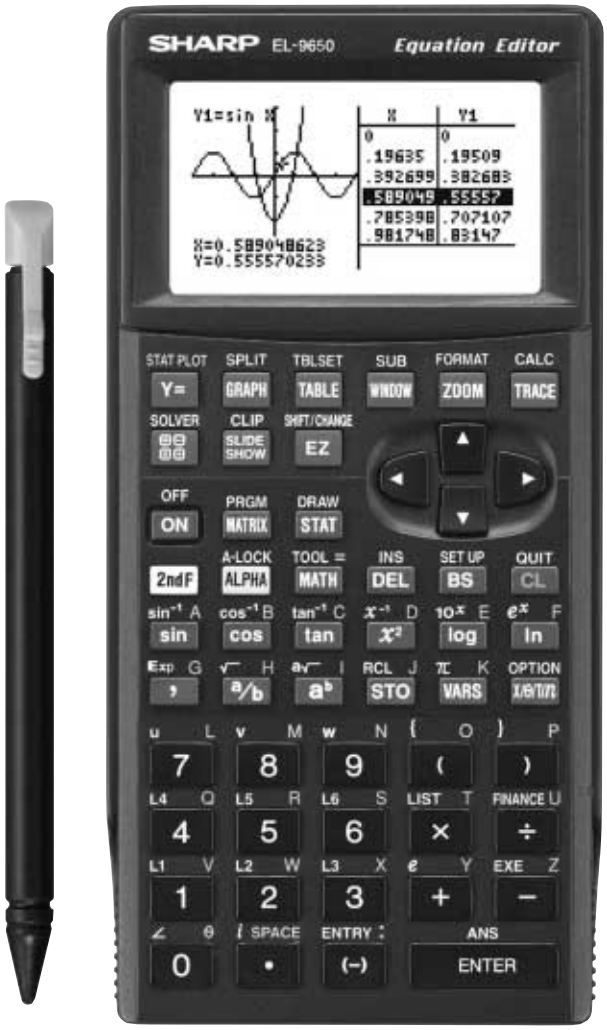
SHARP

Graphing Calculator

EL-9650/9600c/9450/9400

Handbook Vol. 1

Algebra



EL-9650

EL-9450

Contents

Read this first

1. Always read "Before Starting"

The key operations of the set up condition are written in "Before Starting" in each section. It is essential to follow the instructions in order to display the screens as they appear in the handbook.

2. Set Up Condition

As key operations for this handbook are conducted from the initial condition, reset all memories to the initial condition beforehand.

[2nd F] [OPTION] [E] [2] [CL]

Note: Since all memories will be deleted, it is advised to use the CE-LK1P PC link kit (sold separately) to back up any programmes not to be erased, or to return the settings to the initial condition (cf. 3. Initial Settings below) and to erase the data of the function to be used.

- To delete a single data, press [2nd F] [OPTION] [C] and select data to be deleted from the menu.
- Other keys to delete data:

[CL] : to erase equations and remove error displays

[2nd F] [QUIT] : to cancel previous function

3. Initial settings

Initial settings are as follows:

☆ Set up	([2nd F] [SET UP]):	Rad, FloatPt, 9, Rect, Decimal(Real), Equation
☆ Format	([2nd F] [FORMAT]):	RectCoord, OFF, OFF, Connect, Sequen
☆ Stat Plot	([2nd F] [STAT PLOT] [E]):	2. PlotOFF
Shade	([2nd F] [DRAW] [G]):	2. INITIAL
Zoom	([ZOOM] [A]):	5. Default
Period	([2nd F] [FINANCE] [C]):	1. PmtEnd

Note: ☆ returns to the default setting in the following operation.

([2nd F] [OPTION] [E] [1] [ENTER])

4. Using the keys

Press [2nd F] to use secondary functions (in yellow).

To select "$\sin^{-1}$": [2nd F] [sin] → Displayed as follows: [2nd F] [$\sin^{-1}$]

Press [ALPHA] to use the alphabet keys (in blue).

To select A: [ALPHA] [sin] → Displayed as follows: [ALPHA] [A]

5. Notes

- Some features are provided only on the EL-9650/9600c and not on the EL-9450/9400. (Substitution, Solver, Matrix, Tool etc.)
- As this handbook is only an example of how to use the EL-9650/9600c and 9450/9400, please refer to the manual for further details.

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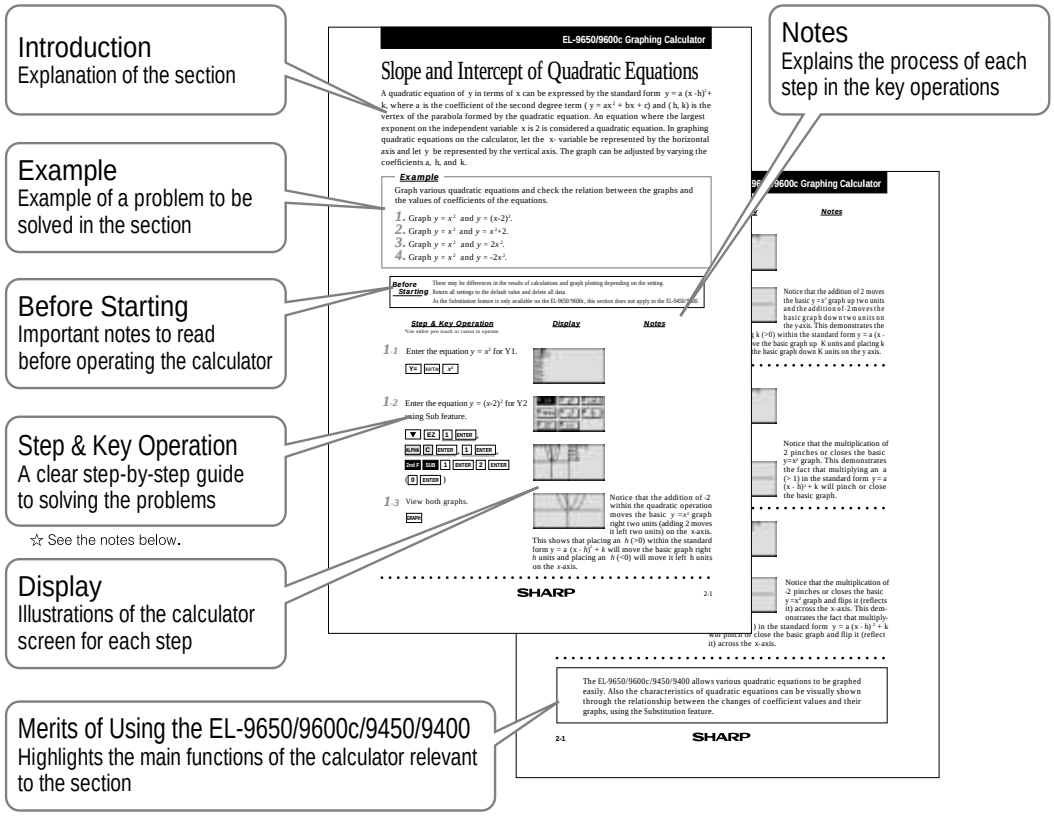
Using this Handbook

