Sharp EL-9900 Graphing Calculator

Basic Keyboard Activities

General Mathematics

Algebra

Programming

Advanced Keyboard Activities

Algebra

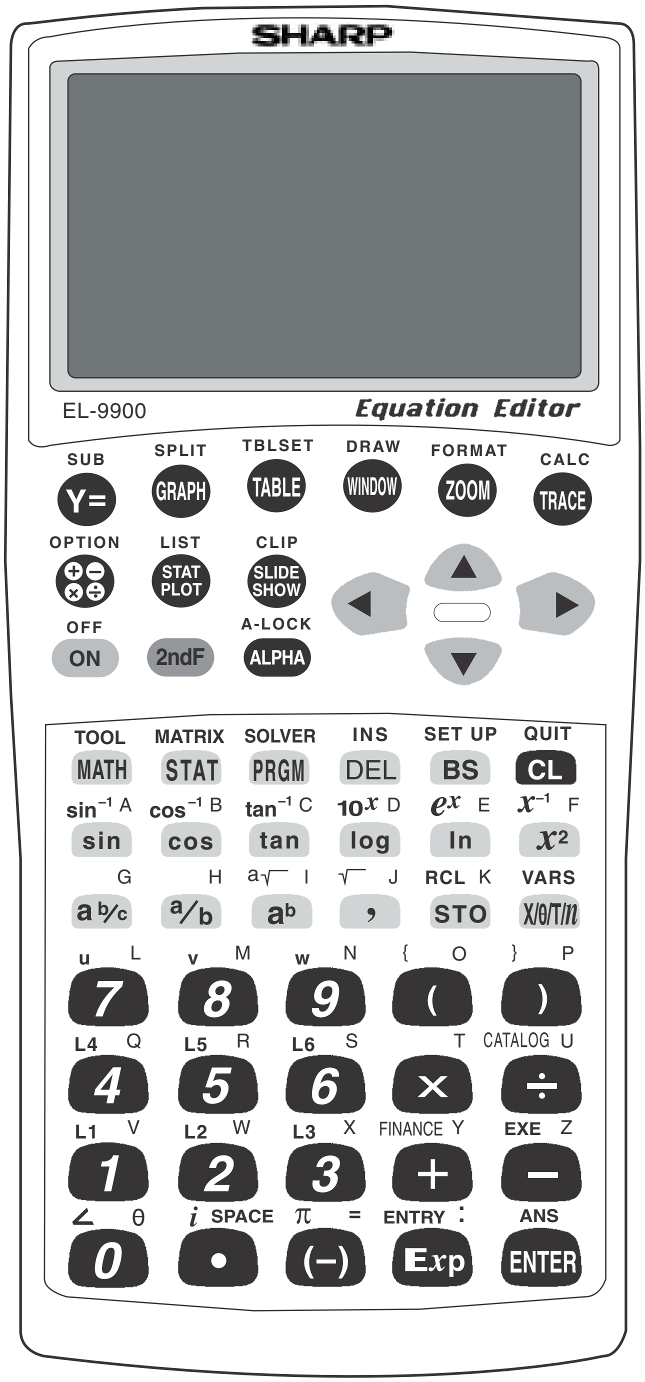
Calculus

Statistics

Trigonometry

Programming

Sharp EL-9900
Graphing Calculator
Advanced Keypad



EVALUATING LIMITS

1. Set the calculator to floating point decimal display by pressing [2ndF] [SET UP] [C] **(FSE)** and [1] **(Float Pt)**. Set the calculator to rectangular coordinates [E] **(COORD)** and [1] **(Rect)**. Press [2ndF] [QUIT] to exit the set up menu.

2. Consider the function $f(x) = \frac{(2x + 2)}{(x^2 - 1)}$. Press [Y=] [CL] to access and clear the Y1 prompt. Press [ENTER] [CL] to clear the remaining prompts.

3. Construct a graph of $f(x)$ in the Decimal viewing window by first entering Y1= $\frac{(2x + 2)}{(x^2 - 1)}$ with the keystrokes [a/b] [2] [X/θ/T/*n*] [+] [2] [▶] [X/θ/T/*n*] [x^2] [−] [1], and then press [ZOOM] [A] **(ZOOM)** [7] **(Dec)** to see the graph.

4. Notice that even though $\frac{(2x + 2)}{(x^2 - 1)}$ is not defined at $x = {}^-1$ (as evidenced by the hole in the graph at that point), the functional values appear to be getting closer and closer to ⁻1. A careful observation of the graph leads to the following estimates:

   $\lim_{x \to -\infty} f(x) = 0,$

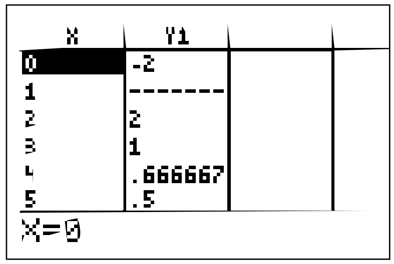
   $\lim_{x \to {}^-1} f(x) = {}^-1,$

   $\lim_{x \to 1} f(x)$ does not exist,

   and $\lim_{x \to \infty} f(x) = 0.$

5. It also appears that the line $y = 0$ is a horizontal asymptote and the line $x = 1$ is a vertical asymptote for this function.

6. Tables of functional values sometimes provide more detailed information than a graph when investigating limits. The TABLE feature will assist you in constructing a numerical table of values. Press $\boxed{\text{TABLE}}$ to access the TABLE feature.



