPTN** **4** (Free Space).

	A	B	C	D
1	0.885	40	1182.9	1046.9
2	0.885	75	2218	
3	0.885	100	2957.3	
4	0.885	125	3696.6	

=A1×C1

	A	B	C	D
3	0.885	100	2957.3	2617.2
4	0.885	125	3696.6	3271.5
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1

=A6×C6

- 1 :Fill Formula
- 2 :Fill Value
- 3 :Edit Cell
- 4 :Free Space

SPREADSHEET

1318 Bytes of memory remain as free space.

Numerical values require 10 Bytes each, while formulas require 17+ Bytes each.

Determine the average capacity of the different bottles of laundry detergent.

Navigate to cell **B7**, and press **OPTN**.

Scroll down three pages (**▼** **▼** **▼**), and select **3** (Mean).

Type in the cell range of the average **ALPHA** **„„** **(B)** **1** **ALPHA** **f** **(:** **ALPHA** **„„** **(B)** **6** **)** **=**.

The average capacity is 110.83 fluid ounces.

If one of each of these bottles was purchased, what is the total weight of laundry detergent purchased that would be placed in a car?

Navigate to cell **D7**, and press **OPTN**.

Return again to the summary statistics calculation screen (**▼** **▼** **▼**) and select **4** (Sum).

1318 Bytes Free

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7				
8				

1 :Min
2 :Max
3 :Mean
4 :Sum

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7				
8				

Mean(B1:B6)

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		
8				

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		
8				

1 :Min
2 :Max
3 :Mean
4 :Sum

SPREADSHEET

Use the **Grab** command rather than typing the locations of the cells in the cell range.

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		
8				

Sum(D)

Press **OPTN** **2** (Grab).

1:\$
2:Grab

Scroll up to cell **D1**, and **Set** it as the object to be Grabbed by pressing **=**.

	A	B	C	D
1	0.885	40	1182.9	1046.9
2	0.885	75	2218	1962.9
3	0.885	100	2957.3	2617.2
4	0.885	125	3696.6	3271.5

Set :[=]

Use **ALPHA** **COLON** (:) to type a colon.

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		
8				

Sum(D1 :)

Grab cell **D6** as the ending cell in the cell range by pressing **OPTN** **2** **◆** **=**.

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		
8				

Set :[=]

Close the parentheses (D), and press **=** to calculate the sum of the masses in cells **D1** through **D6**.

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		
8				

Sum(D1:D6)=

The bottles would have a total mass of 17404 grams, or about 17.4 kilograms.

But this is a mass, not a weight!

	A	B	C	D
5	0.885	150	4436	3925.8
6	0.885	175	5175.3	4580.1
7		110.83		17404
8				

SPREADSHEET

This is one example of the powerful ways in which various features of the **fx-991EX** can be combined.

Begin entering the formula as shown into cell **D8** by pressing **[ALPHA] [CALC] (=) [ALPHA] [sin] (D) [7]**.

Press **[SHIFT] [8]** (CONV) to access the Conversion menu.

Select **4** (Mass).

Choose mass conversion **4** (kg►lb).

This will convert the mass from cell **D7**, which is currently in kilograms, into pounds.

Press **[EX]**, and Voila!

Even ClassWiz's powerful Conversion feature can be used within the Spreadsheet module. But wait... 38 thousand pounds?!

17404 grams needs to be converted into kilograms.

With cell **D8** highlighted, press **[OPTN] [3]** (Edit Cell).

A cursor appears in the previously entered formula, allowing it to be edited.

D			
A	B	C	D
5 0.885	150	4436	3925.8
6 0.885	175	5175.3	4580.1
7	110.83		17404
8			=D7

1 :Length
2 :Area
3 :Volume
4 :Mass

1:oz►g
3:lb►kg
2:g►oz
4:kg►lb

D			
A	B	C	D
5 0.885	150	4436	3925.8
6 0.885	175	5175.3	4580.1
7	110.83		17404
8			=D7kg►lb

D			
A	B	C	D
6 0.885	175	5175.3	4580.1
7	110.83		17404
8			38370
9			=D7kg►lb

1 :Fill Formula
2 :Fill Value
3 :Edit Cell
4 :Free Space

D			
A	B	C	D
6 0.885	175	5175.3	4580.1
7	110.83		17404
8			38370
9			=D7kg►lb

SPREADSHEET

Use the right arrow key (▶) to move within the formula, inserting parentheses and a factor-of-1000 adjustment as shown. Press ▶ ⌂ ▶ ▶ ▷ ÷ 1 0 0 0 ▷ =.