This handbook was produced for practical application of the SHARP EL-9650/9600c and EL-9450/9400 Graphing Calculator based on exercise examples received from teachers actively engaged in teaching. It can be used with minimal preparation in a variety of situations such as classroom presentations, and also as a self-study reference book.



- When you see the sign $_*$ on the key:
  $_*$ means same series of key strokes can be done with screen touch on the EL-9650/9600c.
  ($\square_*$: for the corresponding key; $\underline{\square\ \square\ \square}_*$: for the corresponding keys underlined.)

  Key operations may also be carried out with the cursor (not shown).
- Different key appearance for the EL-9450/9400: for example [x/θ/T/n] → [X/T]

We would like to express our deepest gratitude to all the teachers whose cooperation we received in editing this book. We aim to produce a handbook which is more replete and useful to everyone, so any comments or ideas on exercises will be welcomed.

(Use the attached blank sheet to create and contribute your own mathematical problems.)

Thanks to Dr. David P. Lawrence at Southwestern Oklahoma State University for the use of his teaching resource book (Applying Pre-Algebra/Algebra using the SHARP EL-9650/9600c Graphing Calculator).

Other books available:
Graphing Calculator EL-9450/9400 TEACHERS' GUIDE

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Solving Absolute Value Inequalities

To solve an inequality means to find all values that make the inequality true. Absolute value inequalities are of the form $|f(x)| < k$, $|f(x)| \leq k$, $|f(x)| > k$, *or* $|f(x)| \geq k$. The graphical solution to an absolute value inequality is found using the same methods as for normal inequalities. The first method involves rewriting the inequality so that the right-hand side of the inequality is 0 and the left-hand side is a function of x. The second method involves graphing each side of the inequality as an individual function.

Example

Solve absolute value inequalities in two methods.

1. Solve $|20 - \frac{6x}{5}| < 8$ by rewriting the inequality so that the right-hand side of the inequality is zero.

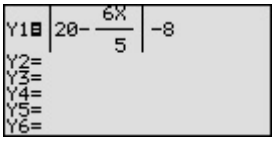
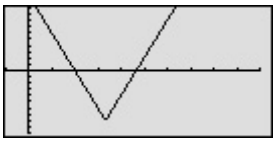
2. Solve $|3.5x + 4| > 10$ by shading the solution region.

Before Starting

There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

Set viewing window to "-5< x <50," and "-10< y <10" using Rapid Window feature to solve Q1.

WINDOW EZ 3 ENTER * 3 ENTER * 3 ENTER *

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***
1-1 Rewrite the equation.		$\|20 - \frac{6x}{5}\| < 8$ $\rightarrow \|20 - \frac{6x}{5}\| - 8 < 0.$
1-2 Enter $y = \|20 - \frac{6x}{5}\| - 8$ for Y1. Y= MATH B * 5 * 2 0 — a/b 6 X/θ/T/n ▶ * 5 ▶ ▶ * — 8		
1-3 View the graph, and find the x-intercepts. GRAPH 2nd F CALC 5 * → $x = 10,\ y = 0$ 2nd F CALC 5 * → $x = 23.33333334$ $y = 0.00000006$ (* Note)		The intersections with the x-axis are (10, 0) and (23.3, 0) (* Note: The value of y in the x-intercepts may not appear exactly as 0 as shown in the example, due to an error caused by approximate calculation.)
1-4 Solve the inequality.		Since the graph is below the x-axis for x in between the two x-intercepts, the solution is $10 < x < 23.3$.

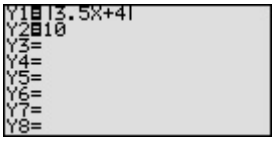
Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***

2-1 Enter the function $y = |3.5x + 4|$ for Y1. Enter $y = 10$ for Y2.

Y= CL MATH B* 1*

3 • 5 X/θ/T/n + 4 ENTER*

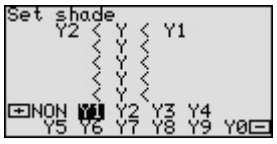
1 0



2-2 Set up shading.

2nd F DRAW G* 1*

— —* ▶* —*

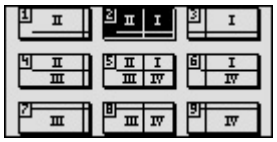


Since the inequality you are solving is Y1 > Y2, the solution is where the graph of Y2 is "on the bottom" and Y1 in "on the top."

2-3 Set viewing window to "$-10 < x < 10$" and "$-5 < y < 50$" using Rapid Window feature and view the graph.

WINDOW EZ 2 ENTER* 5 ENTER*

3 ENTER*

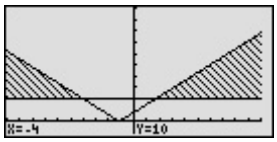


2-4 Find the points of intersection. Solve the inequality.