7. Notice the table provides the *x*-values and their corresponding *y*-values according to Y1. You can change the table settings by pressing $\boxed{\text{2ndF}}$ $\boxed{\text{TBLSET}}$. You can change the table start value and the table step value. Verify the following values using the the TABLE feature.

x gets smaller and smaller→

x	-10	-50	-100	-250	-500	-1000	-10,000
y	-.18182	-.03922	-.01980	.00797	-.00399	-.00200	-.00020

y = *f*(*x*) appears to get closer and closer to 0

This provides evidence that $\lim_{x \to \infty} f(x) = 0$.

x approaches -1 from the left | *x* approaches -1 from the right

x	-1.05	-1.01	-1.001	-1.0001		-.9999	-.999	-.99	-.90
y	-.9756	-.99502	-.9995	-.9999		-1.0001	-1.0005	-1.0051	-1.0526

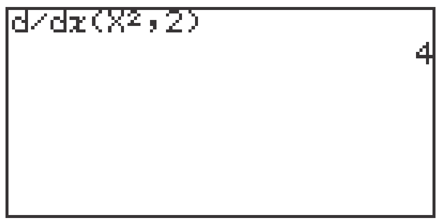
y = *f*(*x*) gets closer and closer to -1 from above | *y* = *f*(*x*) gets closer and closer to -1 from below

This provides evidence that $\lim_{x \to -1} f(x) = -1$.

DERIVATIVES

1. The calculator has a built-in function denoted by *d/dx* that uses numerical methods to estimate the derivative of a function at a given value. The entry form of the derivative function is *d/dx* ($f(x)$, a).

2. Estimate $f'(2)$ for $f(x) = x^2$ using the derivative function. Press $\boxed{\begin{smallmatrix}+&-\\\times&\div\end{smallmatrix}}$ $\boxed{\text{MATH}}$ $\boxed{\text{A}}$ **(CALC)** $\boxed{0}$ $\boxed{5}$ **(*d/dx*()** $\boxed{\text{X}/\theta/\text{T}/n}$ $\boxed{x^2}$ $\boxed{,}$ $\boxed{2}$ $\boxed{)}$ to input: *d/dx* (X^2, 2). Press $\boxed{\text{ENTER}}$ to compute.

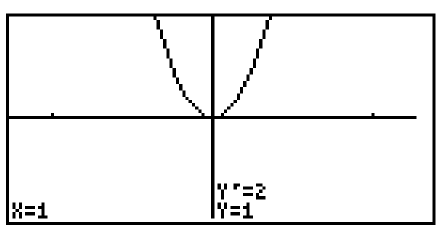


3. The calculator also has a derivative trace. Activate the derivative trace by pressing $\boxed{\text{2ndF}}$ $\boxed{\text{FORMAT}}$ $\boxed{\text{C}}$ **(Y')** and $\boxed{1}$ **(ON)**. Press $\boxed{\text{2ndF}}$ $\boxed{\text{QUIT}}$ to exit the **FORMAT** menu.

4. Press $\boxed{\text{Y=}}$ $\boxed{\text{CL}}$ and enter the function for Y1 by pressing $\boxed{\text{X}/\theta/\text{T}/n}$ $\boxed{x^2}$.

5. Draw the graph by pressing $\boxed{\text{ZOOM}}$ $\boxed{\text{A}}$ **(Zoom)** $\boxed{7}$ **(Dec)**.

6. Press $\boxed{\text{TRACE}}$ to activate the trace and press $\boxed{\blacktriangleright}$ to the values for the derivative.



7. Be sure to turn off the derivative trace.

TANGENT LINES

Enter and execute a program for finding a tangent line to a curve at a given point.

1. Turn the calculator on and press [PRGM] to enter the programming menu.

2. Press [C] **(NEW)** and [ENTER] to open a new program.

3. Name the new program TANGENT by pressing [T] [A] [N] [G] [E] [N] [T] [ENTER] .

4. Press [ENTER] at the end of each line. If you make a mistake, use the calculator's editing features to correct the error. Enter the following program:

PROGRAM	KEYSTROKES
Input X	[PRGM] [A] [3] [X/θ/T/*n*] [ENTER]
$\frac{d}{dx}$(Y1,X)⇒M	[MATH] [A] [0] [5] [2ndF] [VARS] [A] [ENTER] [A] [1] [,] [X/θ/T/*n*] [)] [STO] [ALPHA] [M] [ENTER]
Y1(X)⇒Y	[2ndF] [VARS] [A] [ENTER] [1] [(] [X/θ/T/*n*] [)] [STO] [ALPHA] [Y] [ENTER]
⁻M×X+Y⇒B	[(–)] [ALPHA] [M] [×] [X/θ/T/*n*] [+] [ALPHA] [Y] [STO] [ALPHA] [B] [ENTER]
ClrT	[PRGM] [C] [1] [ENTER]
Print "TANGENT LINE=	[PRGM] [A] [1] [PRGM] [2] [2ndF] [A-LOCK] [T] [A] [N] [G] [E] [N] [T] [SPACE] [L] [I] [N] [E] [=] [ALPHA] [ENTER]
Print "Y=MX+B	[PRGM] [1] [PRGM] [2] [ALPHA] [Y] [ALPHA] [=] [ALPHA] [M] [X/θ/T/*n*] [+] [ALPHA] [B] [ENTER]

Continue to enter the TANGENT program.

