

**Introduction to the TI-89 for Beginners**

**International Teachers Teaching with Technology  
Columbus, OH**

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**1:30 - 3:00 PM**

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### DISPLAY CONTRAST

To *increase* the contrast, hold down the green diamond key (◆) and the + sign  
To *decrease* the contrast, hold down the green diamond key (◆) and the - sign

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### LAYOUT OF THE KEYBOARD

Many keys on the calculator have more than one function:

- what is written on the key in white lettering (just press the key)
- what is written above the key in green lettering (press **green diamond** ◆, located row 3, column A)
- what is written above the key in yellow lettering (press **2nd**, located row 2, column A)
- what is written above the key in purple lettering (press **alpha**, row 3, column B)
- the  $\hat{\uparrow}$  (shift or up arrow key, row 2, column B) is used to capitalize a letter.

Function keys (8 of them F1-F8) below the calculator screen.

Special keys:

- ◆ green diamond key (row 3, column A, shortcut for Y=, Window, Graph, TblSet, Table, Cut, Copy, Paste,  $\approx$ , Del)

- 2nd** yellow key (row 2, column A, access to functions printed in yellow above the key)

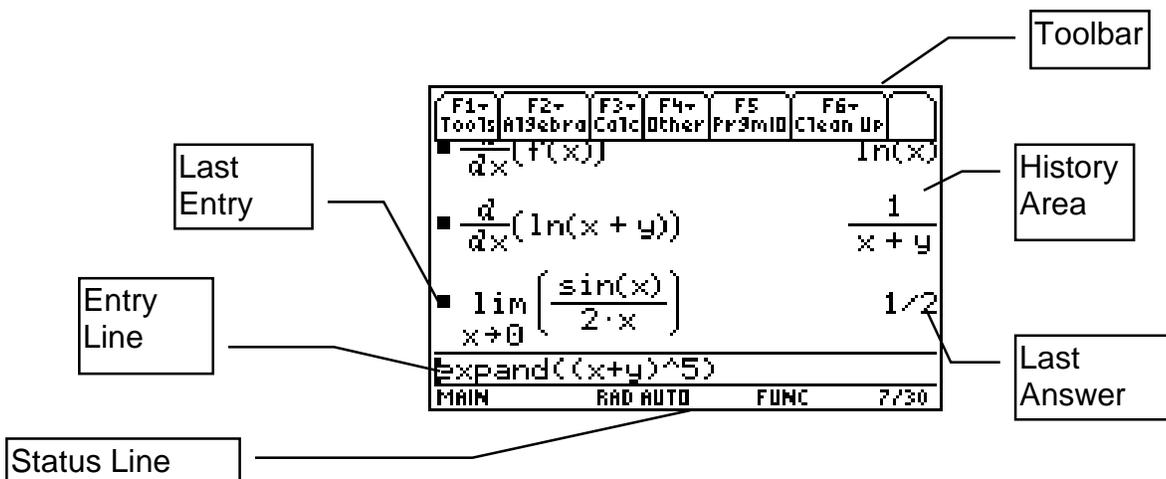
- Four Cursor keys (left, right, up, down arrow keys)

- ENTER** keys (row 10, column E)

- ESC** key (row 2, column C)

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### LAYOUT OF SCREEN



## LAYOUT OF SCREEN

The top row is the Toolbar for the F1-F6 keys

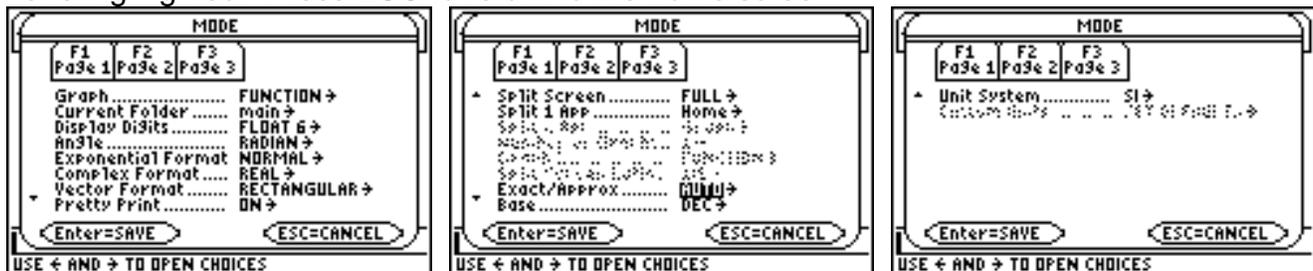
The next area, called the "History Area," may show up to 5 rows of print; keeps a record of your entry/answer pairs

The Entry line is between two horizontal lines.