2nd F CALC 2* → $x = -4$, $y = 10$

2nd F CALC 2* → $x = 1.714285714$

$y = 9.999999999$ (∗ Note)



The intersections are (-4, 10) and (1.7, 10.0). The solution is all values of x such that $x < -4$ or $x > 1.7$.
(∗ Note: The value of y in the intersection of the two graphs may not appear exactly as 10 as shown in the example, due to an error caused by approximate calculation.)

The EL-9650/9600c/9450/9400 shows absolute values with | |, just as written on paper, by using the Equation editor. Graphical solution methods not only offer instructive visualization of the solution process, but they can be applied to inequalities that are often difficult to solve algebraically. The Shade feature is useful to solve the inequality visually and the points of intersection can be obtained easily.

Evaluating Absolute Value Functions

The absolute value of a real number x is defined by the following:

$$|x| = \begin{cases} x & \text{if } x \geq 0 \\ -x & \text{if } x \leq 0 \end{cases}$$

Note that the effect of taking the absolute value of a number is to strip away the minus sign if the number is negative and to leave the number unchanged if it is nonnegative. Thus, $|x| \geq 0$ for all values of x.

Example

Evaluate various absolute value functions.

1. Evaluate $|-2(5-1)|$

2. Is $|-2+7| = |-2| + |7|$?
Evaluate each side of the equation to check your answer.
Is $|x + y| = |x| + |y|$ for all real numbers x and y?
If not, when will $|x + y| = |x| + |y|$?

3. Is $\left|\frac{6-9}{1+3}\right| = \frac{|6-9|}{|1+3|}$?
Evaluate each side of the equation to check your answer. Investigate with more examples, and decide if you think $|x / y| = |x| / |y|$

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

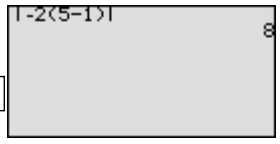
Step & Key Operation	Display	Notes
(When using EL-9650/9600c) *Use either pen touch or cursor to operate.	(When using EL-9650/9600c)	

1-1 Access the home or computation screen.

[⊞]

1-2 Enter $y = |-2(5-1)|$ and evaluate.

[MATH] [B]* [1]* [(-)] [2] [(] [5] [—] [1] [)] [ENTER]



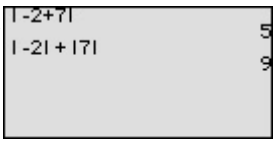
The solution is ±8.

2-1 Evaluate $|-2 + 7|$. Evaluate $|-2| + |7|$.

[CL]

[MATH] [1]* [(-)] [2] [+] [7] [ENTER]

[MATH] [1]* [(-)] [2] [▶] [+] [MATH] [1]* [7] [ENTER]



$|-2 + 7| = 5$, $|-2| + |7| = 9$
→ $|-2 + 7| \neq |-2| + |7|$.

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***

2-2

Is $|x + y| = |x| + |y|$? Think about this problem according to the cases when x or y are positive or negative.

If $x \geq 0$ and $y \geq 0$ [e.g.; $(x, y) = (2,7)$]	$\|x+y\| = \|2 + 7\| = 9$ $\|x\|+\|y\| = \|2\| + \|7\| = 9$	$\rightarrow \|x + y\| = \|x\| + \|y\|$.
If $x \leq 0$ and $y \geq 0$ [e.g.; $(x, y) = (-2, 7)$]	$\|x+y\| = \|-2 + 7\| = 5$ $\|x\|+\|y\| = \|-2\| + \|7\| = 9$	$\rightarrow \|x + y\| \neq \|x\| + \|y\|$.
If $x \geq 0$ and $y \leq 0$ [e.g.; $(x, y) = (2, -7)$]	$\|x+y\| = \|2-7\| = 5$ $\|x\|+\|y\| = \|2\| + \|-7\| = 9$	$\rightarrow \|x + y\| \neq \|x\| + \|y\|$.
If $x \leq 0$ and $y \leq 0$ [e.g.; $(x, y) = (-2, -7)$]	$\|x+y\| = \|-2-7\| = 9$ $\|x\|+\|y\| = \|-2\| + \|-7\| = 9$	$\rightarrow \|x + y\| = \|x\| + \|y\|$.

Therefore $|x+y| = |x|+|y|$ when $x \geq 0$ and $y \geq 0$, and when $x \leq 0$ and $y \leq 0$.

3-1

Evaluate $\left|\frac{6-9}{1+3}\right|$. Evaluate $\frac{|6-9|}{|1+3|}$.

$\left|\frac{6-9}{1+3}\right| = 0.75$, $\frac{|6-9|}{|1+3|} = 0.75$

$\rightarrow \left|\frac{6-9}{1+3}\right| = \frac{|6-9|}{|1+3|}$

[CL] [MATH] [1]* [a/b] [6] [—] [9]

[▶]* [1] [+] [3] [ENTER]

[MATH] [1]* [6] [—] [9] [▶]* [a/b]

[MATH] [1]* [1] [+] [3] [ENTER]

3-2

Is $|x /y| = |x| / |y|$?
Think about this problem according to the cases when x or y are positive or negative.

If $x \geq 0$ and $y \geq 0$ [e.g.; $(x, y) = (2,7)$]	$\|x /y\| = \|2/7\| = 2/7$ $\|x\| / \|y\| = \|2\| / \|7\| = 2/7$	$\rightarrow \|x /y\| = \|x\| / \|y\|$
If $x \leq 0$ and $y \geq 0$ [e.g.; $(x, y) = (-2, 7)$]	$\|x /y\| = \|(-2)/7\| = 2/7$ $\|x\| / \|y\| = \|-2\| / \|7\| = 2/7$	$\rightarrow \|x /y\| = \|x\| / \|y\|$
If $x \geq 0$ and $y \leq 0$ [e.g.; $(x, y) = (2, -7)$]	$\|x /y\| = \|2/(-7)\| = 2/7$ $\|x\| / \|y\| = \|2\| / \|-7\| = 2/7$	$\rightarrow \|x /y\| = \|x\| / \|y\|$
If $x \leq 0$ and $y \leq 0$ [e.g.; $(x, y) = (-2, -7)$]	$\|x /y\| = \|(-2)/-7\| = 2/7$ $\|x\| / \|y\| = \|-2\| / \|-7\| = 2/7$	$\rightarrow \|x /y\| = \|x\| / \|y\|$

The statement is true for all $y \neq 0$.