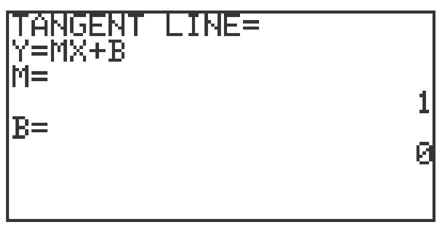
Print "M=	PRGM 1 PRGM 2 ALPHA M ALPHA = ENTER
Print M	PRGM 1 ALPHA M ENTER
Print "B=	PRGM 1 PRGM 2 ALPHA B ALPHA = ENTER
Print B	PRGM 1 ALPHA B ENTER
End	PRGM 6 ENTER

5. Press 2ndF QUIT to save the program and exit the editing mode.

6. Enter $f(x) = x^3 - x^2 + 1$ for Y1 by pressing Y= CL X/θ/T/*n* a^b 3 ▶ – X/θ/T/*n* x^2 + 1 ENTER .

7. Execute the TANGENT program by pressing PRGM A **(EXEC)** and selecting **TANGENT**.

8. Enter an X of 1 by pressing 1 ENTER . You should then see the equation for the tangent line to the curve at $x = 1$.



9. You can repeat this process for other x values. Press ENTER to execute the program over and over again.

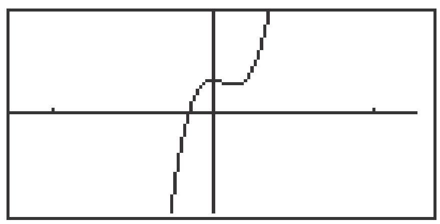
10. If you receive an error statement, press ◀ or ▶ to go to the line within the program in which the error occurs. Compare your line with the correct one above to find the error. Correct the error using the editing features of the calculator and save the corrections by pressing ENTER . Press 2ndF QUIT and try executing the program again.

TANGENT LINES

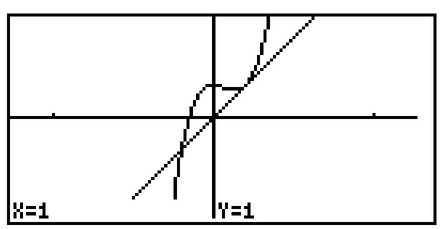
Draw the tangent line to a function at a given point.

1. To draw the tangent line on a displayed graph, you must first enter the graph for Y1. Enter the function $f(x) = x^3 - x^2 + 1$ for Y1 by pressing [Y=] [CL] [X/θ/T/*n*] [a^b] [3] [▶] [–] [X/θ/T/*n*] [x^2] [+] [1] [ENTER] .

2. Graph the function by pressing [ZOOM] [A] **(ZOOM)** [7] **(Dec)**.



3. Draw the tangent line at $x = 1$ by pressing [2ndF] [DRAW] [A] **(DRAW)** [5] **(T_line()**, move the tracer right to x =1 by pressing [▶] repeatedly, and then press [ENTER] .

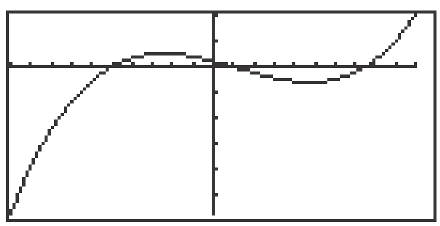


RELATIVE EXTREMA

1. Set the graphing calculator to rectangular graphing by pressing 2ndF SET UP E **(COORD)** 1 **(Rect)**. Press 2ndF QUIT to exit the SET UP menu.

2. Consider $f(x) = 2x^3 - 7x^2 - 70x + 75$. Press Y= CL to access and clear Y1. Press ENTER CL to clear additional Y prompts. Enter $f(x)$ for Y1 by pressing 2 X/θ/T/*n* a^b 3 ▶ – 7 X/θ/T/*n* x^2 – 7 0 X/θ/T/*n* + 7 5 .

3. Graph the function by pressing WINDOW (–) 1 0 ENTER 1 0 ENTER 1 ENTER ZOOM A **(Zoom)** 1 **(Auto)**.



4. To determine the point at which the relative maximum occurs, press 2ndF CALC 4 **(Maximum)**. The maximum occurs at $x = {}^{-}2.44$.

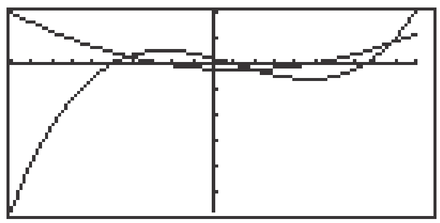
5. Find the point at which the relative minimum occurs by pressing 2ndF CALC 3 **(Minimum)**. The minimum occurs at $x = 4.776$.

6. Combining this information with a view of the graph, we see that $f(x)$ is increasing for $x = {}^{-}\infty$ to ${}^{-}2.4427$ and from 4.776 to ∞ while $f(x)$ is decreasing for x between ${}^{-}2.4427$ and 4.776.

GRAPHS OF DERIVATIVES

1. Graph $f'(x)$ by pressing [Y=] [ENTER] entering $f(x) = 2x^3 - 7x^2 - 70x + 75$ for Y1, and entering $\frac{d}{dx}$ (Y1) for Y2. Enter Y2 by pressing [MATH] [A] **(CALC)** [0] [5] **(d/dx()** [2ndF] [VARS] [ENTER] [A] **(XY)** [1] **(Y1)** and press [)] [ENTER].