Phew! That's better. The car is no longer carrying 19+ tons of laundry detergent home. The actual total weight is a much more reasonable 38 pounds.

	A	B	C	D
6	0.885	175	5175.3	4580.1
7		110.83		17404
8				38370
9				

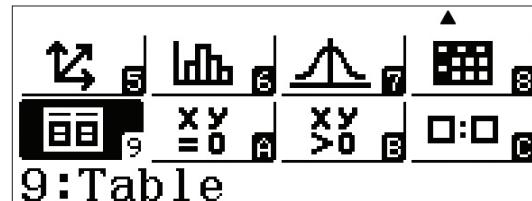
= (D7 ÷ 1000) kg ► lb

	A	B	C	D
6	0.885	175	5175.3	4580.1
7		110.83		17404
8				38.37
9				

TABLE

The Table feature on the **fx-991EX** is a powerful way to solve a single function or two functions simultaneously. The table range and step is easily customizable.

From the Main Menu, use the arrow keys to highlight the Table icon and press **EX** or press **9**.



To change the setup of the table to generate a table with only one function, press **SHIFT MENU** (SET UP).

$$f(x) =$$

Use the down arrow key to view the menu option for Table; it will be the 3rd screen.

Press **2** (Table) to choose the number of functions used in the table.

- 1 : Equation/Func
- 2 : Table
- 3 : Decimal Mark
- 4 : Digit Separator

Press **1** ($f(x)$) to generate a table with only one function as an input.

- 1 : $f(x)$
- 2 : $f(x), g(x)$

Consider the classic volume of a box problem. What is the maximum volume of a box made from a 20x15 sheet of cardboard by removing squares from each corner?

The function that represents the volume of the box is $f(x) = x(20-x)(15-x)$.

$$f(x) = x(20-x)(15-x)$$

To enter this function, press **x** **(** **2** **0** **-** **x** **)** **(** **1** **5** **-** **x** **)** **EX**.

$$f(x) = (20-x)(15-x)$$

TABLE

To set the range from 1 to 7 and the step at 1, press **1** **EQ** **7** **EQ** **1** **EQ**.

Table Range
Start :1
End :7
Step :1

Press **EXE** to view the table.

Use the arrow keys to scroll through the values.

	\sqrt{x}	$f(x)$
1	1	266
2	2	468
3	3	612
4	4	704

1

The maximum value appears to be between 5 and 6.

	\sqrt{x}	$f(x)$
4	4	704
5	5	750
6	6	756
7	7	728

7

To refine the search, enter a new value in any place in the table.

	\sqrt{x}	$f(x)$
7	7	728
8	6.5	745.87
9	5.5	757.62
10		

For example, at line 8, press **6** **•** **5** **EQ**.

To enter a value one-step greater than the previous value, press **+**.

	\sqrt{x}	$f(x)$
8	6.5	745.87
9	5.5	757.62
10	6.5	745.87
11	7.5	703.12

6.5

To enter a value one-step less than the previous value, press **-**.

To change the step value or change the start and end values of the table, press **AC** **EQ**.

Enter the new values and press **EXE** to view the table.

Use the arrow keys to scroll to the value that gives the maximum volume.

Table Range
Start :5.1
End :6.5
Step :0.1

	\sqrt{x}	$f(x)$
1	5.1	752.3
2	5.2	754.2
3	5.3	755.72
4	5.4	756.86

5.1

TABLE

The maximum volume calculated to one decimal place appears at 5.7 inches.

	\sqrt{x}	D
x	f(x)	
5	5.5	757.62
6	5.6	758.01
7	5.7	758.04
8	5.8	757.71

5.8

Consider the following two functions

$$\begin{cases} f(x) = x^3 - 7x + 6 \\ g(x) = x^2 - 3x + 2 \end{cases}$$

Find the roots of the equations and points of intersection, as well as the end behavior of each function.

Press **SHIFT MENU** (SET UP) and use the down arrow key to view the menu option for Table. Press **2** (Table) to choose the number of functions used in the table.