The EL-9650/9600c/9450/9400 shows absolute values with | |, just as written on paper, by using the Equation editor. The nature of arithmetic of the absolute value can be learned through arithmetical operations of absolute value functions.

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Graphing Rational Functions

A rational function $f(x)$ is defined as the quotient $\frac{p(x)}{q(x)}$ where $p(x)$ and $q(x)$ are two polynomial functions such that $q(x) \neq 0$. The domain of any rational function consists of all values of x such that the denominator $q(x)$ is not zero.

A rational function consists of branches separated by vertical asymptotes, and the values of x that make the denominator $q(x) = 0$ but do not make the numerator $p(x) = 0$ are where the vertical asymptotes occur. It also has horizontal asymptotes, lines of the form $y = k$ (k, a constant) such that the function gets arbitrarily close to, but does not cross, the horizontal asymptote when $|x|$ is large.

The x intercepts of a rational function $f(x)$, if there are any, occur at the x-values that make the numerator $p(x)$, but not the denominator $q(x)$, zero. The y-intercept occurs at $f(0)$.

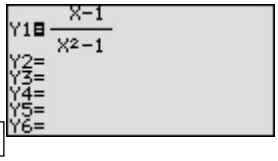
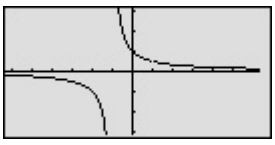
Example

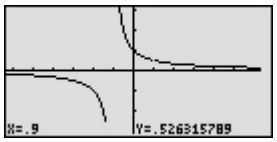
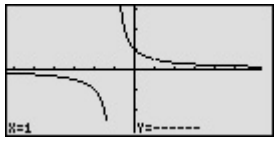
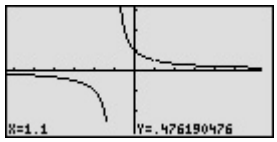
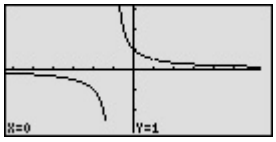
Graph the rational function and check several points as indicated below.

1. Graph $f(x) = \frac{x-1}{x^2-1}$.
2. Find the domain of $f(x)$, and the vertical asymptote of $f(x)$.
3. Find the x- and y-intercepts of $f(x)$.
4. Estimate the horizontal asymptote of $f(x)$.

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

Set the zoom to the decimal window: [ZOOM] [A]* ([ENTER] [ALPHA] [▼]*) [7]*

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	Display (When using EL-9650/9600c)	Notes
1-1 Enter $y = \frac{x-1}{x^2-1}$ for Y1. [Y=] [a/b] [X/θ/T/n] [—] [1] [▼]* [X/θ/T/n] [x^2] [—] [1]		
1-2 View the graph. [GRAPH]		The function consists of two branches separated by the vertical asymptote.

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	Display (When using EL-9650/9600c)	Notes
2 Find the domain and the vertical asymptote of $f(x)$, tracing the graph to find the hole at $x = 1$.		Since $f(x)$ can be written as $\frac{x - 1}{(x + 1)(x - 1)}$, the domain consists of all real numbers x such that $x \neq 1$ and $x \neq -1$. There is no vertical asymptote where $x = 1$ since this value of x also makes the numerator zero. Next to the coordinates $x = 0.9$, $y = 0.52$, see that the calculator does not display a value for y at $x = 1$ since 1 is not in the domain of this rational function.
TRACE ▶ (repeatedly)		
▶		
3 Find the x- and y-intercepts of $f(x)$. 2nd F CALC 6*		The y-intercept is at (0 ,1). Notice that there are no x-intercepts for the graph of $f(x)$.
4 Estimate the horizontal asymptote of $f(x)$.		The line $y = 0$ is very likely a horizontal asymptote of $f(x)$.

The graphing feature of the EL-9650/9600c/9450/9400 can create the branches of a rational function separated by vertical asymptote. The calculator allows the points of intersection to be obtained easily.

Solving Rational Function Inequalities

A rational function $f(x)$ is defined as the quotient $\frac{p(x)}{q(x)}$ where $p(x)$ and $q(x)$ are two polynomial functions such that $q(x) \neq 0$. The solutions to a rational function inequality can be obtained graphically using the same method as for normal inequalities. You can find the solutions by graphing each side of the inequalities as an individual function.

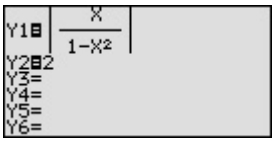
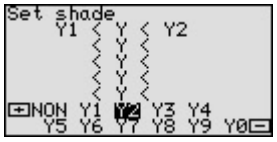
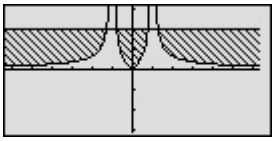
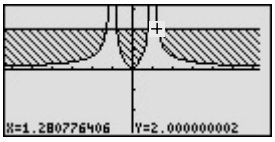
Example

Solve a rational inequality.

Solve $\left|\frac{x}{1-x^2}\right| \leq 2$ by graphing each side of the inequality as an individual function.