Below the entry line is the Status Line - current state of your calculator.

## SETTINGS

To clear the home screen, press **F1** and choose #8:Clear Home, press **CLEAR** if there is something on the insert line. For this worksheet, change the **MODE** (row 4, column B) settings of your calculator to look like the screen below. Press **ENTER** to select what you have highlighted. Press **ESC** to return to the home screen.



**Exact:** Any result that is not a whole number is displayed in a fractional or symbolic form ( $2/3$ ,  $\pi/4$ ,  $2\sqrt{2}$ )

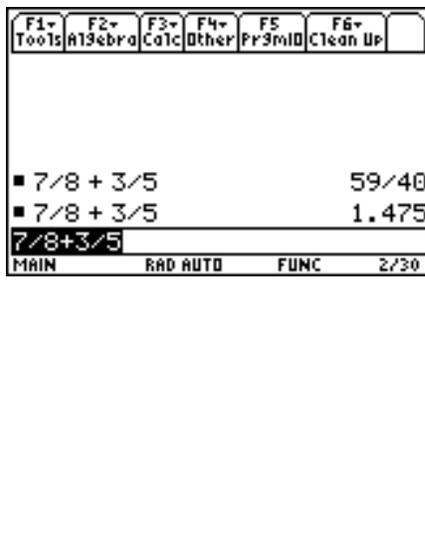
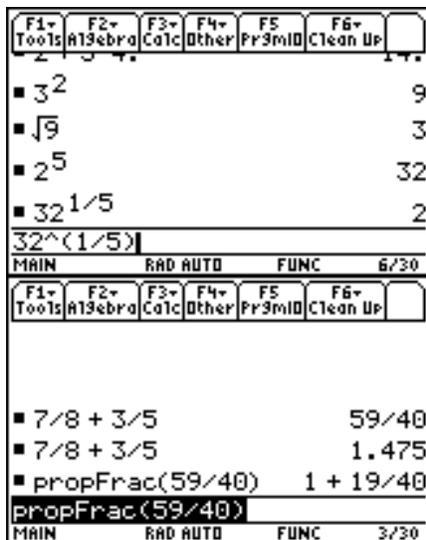
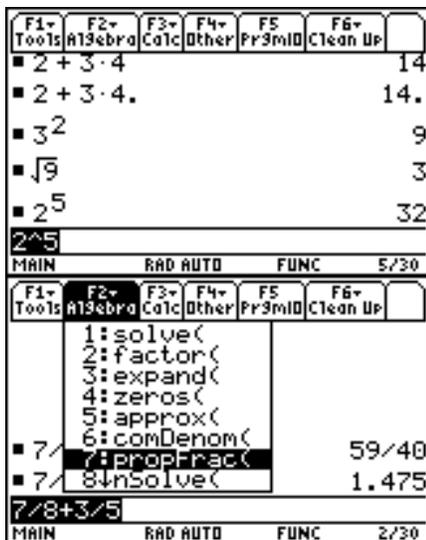
**Approximate:** All numeric results, where possible, are displayed in floating-point (decimal) form.

**Auto:** Uses Exact form where possible, but uses the Approximate form when entry contains a decimal point.

**Accuracy:** Floating-point decimal values in memory are stored using up to 14 digits with a 3-digit exponent. Integer values in memory are stored using up to 614 digits. The TI-89 carries more digits internally than it displays.