2. Press [WINDOW] [(−)] [1] [0] [ENTER] [1] [0] [ENTER] [1] [ENTER] [ZOOM] [A] **(Zoom)** [1] (Auto) to obtain the graphs of $f(x)$ and $f'(x)$.



3. We now want to find the two x-intercepts of $f'(x)$. Press [TRACE] [▼] to place the tracer on the graph of the derivative. Then, press [2ndF] [CALC] and [5] **(X_Incpt)**. Press [2ndF] [CALC] [5] **(X_Incpt)** again to obtain the other x-intercept.

4. Comparing these values to the x-coordinates of the points at which the maxima and minima of $f(x)$ occur, we see they are the same.

5. Where is $f'(x)$ positive? Notice this is where the graph of $f(x)$ is increasing. Where is $f'(x)$ negative? Notice this is where $f(x)$ is decreasing.

6. Next, find the minimum point of $f'(x)$ by first making sure the trace cursor is on the graph of the derivative, pressing [2ndF] [CALC] [3] **(Minimum)**.

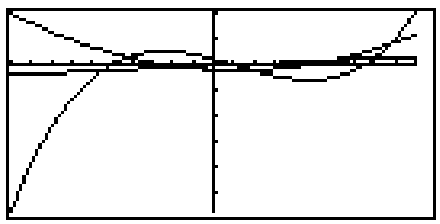
7. Look at $f(x)$ and observe that this appears to be the point at which the function “bends a different way.”

8. Find the point of inflection directly by moving the cursor to the original function and pressing [2ndF] [CALC] [7] **(Inflec)**.

GRAPHS OF DERIVATIVES (continued)

9. Graph the second derivative by pressing [Y=] [ENTER] [ENTER], and input *d/dx* (Y2) in the Y3 location with the keystrokes [MATH] [A] **(CALC)** [0] [5] ***(d/dx()*** [2ndF] [VARS] [ENTER] [A] **(XY)** [2] **(Y2)** and press [)] [ENTER].

10. Press [GRAPH] to obtain the graphs of $f(x)$, $f'(x)$, and $f''(x)$. Where is $f''(x)$. zero? After pressing [TRACE] [▼] [▼] to place the tracer on the second derivative, press [2ndF] [CALC] [5] **(X_Incpt)** to find that $f''(x) = 0$ at X= 1.167.



11. Find the *y*-value of this point of inflection by pressing [▲] [▲] to move the cursor to the original function. Press [2ndF] [CALC] [1] **(Value)** and enter 1.167 and press [ENTER].

12. The connections we have discovered between the graphs of $f(x)$, $f'(x)$, and $f''(x)$ are summarized in the tables below.

Interval	$f(x)$ is	$f'(x)$ is	$f''(x)$ is
$x < {}^-2.4427$	increasing, concave down	positive	negative
${}^-2.4427 < x < 1.1656$	decreasing, concave down	negative	negative
$1.1656 < x < 4.776$	decreasing, concave up	negative	positive
$x > 4.776$	increasing, concave up	positive	positive

x – value	$f(x)$ has	$f'(x)$ has	$f''(x)$ has
$x = {}^-2.4427$	relative maximum	x-intercept	---
$x = 1.16567$	inflection point	minimum	x-intercept
$x = 4.776$	relative minimum	x-intercept	---

OPTIMIZATION

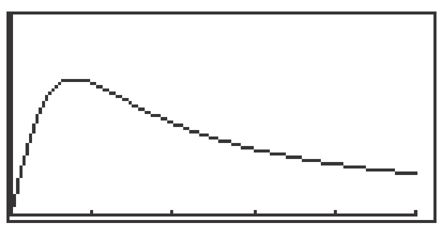
1. Set the calculator to rectangular graphing by pressing [2ndF] [SETUP] [E] **(Coord)** [1] **(Rect)**. Press [2ndF] [QUIT] to exit the setup menu.

2. A new product was introduced through a television advertisement appearing during the Super Bowl. Suppose that the proportion of people that purchased the product x days after the advertisement appeared is given by $f(x) = \dfrac{(5.3x)}{(x^2 + 15)}$. When did maximum sales occur and what proportion of people purchased the product at that time?

3. Press [Y=] [CL] to clear the Y1 prompt. Press [ENTER] [CL] to clear additional prompts. Enter $f(x)$ in the Y1 location with the keystrokes [a/b] [5] [•] [3] [X/θ/T/n] [▶] [X/θ/T/n] [x^2] [+] [1] [5] .

4. Let's examine the graph for the first 25 days after the advertisement appeared. Press [WINDOW] , enter Xmin = 0, Xmax = 25, Xscl = 5, Ymin = 0, Ymax = 1, Yscl = 1.

5. Press [GRAPH] to view the graph.



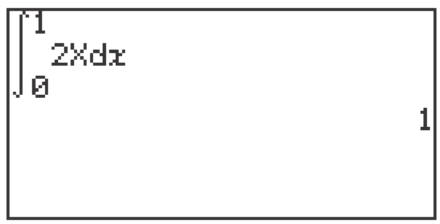
6. When did maximum sales occur and what proportion of people purchased the product at that time? Press [2ndF] [CALC] and [4] **(Maximum)** to find a maximum sales at $x = 3.87$ days with a 68% proportion.