Press **2** (f(x),g(x)) to generate a table with two function as inputs.

Enter the first function as f(x) by pressing **x** **x³** **3** **▶** **-** **7** **x** **+** **6** **=**.

If there is already a function present, press **AC** to clear the previous function.

Enter the second function as g(x) by pressing **x** **x²** **-** **3** **x** **+** **2** **=**.

Create a table that has a domain of -5 to 5 with step of 1.

1 :Equation/Func
2 :Table
3 :Decimal Mark
4 :Digit Separator

1 :f(x)
2 :f(x), g(x)

$f(x) = x^3 - 7x + 6$

$g(x) = x^2 - 3x + 2$

Table Range
Start : -5
End : 5
Step : 1

TABLE

Press **[TABLE]** to view the table.

Based on the information from the table, it appears $f(x)$ goes to negative infinity to the left and $g(x)$ goes to positive infinity to the left.

There appears to be roots of 1 and 2 for both functions.
To determine the behavior between roots, type in a number
between 1 and 2, like 1.5.

	$\sqrt{6}$ [D] x	$f(x)$	$g(x)$
1	-5	-84	42
2	-4	-30	30
3	-3	0	20
4	-2	12	12

-5

	$\sqrt{6}$ [D] x	$f(x)$	$g(x)$
7	1	0	0
8	2	0	0
9	1.5	-1.125	-0.25
10	4	42	6

4

The right end behavior for both functions appears to be increasing towards positive infinity.

EQUATION/FUNC

The **fx-991EX** numerically solves equations elegantly. It is accomplished with the help of the Natural Textbook Display™ in the Equation/Func mode. The Equation/Func mode uses Newton's method to find solutions to equations. The **fx-991EX** has the power to handle Simultaneous Equations with up to 4 unknowns and Polynomial Equations up to the 4th degree.

SIMULTANEOUS EQUATIONS

From the Main Menu, use the arrow keys to highlight the Equation/Func icon and press **EXE** or press **(A)**.



To solve the following system of simultaneous equations

$$\begin{cases} 2x + y = 5 \\ -4x + 6y = 12 \end{cases}$$

select **1** (Simul Equation).

Choose the number of Unknowns. For this example, press **2** (Unknowns).

1:Simul Equation
2:Polynomial

Simul Equation
Number of
Unknowns?
Select 2~4

A 2x2 system of equations template is displayed. The template is in Ax + BY = C form in which A, B and C can be any value. For fractional values, use the **EX** key.

✓EX □
{
0x + 0y = 0
0x + 0y = 0
0

Type in each value followed by the **EX** key.

✓EX □
{-
2x + 1y = 5
4x + 6y = 12
12

Press **2 EX 1 EX**, etc.

EQUATION/FUNC

To solve, press **[SOLV]** and use the arrow keys (**▼** **▲**) to toggle between solutions.

The screen shows the equation $x =$ followed by the fraction $\frac{9}{8}$.

The solutions are shown in natural display format. For decimal approximations, press **[S+D]**.

The screen shows the equation $y =$ followed by the fraction $\frac{11}{4}$.

To change the values in the system of equations without changing the type of equation or system, press **[AC]**.

The screen shows a system of equations in matrix form:
$$\begin{cases} 2x + & 1y = & 5 \\ 4x + & 6y = & 12 \end{cases}$$

To change the type of equation or system size, press **[OPTN]** and select from the on-screen menus.

1:Simul Equation
2:Polynomial

Simul Equation
Number of
Unknowns?
Select 2~4

1:Simul Equation
0x + 0y = 0
0x + 0y = 0

The **fx-991EX** also solves inconsistent systems, both independent and dependent. Enter the displayed inconsistent and independent system

The screen shows a system of equations in matrix form:
$$\begin{cases} 2x + & 3y = & 6 \\ 2x + & 3y = & 5 \end{cases}$$

Press **[SOLV]** to see the solution.

No Solution

EQUATION/FUNC

Enter the displayed inconsistent dependent system.

$$\left\{ \begin{array}{l} \sqrt{2}x = 6 \\ 2x + 3y = 6 \\ 4x + 6y = 12 \end{array} \right.$$

12

Press **[EXE]** to see the solution.