## OPERATIONS

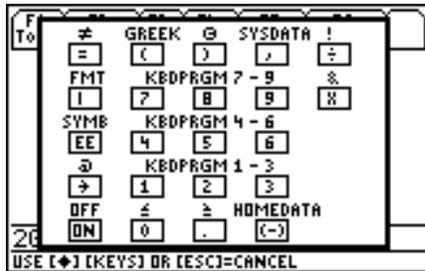
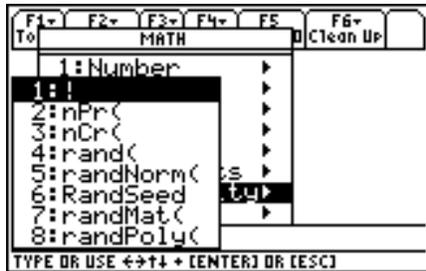
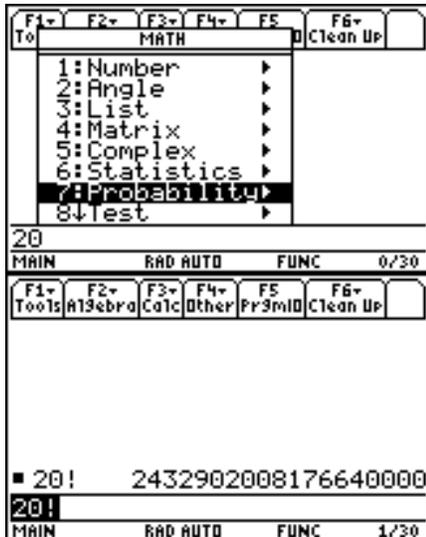
$2+3*4$ , <b>ENTER</b>	14
$2+3*4.$ , <b>ENTER</b> (notice a decimal in one number of the expression determines that the answer will be printed with a decimal point)	14.
$3^2$ , (type $3 \wedge 2$ , $\wedge$ row 5, column E, notice the pretty print), <b>ENTER</b>	9
$\sqrt{9}$ , (square root, row 7, column E), (remember right parenthesis), <b>ENTER</b>	3
$2^5$ ( $2^5$ , use $\wedge$ (row 5, col E) to raise a number to a power)	32
$\sqrt[3]{32}$ ( $32^{(1/5)}$ )	2
Add $7/8$ and $3/5$	$59/40$
Use Green Diamond (◆) and <b>ENTER</b>	1.475
Write $59/40$ as a mixed number	$1 + 19/40$



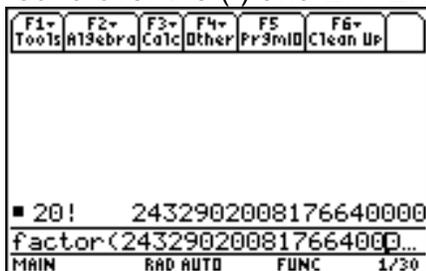
### Factorial, Factor, Expand, Solve, Zeros Commands

20! can be entered two ways. One way, using the MATH key and 7: Probability menu 1:!, a second way using the short cut. To find the short cut for!, activate the keyboard map with

◆K. Note that factorial is ◆÷.



A choice was made not to clutter the keyboard with all the special characters. Factor the answer given for 20!. Either type the word “factor”, or under the **F2:Algebra** menu, select 2:factor(), or press **CATALOG** (row 4 column C) select factor() by pressing **ENTER** once it is highlighted in the list. In the Entry line, type **factor(ans(1))**. Note ans and entry are found over the (-) and ENTER keys.



Expand  $(x+y)^5$ , then factor the expansion! To expand this expression in general, use the **with** (|)command (row 7, column A) with  $n = 3$ , then 4, etc. A list can be used to do multiple expansions in the same command.