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

Set the zoom to the decimal window: [ZOOM] [A]* ([ENTER] [ALPHA] [▼]*) [7]*

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	Display (When using EL-9650/9600c)	Notes
1 Enter $y = \left\|\frac{x}{1-x^2}\right\|$ for Y1. Enter $y = 2$ for Y2. [Y=] [MATH] [B]* [1]* [a/b] [X/θ/T/n] [▼]* [1] [—] [X/θ/T/n] [x^2] [ENTER]* [2]		
2 Set up the shading. [2nd F] [DRAW] [G]* [1]* [—] [▶]* [—] [—]*		Since Y1 is the value "on the bottom" (the smaller of the two) and Y2 is the function "on the top" (the larger of the two), Y1 < Y < Y2.
3 View the graph. [GRAPH]		
4 Find the intersections, and solve the inequality. [2nd F] [CALC] [2]* Do this four times		The intersections are when x = -1.3, -0.8, 0.8, and 1.3. The solution is all values of x such that $x \leq -1.3$ or $-0.8 \leq x \leq 0.8$ or $x \geq 1.3$.

The EL-9650/9600c/9450/9400 allows the solution region of inequalities to be indicated visually using the Shade feature. Also, the points of intersections can be obtained easily.

Graphing Parabolas

The graphs of quadratic equations ($y = ax^2 + bx + c$) are called parabolas. Sometimes the quadratic equation takes on the form of $x = ay^2 + by + c$.
There is a problem entering this equation in the calculator graphing list for two reasons:
a) it is not a function, and only functions can be entered in the Y= list locations,
b) the functions entered in the Y= list must be in terms of x, not y.
There are, however, two methods you can use to draw the graph of a parabola.

Method 1: Consider the "top" and "bottom" halves of the parabola as two different parts of the graph because each individually is a function. Solve the equation of the parabola for y and enter the two parts (that individually are functions) in two locations of the Y= list.

Method 2: Choose the parametric graphing mode of the calculator and enter the parametric equations of the parabola. It is not necessary to algebraically solve the equation for y. Parametric representations are equation pairs $x = F(t)$, $y = F(t)$ that have x and y each expressed in terms of a third parameter, t.

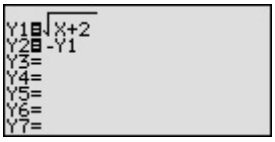
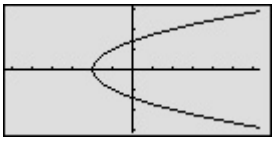
Example

Graph a parabola using two methods.

1. Graph the parabola $x = y^2 - 2$ in rectangular mode.
2. Graph the parabola $x = y^2 - 2$ in parametric mode.

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

Set the zoom to the decimal window: [ZOOM] [A]* ([ENTER] [ALPHA] [▼]*) [7]*

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	Display (When using EL-9650/9600c)	Notes
1-1 Solve the equation for y.		$x = y^2 - 2$ $x + 2 = y^2$ $y = \pm\sqrt{x + 2}$
1-2 Enter $y = \sqrt{x+2}$ for Y1 and enter $y = -Y1$ for Y2. [Y=] [2nd F] [√] [X,θ,T,n] [+] [2] [ENTER]* [(-)] [VARS] [A]* [ENTER] [1]*		
1-3 View the graph. [GRAPH]		The graph of the equation $y = \sqrt{x+2}$ is the "top half" of the parabola and the graph of the equation $y = -\sqrt{x + 2}$ gives the "bottom half."

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***

2-1 Change to parametric mode.

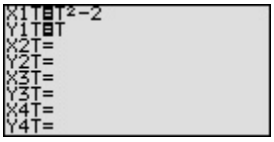
[2nd F] [SET UP] [E]*

[2]*

2-2 Rewrite $x = y^2 - 2$ in parametric form. Enter X1T = T^2 -2 and Y1T = T.

[Y=] [X|θ|T|n] [x^2] [—] [2] [ENTER]*

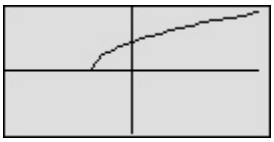
[X|θ|T|n]



Let y = T and substitute in $x = y^2 - 2$, to obtain $x = T^2 - 2$.

2-3 View the graph. Consider why only half of the parabola is drawn. (To understand this, use Trace feature.)

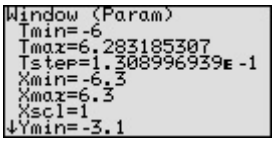
[GRAPH] ([TRACE] [▶])



The graph starts at T =0 and increases. Since the window setting is T ≥ 0, the region T < 0 is not drawn in the graph.

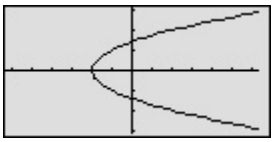
2-4 Set Tmin to -6.

[WINDOW] [(-)] [6] [ENTER]*



2-5 View the complete parabola.

[GRAPH]



The calculator provides two methods for graphing parabolas, both of which are easy to perform.

Graphing Circles

The standard equation of a circle of radius r that is centered at a point (h, k) is $(x - h)^2 + (y - k)^2 = r^2$. In order to put an equation in standard form so that you can graph in rectangular mode, it is necessary to solve the equation for y. You therefore need to use the process of completing the square.

Example

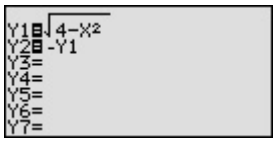
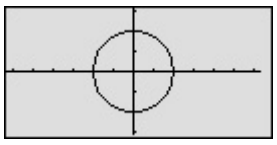
Graph the circles in rectangular mode. Solve the equation for y to put it in the standard form.

1. Graph $x^2 + y^2 = 4$.

2. Graph $x^2 - 2x + y^2 + 4y = 2$.

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

Set the zoom to the decimal window: [ZOOM] [A]* ([ENTER] [ALPHA] [▼]*) [7]*

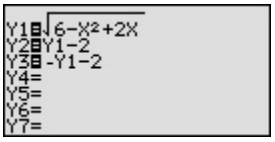
Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	Display (When using EL-9650/9600c)	Notes
1-1 Solve the equation for y. Enter $y = \sqrt{4 - x^2}$ for Y1 (the top half). Enter $y = -\sqrt{4 - x^2}$ for Y2. [Y=] [2nd F] [√] [4] [—] [X/θ/T/n] [x^2] [ENTER]* [(-)] [VARS] [A]* [ENTER] [1]*		$y^2 = 4 - x^2$ $y = \pm\sqrt{4 - x^2}$
1-2 View the graph. [GRAPH]		This is a circle of radius r, centered at the origin.