SHADING AND CALCULATING AREAS REPRESENTED BY AN INTEGRAL

1. Find an estimate of $\int_0^1 2x\,dx$.

2. Integrate a function by pressing [+−×÷] [MATH] [A] **(CALC)** [0] [6] **(∫)**.

3. Enter 0 for the lower limit. Press [▲], input 1 for the upper limit, and press [▶]. Next, press [2] [X/θ/T/*n*] to input the integrand. Enter the "dx" by pressing [MATH] [0] [7] **(dx)**. Press [ENTER] to compute.



4. Shade the region by first pressing [Y=] [CL] to access and clear the Y1 prompt. Clear additional prompts by pressing [ENTER] [CL].

5. Enter *f*(*x*) in Y1 with the keystrokes [2] [X/θ/T/*n*]. Press [WINDOW] and enter Xmin = 0 and Xmax = 1. Draw the graph by pressing [ZOOM] [A] **(ZOOM)** [1] **(Auto)**.

6. Shade the region by pressing [2ndF] [DRAW] [G] **(SHADE)** and [1] **(Set)** to access the shading screen.

7. Since Y1= 2X is the function "on the top," press [▶] [2ndF] [VARS] [ENTER] [A] **(XY)** [1]. Leave the lower bound location empty. Press [GRAPH] to view the shaded region.

8. Turn off the shading by pressing [2ndF] [DRAW] [G] **(SHADE)** [2] **(INITIAL)**.

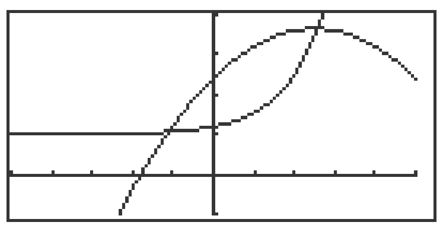
AREA BETWEEN CURVES

1. Calculate and draw a graph of the area of the region between $f(x) = 5x - x^2 + 12$ and $g(x) = e^x + 5$.

2. Return to and clear the Y prompts by pressing [Y=] [CL]. Clear additional prompts if necessary.

3. Input $f(x)$ in Y1 with the keystrokes [5] [X/θ/T/n] [–] [X/θ/T/n] [x^2] [+] [1] [2] [ENTER]. Input $g(x)$ in Y2 with the keystrokes [2ndF] [e^x] [X/θ/T/n] [▶] [+] [5].

4. Enter the viewing window $^-5 < x < 5$ and $^-5 < y < 20$. Your viewing window should clearly show the region between $f(x)$ and $g(x)$ and, if applicable, display the intersections of the functions. Press [GRAPH] to view the graphs.



5. Shade the region between the two curves by pressing [2ndF] [DRAW] [G] **(SHADE)** [1] **(SET)**. Since Y2 is the function "on the bottom," press [2ndF] [VARS] [ENTER] [A] **(EQVARS)** [ENTER] [2] **(Y2)** and since Y1 is the function "on the top," press [2ndF] [VARS] [ENTER] [1] **(Y1)**. Press [GRAPH] to view the shaded region.

6. Next, find the limits of integration. Press [2ndF] [CALC] [2] **(Intsct)**. Do this twice to obtain the x-coordinates of the two points of intersection. The points of intersection are $x = {}^-1.09$ and $x = 2.58$.

7. Find the approximate area by pressing [+ − × ÷] [CL] [MATH] [A] **(CALC)** [0] [6] **(∫)** enter $^-1.09$, press [▲], enter 2.58, press [▶], enter the function "on the top," $5x - x^2 + 12$, press [–] [(], enter the function "on the bottom," $e^x + 5$, press [)] [MATH] [0] [7] **(dx)**. Press [ENTER] to obtain the approximate area of 20.34.

PROGRAM FOR RECTANGULAR APPROXIMATION OF AREA

Enter and execute a program for finding the rectangular approximation for an area,

1. Press [2ndF] [PRGM] to enter programming mode. Press [C] **(NEW)** to enter a new program, followed by [ENTER]. Name the new program RECTAPP by pressing [R] [E] [C] [T] [A] [P] [P] followed by [ENTER].

2. You can now enter in the RECTAPP program. Remember to press [ENTER] at the end of each line. If you make a mistake, use the calculator's editing features to make corrections. Enter the following program:

PROGRAM	KEYSTROKES
Input N	[PRGM] [A] [3] [ALPHA] [N] [ENTER]
Input A	[PRGM] [3] [ALPHA] [A] [ENTER]
Y1(A)⇒L	[2ndF] [VARS] [A] [ENTER] [A] [1] [(] [ALPHA] [A] [)] [STO] [ALPHA] [L] [ENTER]
Input B	[PRGM] [3] [ALPHA] [B] [ENTER]
Y1(B)⇒R	[2ndF] [VARS] [ENTER] [1] [(] [ALPHA] [B] [)] [STO] [ALPHA] [R] [ENTER]
(B–A)÷N⇒W	[(] [ALPHA] [B] [–] [ALPHA] [A] [)] [÷] [ALPHA] [N] [STO] [ALPHA] [W] [ENTER]
A+W÷2⇒X	[ALPHA] [A] [+] [ALPHA] [W] [÷] [2] [STO] [X/θ/T/*n*] [ENTER]
Y1(X)⇒M	[2ndF] [VARS] [ENTER] [1] [(] [X/θ/T/*n*] [)] [STO] [ALPHA] [M] [ENTER]
A+W⇒X	[ALPHA] [A] [+] [ALPHA] [W] [STO] [X/θ/T/*n*] [ENTER]
Label LOOP	[PRGM] [B] [0] [1] [2ndF] [A-LOCK] [L] [O] [O] [P] [ALPHA] [ENTER]
Y1(X)+L⇒L	[2ndF] [VARS] [ENTER] [1] [(] [X/θ/T/*n*] [)] [+] [ALPHA] [L] [STO] [ALPHA] [L] [ENTER]