<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>F1+ Tools</td><td>F2+ A13ebra</td><td>F3+ Calc</td><td>F4+ Other</td><td>F5 Pr3mid</td><td>F6+ Clean Up</td></tr> </table> <p>▪ <math>\text{expand}((x+y)^5)</math>  <math>x^5 + 5 \cdot x^4 \cdot y + 10 \cdot x^3 \cdot y^2 + 10 \cdot x^2 \cdot y^3 + 5 \cdot x \cdot y^4 + y^5</math></p> <p>▪ <math>\text{factor}(x^5 + 5 \cdot x^4 \cdot y + 10 \cdot x^3 \cdot y^2 + 10 \cdot x^2 \cdot y^3 + 5 \cdot x \cdot y^4 + y^5)</math>  <math>(x+y)^5</math></p> <p>MAIN RAD AUTO FUNC 2/30</p>	F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>F1+ Tools</td><td>F2+ A13ebra</td><td>F3+ Calc</td><td>F4+ Other</td><td>F5 Pr3mid</td><td>F6+ Clean Up</td></tr> </table> <p>▪ <math>\text{expand}((x+y)^n   n=3)</math>  <math>x^3 + 3 \cdot x^2 \cdot y + 3 \cdot x \cdot y^2 + y^3</math></p> <p>▪ <math>\text{expand}((x+y)^n   n={3,4,5})</math>  <math>x^3 + 3 \cdot x^2 \cdot y + 3 \cdot x \cdot y^2 + y^3</math>  <math>x^4 + 4 \cdot x^3 \cdot y + 6 \cdot x^2 \cdot y^2 + 4 \cdot x \cdot y^3 + y^4</math></p> <p>expand((x+y)^n   n={3,4,5})</p> <p>MAIN RAD AUTO FUNC 1/30</p>	F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr><td>F1+ Tools</td><td>F2+ A13ebra</td><td>F3+ Calc</td><td>F4+ Other</td><td>F5 Pr3mid</td><td>F6+ Clean Up</td></tr> </table> <p>▪ <math>\text{expand}((x+y)^n   n=3)</math>  <math>x^3 + 3 \cdot x^2 \cdot y + 3 \cdot x \cdot y^2 + y^3</math></p> <p>▪ <math>\text{expand}((x+y)^n   n={3,4,5})</math>  <math>x^3 + 3 \cdot x^2 \cdot y + 3 \cdot x \cdot y^2 + y^3</math>  <math>x^4 + 4 \cdot x^3 \cdot y + 6 \cdot x^2 \cdot y^2 + 4 \cdot x \cdot y^3 + y^4</math></p> <p>expand((x+y)^n   n={3,4,5})</p> <p>MAIN RAD AUTO FUNC 1/2</p>	F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
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Notice how the TI-89 factors  $x^2 - 4$ ,  $x^2 + 4$ ,  $x^2 - 2$ . By placing the variable after the expression, the expression is factored as much as possible toward real factors that are linear, even if it introduces irrational constants. A “cFactor” was necessary before factoring complex roots.

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### Solving Linear Equations Showing All the Steps

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F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$(2 \cdot x = 6 \cdot x + 11) - 6 \cdot x$   
 $-4 \cdot x = 11$   
 $\frac{-4 \cdot x = 11}{-4} \quad x = -11/4$   
 $2 \cdot x - 5 = 6 \cdot x + 6 \mid x = -11/4$   
 true  
**2\*x-5=6\*x+6|x=-11/4**

MAIN	RAD AUTO	FUNC	6/30
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## Exploring Repeating Decimals

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

NewProb Done  
 $n = 3.1616161616161 \rightarrow x$   
 $n = 3.16161616162$   
 $100 \cdot x$   
 $100 \cdot n = 316.161616162$   
 $100 \cdot x - x \quad 99 \cdot n = 313.$   
 $99 \cdot n = 313.9999999999999$

MAIN	RAD AUTO	FUNC	4/30
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F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$100 \cdot x$   
 $100 \cdot n = 316.161616162$   
 $100 \cdot x - x \quad 99 \cdot n = 313.$   
 $\text{solve}(99 \cdot n = 313, n)$   
 $n = \frac{313}{99}$   
**solve(99\*n=313,n)**

MAIN	RAD AUTO	FUNC	5/30
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F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

NewProb Done  
 $n = .12121212121212 \rightarrow x$   
 $n = .121212121212$   
 $100 \cdot x$   
 $100 \cdot n = 12.1212121212$   
 $100 \cdot x - x \quad 99 \cdot n = 12.$   
 $99 \cdot n = 12.$

MAIN	RAD AUTO	FUNC	4/30
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F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$n = .12121212121212$   
 $100 \cdot x$   
 $100 \cdot n = 12.1212121212$   
 $100 \cdot x - x \quad 99 \cdot n = 12.$   
 $\text{solve}(99 \cdot n = 12, n)$   
 $n = 4/33$   
**solve(99\*n=12,n)**

MAIN	RAD AUTO	FUNC	5/30
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Try  $n=1.23555555\dots$

## Algebraic Fractions

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$\text{expand}\left(\frac{x^2}{(x-1)^2 \cdot (x^2-4)}\right)$   
 $\frac{-1}{9 \cdot (x+2)} - \frac{8}{9 \cdot (x-1)} - \frac{1}{3 \cdot (x-2)}$   
**expand(x^2/((x-1)^2(x^2-4)))**