2-1 Solve the equation for y, completing the square.

$x^2 - 2x + y^2 + 4y = 2$	Place all variable terms on the left and the constant term on the right-hand side of the equation.
$x^2 - 2x + y^2 + 4y + 4 = 2 + 4$	Complete the square on the y-term.
$x^2 - 2x + (y+2)^2 = 6$	Express the terms in y as a perfect square.
$(y+2)^2 = 6 - x^2 + 2x$	Leave only the term involving y on the left hand side.
$y+2 = \pm\sqrt{6-x^2+2x}$	Take the square root of both sides.
$y = \pm\sqrt{6-x^2+2x} - 2$	Solve for y.

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***

2-2 Enter $y = \sqrt{6 - x^2 + 2x}$ for Y1, y = Y1 - 2 for Y2, and y = -Y1 -2 for Y3.



Y= CL 2nd F √ 6 — X/θ/T/n

x^2 + 2 Xθ/T/n ENTER* CL

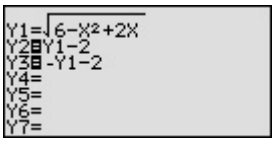
VARS A* ENTER 1* —

2 ENTER*

(-) VARS ENTER 1* — 2

Notice that if you enter $y = \sqrt{6 - x^2 + 2x} - 2$ for Y1 and y = - Y1 for Y2, you will not get the graph of a circle because the "±" does not go with the "-2".

2-3 "Turn off" Y1 so that it will not graph.



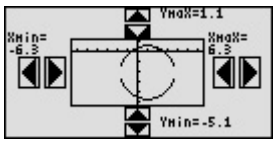
▲ ▲ ◀* ENTER*

Notice that "=" for Y1 is no longer darkened. You now have the top portion and the bottom portion of the circle in Y2 and Y3.

2-4 View the graph.

GRAPH

2-5 Adjust the screen to see the bottom part of the circle using the Rapid feature.



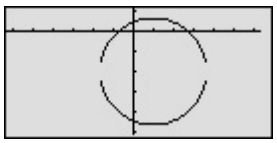
EZ ▼* ▼* ▼* ENTER*

ENTER* ▲* ▲* ENTER* ENTER*

Wait until the graph is displayed after each operation. (It takes few seconds to graph)

2-6 View the graph in the new window.

GRAPH



Graphing circles can be performed easily on the calculator display. Also, the Rapid Zoom feature of the EL-9650/9600c/9450/9400 allows shifting and adjusting display area (window) of a graph easily.

Graphing Ellipses

The standard equation for an ellipse whose center is at the point (h, k) with major and minor axes of length a and b is $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$.

There is a problem entering this equation in the calculator graphing list for two reasons:

a) it is not a function, and only functions can be entered in the Y = list locations.

b) the functions entered in the Y = list locations must be in terms of x, not y.

To draw a graph of an ellipse, consider the "top" and "bottom" halves of the ellipse as two different parts of the graph because each individual is a function. Solve the equation of the ellipse for y and enter the two parts in two locations of the Y = list.

Example

Graph an ellipse in rectangular mode. Solve the equation for y to put it in the standard form.

Graph the ellipse $3(x-3)^2 + (y+2)^2 = 3$

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

Set the zoom to the decimal window: [ZOOM] [A]* ([ENTER] [ALPHA] [▼]*) [7]*

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***

1 Solve the equation for y, completing the square.

Enter

$Y1 = \sqrt{3 - 3(x-3)^2}$

$Y2 = Y1 - 2$

$Y3 = -Y1 - 2$

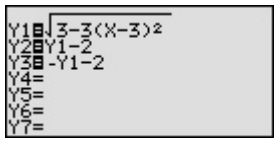
[Y=] [2nd F] [√‾] [3] [—] [3] [(]

[XθT/n] [—] [3] [)] [x^2] [ENTER]*

[VARS] [A]* [ENTER] [1]* [—]

[2] [ENTER]* [(-)] [VARS] [ENTER]

[1] [—] [2]



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

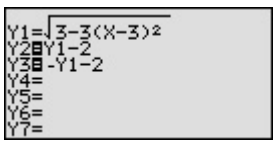
$(y+2)^2 = 3 - 3(x-3)^2$

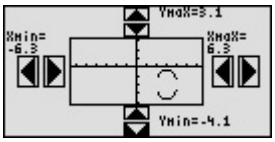
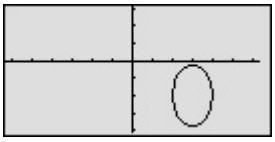
$y + 2 = \pm\sqrt{3 - 3(x-3)^2}$

$y = \pm\sqrt{3 - 3(x-3)^2} - 2$

2 Turn off Y1 so that it will not graph.

[▲] [▲] [◀]* [ENTER]*



Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***
3 View the graph. GRAPH		
4 Adjust the screen to see the bottom part of the ellipse using the Rapid Zoom feature. EZ ▼ ▼ ▼ * ENTER *		Wait until the graph is displayed after each operation. (It takes few seconds to graph)
5 View the graph in the new window. GRAPH		

Graphing an ellipse can be performed easily on the calculator display. In addition to the Zoom-in/Zoom-out features, the EL-9650/9600c/9450/9400 have the Rapid Zoom feature to adjust the display easily.

Graphing Hyperbolas

The standard equation for a hyperbola can take one of two forms:

$\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$ with vertices at $(h \pm a, k)$ or

$\frac{(x-k)^2}{b^2} - \frac{(y-h)^2}{a^2} = 1$ with vertices at $(h, k \pm b)$.