PROGRAM FOR RECTANGULAR APPROXIMATION OF AREA (continued)

Y1(X)+R⇒R	[2ndF] [VARS] [ENTER] [1] [(] [X/θ/T/*n*] [)] [+] [ALPHA] [R] [STO] [ALPHA] [R] [ENTER]
X+W÷2⇒X	[X/θ/T/*n*] [+] [ALPHA] [W] [÷] [2] [STO] [X/θ/T/*n*] [ENTER]
Y1(X)+M⇒M	[2ndF] [VARS] [ENTER] [1] [(] [X/θ/T/*n*] [)] [+] [ALPHA] [M] [STO] [ALPHA] [M] [ENTER]
X+W÷2⇒X	[X/θ/T/*n*] [+] [ALPHA] [W] [÷] [2] [STO] [X/θ/T/*n*] [ENTER]
If X<BGoto	[PRGM] [B] [0] [3] [X/θ/T/*n*] [MATH] [F] [5] [ALPHA]
LOOP	[B] [PRGM] [B] [0] [2] [2ndF] [A-LOCK] [L] [O] [O] [P] [ALPHA] [ENTER]
ClrT	[PRGM] [C] [1] [ENTER]
Print "LEFT=	[PRGM] [A] [1] [PRGM] [2] [2ndF] [A-LOCK] [L] [E] [F] [T] [=] [ALPHA] [ENTER]
Print W×L	[PRGM] [1] [ALPHA] [W] [×] [ALPHA] [L] [ENTER]
Print "MID=	[PRGM] [1] [PRGM] [2] [2ndF] [A-LOCK] [M] [I] [D] [=] [ALPHA] [ENTER]
Print W×M	[PRGM] [1] [ALPHA] [W] [×] [ALPHA] [M] [ENTER]
Print "RIGHT=	[PRGM] [1] [PRGM] [2] [2ndF] [A-LOCK] [R] [I] [G] [H] [T] [=] [ALPHA] [ENTER]
Print W×R	[PRGM] [1] [ALPHA] [W] [×] [ALPHA] [R] [ENTER]
End	[PRGM] [6] [ENTER]

Press [2ndF] [QUIT] to save the program and exit the editing mode.

Executing a program

3. Enter the function $f(x)$ = cos x, by pressing Y= CL cos X/θ/T/n . Press ENTER CL to clear additional prompts.

4. Execute the RECTAPP program, press PRGM A , highlight the 'RECTAPP' program, and press ENTER . Enter 'N' of 5 by pressing 5 ENTER , followed by 'A' of 0 and 'B' of 1. You will see a display of left, midpoint and right rectangular approximations for the area under the cosine function between 0 and 1 with 5 intervals in the partition.

```
LEFT=
          0.884633979
MID=
          0.842875074
RIGHT=
           0.79269444
```

5. You can repeat this process for a different number of partitions, different limits, or another function. Press ENTER to execute the program over and over again. Press CL to exit the program.

6. If you receive an error statement, press ◀ or ▶ to go to the line within the program in which the error occurs. Compare your line with the correct one above to find the error. Correct the error using the editing features of the calculator and save the program by pressing 2ndF QUIT . Try executing the program again.

TRAPEZOIDAL APPROXIMATION OF AREA

A program for finding the trapezoidal approximation for an area.

Input N	PRGM A 3 ALPHA N ENTER
Input A	PRGM 3 ALPHA A ENTER
Y1(A)⇒L	2ndF VARS A ENTER A 1 (ALPHA A) STO ALPHA L ENTER
Input B	PRGM 3 ALPHA B ENTER
Y1(B)⇒R	2ndF VARS ENTER 1 (ALPHA B) STO ALPHA R ENTER
0⇒Z	0 STO ALPHA Z ENTER
(B–A)÷N⇒W	(ALPHA B – ALPHA A) ÷ ALPHA N STO ALPHA W ENTER
A+W⇒X	ALPHA A + ALPHA W STO X/θ/T/*n* ENTER
Label LOOP	PRGM B 0 1 2ndF A-LOCK L O O P ALPHA ENTER
2Y1(X)+Z⇒Z	2 2ndF VARS ENTER 1 (X/θ/T/*n*) + ALPHA Z STO ALPHA Z ENTER
X+W⇒X	X/θ/T/*n* + ALPHA W STO X/θ/T/*n* ENTER
If X<BGoto	PRGM B 0 3 X/θ/T/*n* MATH F 5 ALPHA B
LOOP	PRGM 0 2 2ndF A-LOCK L O O P ENTER
ClrT	PRGM C 1 ENTER
Print "TRAP=	PRGM A 1 PRGM 2 2ndF A-LOCK T R A P = PRGM 2 ENTER
Print (W÷2)	PRGM 1 (ALPHA W ÷ 2) (ALPHA
(L+Z+R)	L + ALPHA Z + ALPHA R) ENTER
End	PRGM 6 ENTER

Execute like the rectangular program to find an approximate area of .83866.

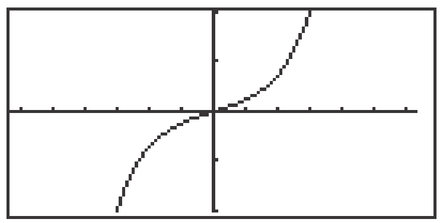
HYPERBOLIC FUNCTIONS

Steps for graphing the hyperbolic sine function.