MAIN	RAD AUTO	FUNC	1/30
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## Partial Fraction Expansion

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$\text{expand}\left(\frac{x^2}{(x-1)^2 \cdot (x^2-4)}\right)$   
 $\frac{8}{(x-1)} - \frac{1}{3 \cdot (x-1)^2} + \frac{1}{x-2}$   
**expand(x^2/((x-1)^2(x^2-4)))**

MAIN	RAD AUTO	FUNC	1/30
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F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$\text{comDenom}\left(\frac{1}{x} + \frac{1}{x+1}\right)$   
 $\frac{2 \cdot x + 1}{x^2 + x}$   
**expand((2\*x+1)/(x^2+x))**

MAIN	RAD AUTO	FUNC	1/30
------	----------	------	------

F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$\text{comDenom}\left(\frac{1}{x} + \frac{1}{x+1}\right)$   
 $\frac{2 \cdot x + 1}{x^2 + x}$   
 $\text{expand}\left(\frac{2 \cdot x + 1}{x^2 + x}\right)$   
 $\frac{1}{x+1} + \frac{1}{x}$   
**factor((2\*x+1)/(x^2+x))**

MAIN	RAD AUTO	FUNC	2/30
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F1+	F2+	F3+	F4+	F5	F6+
Tools	A13ebra	Calc	Other	Pr3mID	Clean Up

$\frac{x^2 + x}{x^2 + x}$   
 $\text{expand}\left(\frac{2 \cdot x + 1}{x^2 + x}\right)$   
 $\frac{1}{x+1} + \frac{1}{x}$   
 $\text{factor}\left(\frac{2 \cdot x + 1}{x^2 + x}\right)$   
 $\frac{2 \cdot x + 1}{x \cdot (x+1)}$   
**factor((2\*x+1)/(x^2+x))**

MAIN	RAD AUTO	FUNC	3/30
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Notice if the degree of the numerator is lower than the degree of the denominator, the same fraction returns; if the degree of the numerator is the same degree as the denominator, or higher than the degree as the denominator, then the partial fractions are returned.

F1+ Tools F2+ A13ebra F3+ Calc F4+ Other F5+ Pr3mid F6+ Clean Up

propFrac( $\frac{x}{x^2 - 3 \cdot x + 2}$ )

propFrac( $\frac{x^2}{x^2 - 3 \cdot x + 2}$ )

propFrac( $x^2/(x^2-3x+2)$ )

MAIN RAD AUTO FUNC 1/30

F1+ Tools F2+ A13ebra F3+ Calc F4+ Other F5+ Pr3mid F6+ Clean Up

$x^2 - 3 \cdot x + 2$

propFrac( $\frac{x^2}{x^2 - 3 \cdot x + 2}$ )

$\frac{3 \cdot x - 2}{x^2 - 3 \cdot x + 2} + 1$

propFrac( $x^2/(x^2-3x+2)$ )

MAIN RAD AUTO FUNC 2/30

F1+ Tools F2+ A13ebra F3+ Calc F4+ Other F5+ Pr3mid F6+ Clean Up

$x^2 - 3 \cdot x + 2$

propFrac( $\frac{x^3}{x^2 - 3 \cdot x + 2}$ )

$\frac{7 \cdot x - 6}{x^2 - 3 \cdot x + 2} + x + 3$

propFrac( $x^3/(x^2-3x+2)$ )

MAIN RAD AUTO FUNC 3/30

Solve  $3^x = x^3$

F1+ Tools F2+ Zoom F3+ Edit F4+ ✓ F5+ All F6+ Style F7+ Plot...

+PLOTS

√y1=3<sup>x</sup>

√y2=x<sup>3</sup>

y3=

y4=

y5=

y6=

y3(x)=

MAIN RAD AUTO FUNC

F1+ Tools F2+ Setup F3+ Header F4+ Table F5+ Plot F6+ Plot...

TABLE SETUP

tblStart: 2

Δtbl: 1

Graph ↔ Table: OFF →

Independent: MATH →

Enter=SAVE ESC=CANCEL

y4(x)=

USE ← AND → TO OPEN CHOICES

F1+ Tools F2+ Setup F3+ Header F4+ Table F5+ Plot F6+ Plot...

x	y1	y2
2.1	10.045	9.261
2.2	11.212	10.648
2.3	12.514	12.167
2.4	13.967	13.824
2.5	15.588	15.625

y2(x)=15.625

MAIN RAD AUTO FUNC

F1+ Tools F2+ Zoom F3+ Trace F4+ ReGraph F5+ Math F6+ Draw F7+ Pen...

xmin=-4.

xmax=4.

xsc1=1.

ymin=-5.

ymax=60.

ysc1=10.

xres=1.