There is a problem entering this equation in the calculator graphing list for two reasons:

a) it is not a function, and only functions can be entered in the Y= list locations.

b) the functions entered in the Y= list locations must be in terms of x, not y.

To draw a graph of a hyperbola, consider the "top" and "bottom" halves of the hyperbola as two different parts of the graph because each individual is a function. Solve the equation of the hyperbola for y and enter the two parts in two locations of the Y= list.

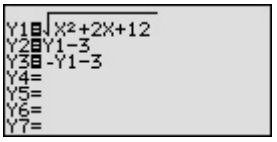
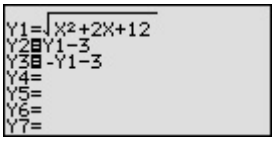
Example

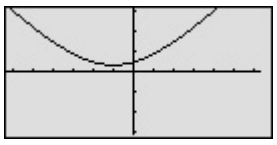
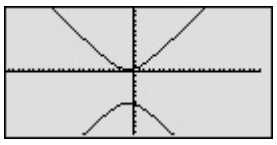
Graph a hyperbola in rectangular mode. Solve the equation for y to put it in the standard form.

Graph the hyperbola $x^2 + 2x - y^2 - 6y + 3 = 0$

Before Starting There may be differences in the results of calculations and graph plotting depending on the setting. Return all settings to the default value and delete all data.

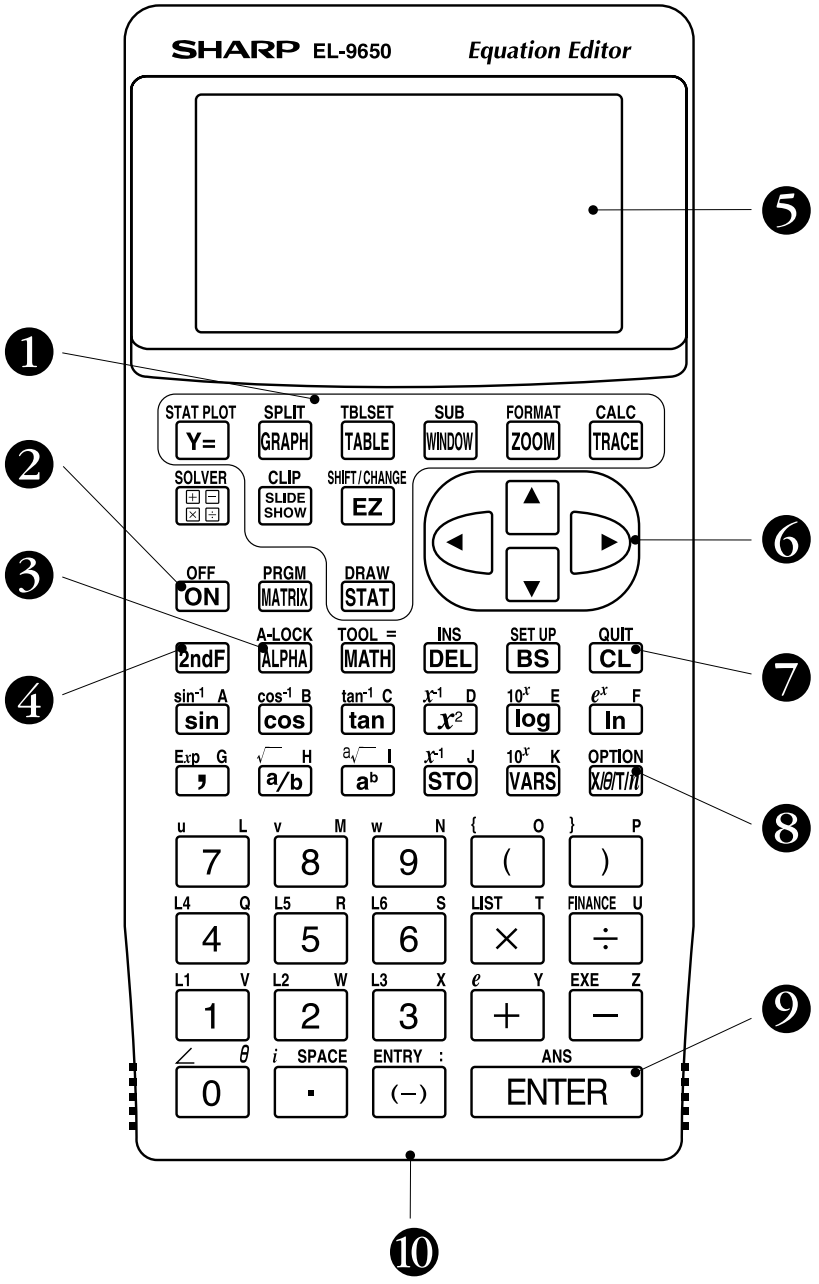
Set the zoom to the decimal window: [ZOOM] [A]* ([ENTER] [ALPHA] [▼]*) [7]*

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	Display (When using EL-9650/9600c)	Notes
1 Solve the equation for y completing the square. Enter $Y1 = \sqrt{x^2 + 2x + 12}$, $Y2 = Y1 - 3$, $Y3 = -Y1 - 3$		$x^2 + 2x - y^2 - 6y = -3$ $x^2 + 2x - (y^2 + 6y + 9) = -3 - 9$ $x^2 + 2x - (y+3)^2 = -12$ $(y+3)^2 = x^2 + 2x + 12$ $y + 3 = \pm\sqrt{x^2 + 2x + 12}$ $y = \pm\sqrt{x^2 + 2x + 12} - 3$
[Y=] [2nd F] [√] [Xθ/T/n] [x^2] [+] [2]		
[Xθ/T/n] [+] [1] [2] [ENTER]*		
[VARS] [A]* [ENTER] [1]* [—] [3] [ENTER]*		
[(-)] [VARS] [A]* [ENTER] [1]* [—] [3]		
2 Turn off Y1 so that it will not graph. [▲] [▲] [◀]* [ENTER]*		