[EXE]

Infinite Solution

To input a larger system of simultaneous equation

$$\begin{cases} 1x + 1y + 1z = 9 \\ 3x + 2y - 1z = 8 \\ 3x + 1y + 2z = 1 \end{cases}$$

press **OPTN** **1** (Simul Equation) **3** (Unknowns).

Enter the coefficients for each equation and press **[EXE]** to solve.

$$\begin{array}{rcl} \sqrt{2}x & = & 9 \\ + & 1y & + 1z = 9 \\ + & 2y & - 1z = 8 \\ + & 1y & + 2z = 1 \end{array}$$

1

x =
$$-\frac{34}{7}$$

y =
$$\frac{85}{7}$$

z =
$$\frac{12}{7}$$

POLYNOMIAL EQUATIONS

The **fx-991EX** has the computing power to solve polynomial equations up to 4th degree.

To start solving polynomial equations, in the Equation/Func icon, press **OPTN** **2** (Polynomial).

Select the degree of the polynomial. For this example, use a 3rd degree polynomial. Press **3** (Degree).

Fill out the template for a 3rd degree polynomial. Type in each coefficient followed by the **=** key.

$$x^3 + 4x^2 + x - 6 = 0$$

Press **=** to solve the equation.

Use the arrow keys (**▲** **▼**) to toggle through the solutions.

1:Simul Equation |
2:Polynomial

**Polynomial
Degree?**

Select 2~4

$\frac{\sqrt{b^2 - 4ac}}{2a} \cdot x^3 + \frac{-b}{3a} \cdot x^2 + \frac{2c}{9a} \cdot x + \frac{-d}{9a}$

ax^3+bx^2+cx+d *i*
 █ █ █ █ x^3+ $0x^2+$ $0x$
 + 0

0

$\frac{\sqrt{b^2 - 4ac}}{2a} \cdot x^3 + \frac{-b}{3a} \cdot x^2 + \frac{2c}{9a} \cdot x + \frac{-d}{9a}$

ax^3+bx^2+cx+d *i*
 █ █ █ █ x^3+ $4x^2+$ $1x$
 - █ █ d
 - 6

$ax^3+bx^2+cx+d=0$
x₁ =

1

$ax^3+bx^2+cx+d=0$
x₂ =

-2

$ax^3+bx^2+cx+d=0$
x₃ =

-3

EQUATION/FUNC

The fx-991EX has the power to solve polynomials in the complex plane.

Press [OPTN] and change the type of polynomial to quadratic ([2]).

Enter the coefficients that appear in the displayed screen into the quadratic template, and press [=].

Polynomial
Degree?

Select 2~4

$$ax^2+bx+c = 0$$

$$1x^2 + 2x + 3$$

1

The solutions are displayed in simplified radical form including the imaginary unit.

$$ax^2+bx+c=0$$

$$x_1 =$$

$$-1+\sqrt{2}i$$

Press [▼] to see the second imaginary solution.

$$ax^2+bx+c=0$$

$$x_2 =$$

$$-1-\sqrt{2}i$$

INEQUALITY

Solving polynomial inequalities has never been easier.

From the Main Menu, use the arrow keys to highlight the Inequality icon and press **=** or press **„ „** (B).



Enter the degree of the polynomial inequality, in this case, **3** (Degree).

Polynomial
Degree?

Select 2~4

Choose the form of the inequality. Press **2** ($ax^3 + bx^2 + cx + d < 0$).

- 1 : $ax^3 + bx^2 + cx + d > 0$
- 2 : $ax^3 + bx^2 + cx + d < 0$
- 3 : $ax^3 + bx^2 + cx + d \geq 0$
- 4 : $ax^3 + bx^2 + cx + d \leq 0$

Enter the coefficients of the polynomial, as shown.

Press **1 = 4 = 1 = 6 =**.

$$\begin{aligned} &\sqrt{a} \boxed{0} \\ &ax^3 + bx^2 + cx + d < 0 \\ &1x^3 + &4x^2 + &1x \\ &- 6 &< 0 \\ &- 6 \end{aligned}$$

Press **=** to see the solutions.

$$\begin{aligned} &x < a, \sqrt{b} \boxed{0} \\ &x < -3, -2 < x < 1 \end{aligned}$$

If the solution runs off the screen, use the left and right (**◀ ▶**) arrow keys to see the entire solution.

NOTES

NOTES



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