1. Turn the calculator on and press [Y=] [CL] to access and clear the [Y1] prompt. Press [ENTER] [CL] to remove additional expressions.

2. To enter the hyperbolic sine function (y = sinh x) for Y1, press [MATH], [A] **(CALC)** [1] [5] **(sinh)** and press [X/θ/T/n] .

3. Enter the viewing window by pressing [ZOOM] [F] **(HYP)** [1] **(sinh x)**.

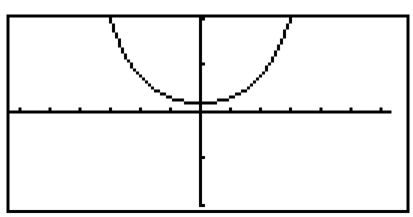


Steps for graphing the hyperbolic cosine function.

4. Press [Y=] [CL] to remove the hyperbolic sine function.

5. To enter the hyperbolic cosine function (y = cosh x) for Y1, press [MATH] [1] [6] **(cosh x)** press [X/θ/T/n] .

6. Press [GRAPH] to view the graph.



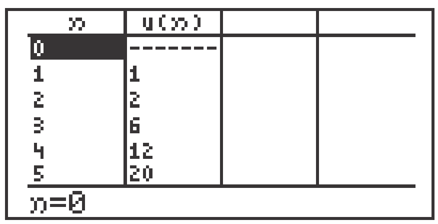
SEQUENCES

1. Turn the calculator on and set the calculator to sequence mode by pressing $\boxed{\text{2ndF}}$ $\boxed{\text{SET UP}}$ $\boxed{\text{E}}$ **(COORD)** $\boxed{\text{4}}$ **(Seq)**.

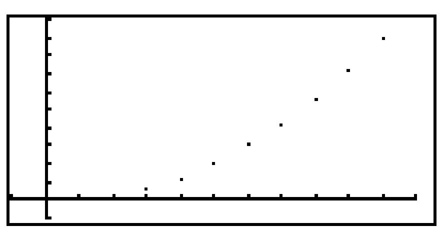
2. Press $\boxed{\text{2ndF}}$ $\boxed{\text{QUIT}}$ $\boxed{\text{Y=}}$ to access the sequence prompts. Clear any sequences by presing $\boxed{\text{CL}}$.

3. Enter the sequence generator $a_n = n^2 - n$ for $u(n)$ by pressing $\boxed{\text{X/}\theta\text{/T/}n}$ $\boxed{x^2}$ $\boxed{-}$ $\boxed{\text{X/}\theta\text{/T/}n}$ $\boxed{\text{ENTER}}$. Enter $n_1 = 1$ for $u(n\text{Min})$ by pressing $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$.

4. View a table of sequence values by pressing $\boxed{\text{TABLE}}$.



5. Graph the sequence by first setting the format to time and drawing to dot mode. Do this by pressing $\boxed{\text{2ndF}}$ $\boxed{\text{FORMAT}}$ $\boxed{\text{G}}$ **(TYPE)** $\boxed{\text{2}}$ **(Time)**. Press $\boxed{\text{2ndF}}$ $\boxed{\text{QUIT}}$ to exit the FORMAT menu. Change to dot mode by pressing $\boxed{\text{2ndF}}$ $\boxed{\text{DRAW}}$ $\boxed{\text{D}}$ **(LINE)** $\boxed{\text{ENTER}}$ $\boxed{\blacktriangleright}$ $\boxed{\text{ENTER}}$. Enter the viewing window by pressing $\boxed{\text{WINDOW}}$ $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{0}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$ $\boxed{(-)}$ $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{ENTER}}$ $\boxed{(-)}$ $\boxed{\text{1}}$ $\boxed{\text{0}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{0}}$ $\boxed{\text{0}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{1}}$ $\boxed{\text{0}}$ $\boxed{\text{ENTER}}$. View the sequence by pressing $\boxed{\text{GRAPH}}$.

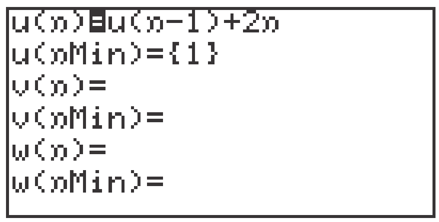


6. Turn off sequence mode and dot mode.

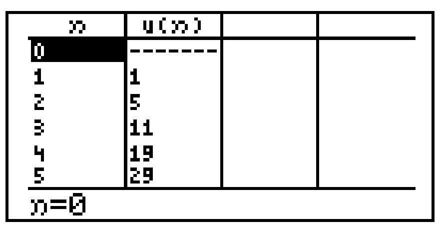
RECURSIVE SEQUENCES

1. Change to sequence mode, time format, and dot mode.

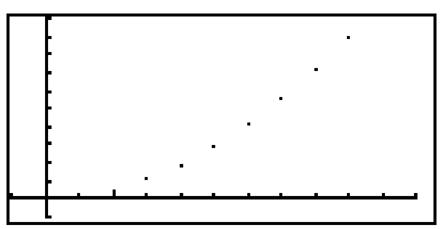
2. Enter the recursive sequence generator $a_n = a_{n-1} + 2n$ for $u(n)$ by pressing $\boxed{\text{Y=}}$ $\boxed{\text{CL}}$ $\boxed{\text{2ndF}}$ $\boxed{\text{u}}$ $\boxed{(}$ $\boxed{\text{X}/\theta/\text{T}/n}$ $\boxed{-}$ $\boxed{1}$ $\boxed{)}$ $\boxed{+}$ $\boxed{2}$ $\boxed{\text{X}/\theta/\text{T}/n}$ $\boxed{\text{ENTER}}$.
   Enter $a_1 = 1$ by pressing $\boxed{1}$ $\boxed{\text{ENTER}}$.