Step & Key Operation (When using EL-9650/9600c) *Use either pen touch or cursor to operate.	***Display*** (When using EL-9650/9600c)	***Notes***
3 View the graph. [GRAPH]		
4 Zoom out the screen. [ZOOM] [A]* [4]*		

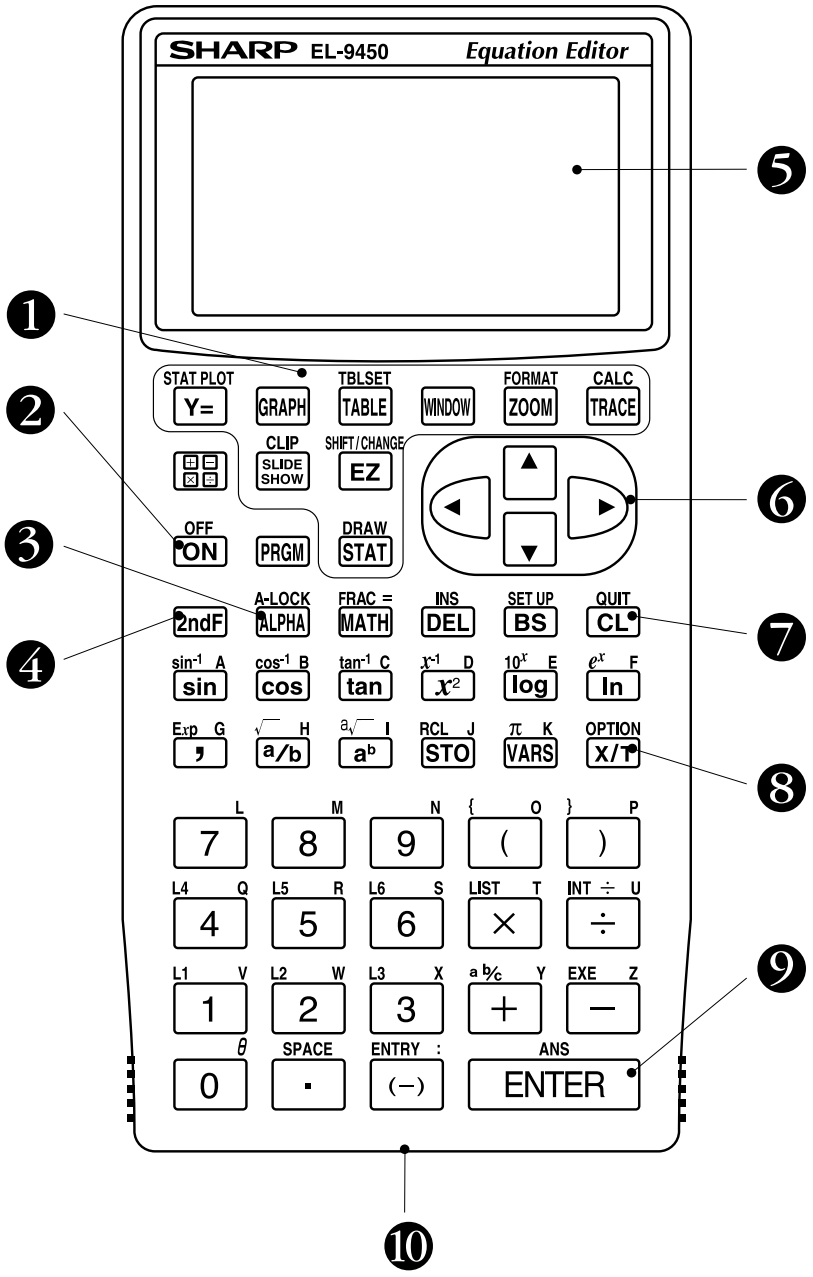
Graphing hyperbolas can be performed easily on the calculator display. In addition to the Zoom-in/Zoom-out features, the EL-9650/9600c/9450/9400 have the Rapid Zoom feature to adjust the display easily. (See the section “Graphing Ellipses (No. 10-3)” about how to use the Rapid Zoom feature.)

Key pad for the SHARP EL-9650/9600c Calculator



1. Graphing keys
2. Power supply ON/OFF key
3. Alphabet specification key
4. Secondary function specification key
5. Display screen
6. Cursor movement keys
7. Clear/Quit key
8. Variable enter key
9. Calculation execute key
10. Communication port for peripheral devices

Key pad for the SHARP EL-9450/9400 Calculator



1. Graphing keys
2. Power supply ON/OFF key
3. Alphabet specification key
4. Secondary function specification key
5. Display screen
6. Cursor movement keys
7. Clear/Quit key
8. Variable enter key
9. Calculation execute key
10. Communication port for peripheral devices

SHARP

Use this form to send us your contribution

Dear Sir/Madam

We would like to take this opportunity to invite you to create a mathematical problem which can be solved with the SHARP graphing calculator EL-9650/9600c/9450/9400. For this purpose, we would be grateful if you would complete the form below and return it to us by fax or mail, specifying which calculator you are writing problems for, the EL-9650/9600c or 9450/9400.

If your contribution is chosen, your name will be included in the next edition of The EL-9650/9600c/9450/9400 Graphing Calculator Handbook. We regret that we are unable to return contributions.

We thank you for your cooperation in this project.

Name: (☐ Mr. ☐ Ms.)

School/College/Univ.:

Address:

Post Code: Country:

Phone: Fax:

E-mail:

* You are making this sheet for the (☐ EL-9650/9600c, ☐ EL-9450/9400).

SUBJECT : Write a title or the subject you are writing about.

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INTRODUCTION : Write an explanation about the subject.

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EXAMPLE : Write example problems.

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BEFORE STARTING : Write any conditions to be set up before solving the problems.

STEP

NOTES

SHARP
SHARP CORPORATION Osaka, Japan
Fax:

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SHARP CORPORATION OSAKA, JAPAN