MAIN RAD AUTO FUNC

F1+ Tools F2+ Setup F3+ Header F4+ Table F5+ Plot F6+ Plot...

x	y1	y2
2.1	.78411	
2.2	.56358	
2.3	.3465	
2.4	.14261	
2.5	-.0365	

y3(x)=-.03654273188

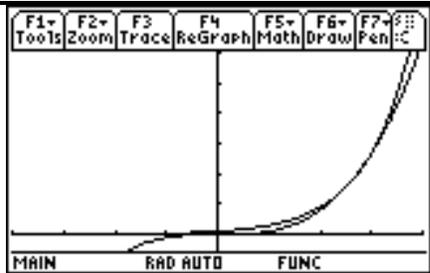
MAIN RAD AUTO FUNC

F1+ Tools F2+ Setup F3+ Header F4+ Table F5+ Plot F6+ Plot...

x	y3
2.45	.04914
2.46	.03133
2.47	.01384
2.48	-.0033
2.49	-.0201

y3(x)=-.003312660765

MAIN RAD AUTO FUNC



F1+ Tools F2+ Setup F3+ Header F4+ Table F5+ Plot F6+ Plot...

+PLOTS

y1=3<sup>x</sup>

y2=x<sup>3</sup>

√y3=y1(x) - y2(x)

y4=

y5=

y6=

y4(x)=

MAIN RAD AUTO FUNC

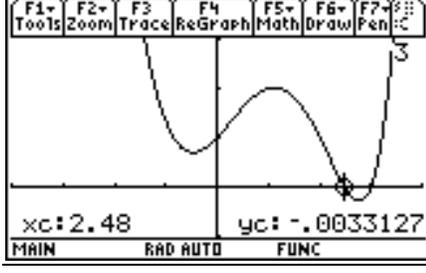
F1+ Tools F2+ A13ebra F3+ Calc F4+ Other F5+ Pr3mid F6+ Clean Up

■ solve(y1(x)=y2(x),x)

x=3. or x=2.47805268029

solve(y1(x)=y2(x),x)

Warnin3: More solutions may exist



## Trigonometric Equations

$\text{solve}(\sin(x) \cdot \cos(x) = 1/2)$   
 $x = \frac{(4 \cdot @n1 + 1) \cdot \pi}{4}$   
 $x = \frac{(4 \cdot @n1 + 1) \cdot \pi}{4} \mid @n1 = 1$   
 $x = \frac{5 \cdot \pi}{4}$   
 $x = \left\{ \frac{5 \cdot \pi}{4}, \frac{9 \cdot \pi}{4}, \frac{13 \cdot \pi}{4} \right\}$

$x = \frac{(4 \cdot @n1 + 1) \cdot \pi}{4}$   
 $x = \frac{(4 \cdot @n1 + 1) \cdot \pi}{4} \mid @n1 = 1$   
 $x = \frac{5 \cdot \pi}{4}$   
 $x = \frac{5 \cdot \pi}{4}$   
 $x = \frac{5 \cdot \pi}{4}$

$x = \frac{(4 \cdot @n1 + 1) \cdot \pi}{4}$   
 $x = \frac{(4 \cdot @n1 + 1) \cdot \pi}{4} \mid @n1 = \{1, 2, 3\}$   
 $x = \frac{5 \cdot \pi}{4}$   
 $x = \left\{ \frac{5 \cdot \pi}{4}, \frac{9 \cdot \pi}{4}, \frac{13 \cdot \pi}{4} \right\}$

Note that @n1 in the example above represents the first arbitrary integer that has appeared in this session. To evaluate some of the answers, highlight and paste the answer in the entry line and use the with | operator (row 7, column A) to assign a list of values to @n1. Use  $\blacklozenge$  STO to get the @ symbol.

The Solve command returns “false” if no real solutions are found, “true” when solve can determine that any finite real value of variable satisfies the equation or inequality.