3. View a table of sequence values by pressing $\boxed{\text{TABLE}}$.



4. Graph the sequence in the window as $^{-}1 < x < 11$, $^{-}10 < y < 100$ by pressing $\boxed{\text{GRAPH}}$.



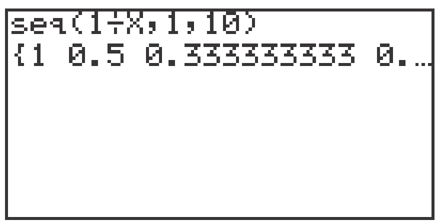
5. Turn off sequence mode and dot mode.

PARTIAL SUM OF A SERIES

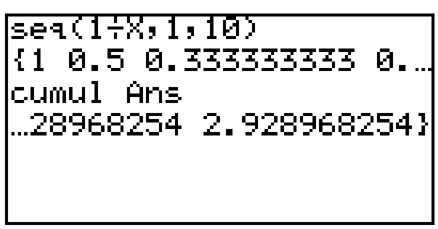
Find the partial sum of a series, ∑ 1/X, for the first 10 terms.

1. Make sure the SET UP to rectangular mode by pressing 2ndF SET UP , E **(COORD)** 1 **(Rect)**. Press 2ndF QUIT to exit the SET UP menu.

2. First find the sequence of the first 10 terms of series ∑ 1/X by first pressing [+−×÷] CL 2ndF LIST A **(OPE)** 5 **(seq(**). Enter the generator 1/X by pressing 1 ÷ X/θ/T/*n* , . Enter the lower and upper bounds for the sequence by pressing 1 , 1 0) . Find the sequence by pressing ENTER . Press ▶ to see more of the sequence.



3. Find the partial sum of the first 10 terms by pressing 2ndF LIST 6 **(cumul)** and pressing 2ndF ANS ENTER . Press ▶ to move right in the sequence of partial sums until the last term is seen. The partial sum of the first 10 terms is 2.9289.



GRAPHING POLAR EQUATIONS

Steps for graphing a polar function:

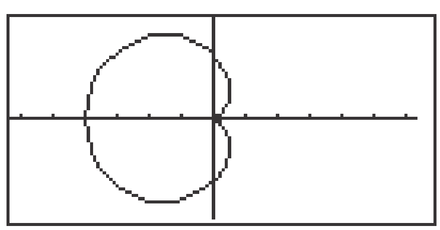
1. Turn the calculator on and press [2ndF] [SET UP] [E] **(COORD)** [3] **(Polar)** to change to polar mode. While in the SET UP menu, the calculator should be setup in radian mode. To complete this setup, press [B] **(DRG)** [2] **(Rad)**. Press [2ndF] [QUIT] to exit the SET UP menu.

2. Make sure calculator is in connected mode by pressing [2ndF] [DRAW] [D] **(LINE)** [ENTER]. The first option should be reflected for R1. Set the calculator to display polar coordinates when tracing, by pressing [2ndF] [FORMAT] [F] **(CURSOR)** and [2] **(PolarCoord)**. Also, set the calculator to display the expression during tracing by pressing [B] **(EXPRESS)** [1] **(ON)**. Press [2ndF] [QUIT] to exit the FORMAT menu.

3. Press [Y=] to access the R1 prompt. Press [CL] to remove an old R1 expression. Press [ENTER] [CL] to clear additional R prompts.

4. Enter the polar function $r = 2(1 - \cos\theta)$ for R1, by pressing [2] [(] [1] [–] [cos] [X/θ/T/*n*] [)]. Notice, when in polar mode the [X/θ/T/*n*] key provides a θ for equation entry.

5. Now, graph the polar function in the Decimal viewing window by pressing [ZOOM] [A] **(ZOOM)** [7] **(Dec)**.



6. This particular shape of curve is called a cardoid. Trace the curve by pressing [TRACE]. Notice the expression is displayed at the top of the screen.

GRAPHING PARAMETRIC EQUATIONS

Steps for graphing a parametric function:

1. Turn the calculator on and press 2ndF SET UP E **(COORD)** 2 **(Param)** to change to parametric mode. Press 2ndF QUIT to exit the SET UP menu.

2. Make sure calculator is set to display rectangular coordinates when tracing by pressing 2ndF FORMAT F **(CURSOR)** 1 **(RectCoord)**. Press 2ndF QUIT to exit the FORMAT menu.

3. To enter the parametric function X1T = 2(cos T)^3, Y1T = 2(sin T)^3, press Y= CL 2 (cos X/θ/T/*n*) a^b 3 ENTER CL 2 (sin X/θ/T/*n*) a^b 3 ENTER. Notice, when in parametric mode the X/θ/T/*n* key provides a T for equation entry.

4. Now, graph the parametric function in the Decimal viewing window by pressing ZOOM A **(ZOOM)** 7 **(Dec)**.

5. Press TRACE and notice the expression and T values now appear on the range screen.