$\text{solve}\left(\tan(2 \cdot x) - \frac{1}{\tan(x)} = 0\right)$   
 $x = 7.85398 \text{ or } x = 6.80678$   
 $x = 4.71239 \text{ or } x = 3.6651$

$\text{solve}\left(\tan(2 \cdot x) - \frac{1}{\tan(x)} = 0\right)$   
 $x = 7.85398 \text{ or } x = 6.80678$   
 $x = 4.71239 \text{ or } x = 3.6651$

$\text{solve}\left(\tan(2 \cdot x) - \frac{1}{\tan(x)} = 0\right)$   
 $x = 7.85398 \text{ or } x = 6.80678$   
 $x = 2.61799 \text{ or } x = 1.5708$

## A useful function for simulations.

The function will be called randint(lower, upper, number)

APPLICATIONS  
 1:Home  
 2:Y= Editor  
 3:Window Editor  
 4:Graph  
 5:Table  
 6:Data/Matrix Editor  
 7:Program Editor  
 8:Text Editor

NEW  
 Type: Function  
 Folder: main  
 Variable: randint

APPLICATIONS  
 1:Home  
 2:Y= Editor  
 3:Window Editor  
 4:Graph  
 5:Table  
 6:Data/Matrix Editor  
 7:Program Editor  
 8:Text Editor

NEW  
 Type: Function  
 Folder: main  
 Variable: randint

APPLICATIONS  
 1:Home  
 2:Y= Editor  
 3:Window Editor  
 4:Graph  
 5:Table  
 6:Data/Matrix Editor  
 7:Program Editor  
 8:Text Editor

NEW  
 Type: Function  
 Folder: main  
 Variable: randint

F1+ Tools	F2+ Control	F3+ I/O	F4+ Var	F5 Find...	F6+ Mode
<pre> :randint(1,u,n) :Funcd :Return seq(1-1+rand(u-1+ ),x,1,n) :EndFunc </pre>					
MAIN	RAD AUTO	FUNC			

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> ■ randint(3,5,10) (3 5 5 4 3 3 5 3) ■ randint(3,5,10) </pre>					
MAIN	RAD AUTO	FUNC			1/30

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> ■ randint(3,5,10) (3 5 5 4 3 3 5 3) ■ randint(1,5,7) (2 5 2 3 4 1 1) ■ randint(1,3,7) (1 3 3 3 2 1 2) ■ randint(1,3,7) </pre>					
MAIN	RAD AUTO	FUNC			3/30

## Random Polynomial

To generate a polynomial with random integer coefficients between -9 and 9, select the MATH key (row 8, column C), then 7:Probability, then 6:RandSeed. After seeding the random number generator, go back to that same menu and choose 8:randPoly(, make the random polynomial of degree 5 in the variable x. The function can then be differentiated. The roots can be found for both the first and second derivative.

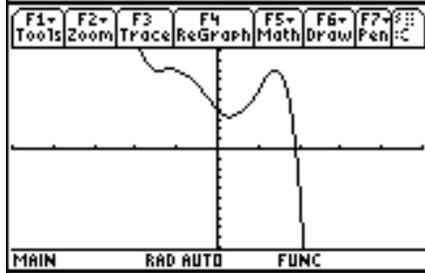
F1+ To	F2+ MATH	F3+ Clean Up
<pre> 1: Number 2: Angle 3: List 4: Matrix 5: Complex 6: Statistics 7: Probability 8: Test </pre>		
MAIN	RAD AUTO	FUNC 0/30

F1+ To	F2+ MATH	F3+ Clean Up
<pre> 1: Number 1: ! 2: nPr( 3: nCr( 4: rand( 5: randNorm( 6: RandSeed 7: randMat( 8: randPoly( </pre>		
MAIN	RAD AUTO	FUNC 0/30

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> ■ RandSeed 123 Done ■ randPoly(x,5) -x^5 - x^4 + 4·x^3 + 4·x^2 - 4·x ■ -x^5 - x^4 + 4·x^3 + 4·x^2 - 4·x Done ans(1)+f(x) </pre>					
MAIN	RAD AUTO	FUNC			3/30

F1+ Tools	F2+ Zoom	
<pre> xmin=-5. xmax=5. xscl=1. ymin=-10. ymax=10. yscl=1. xres=2. </pre>		
MAIN	RAD AUTO	FUNC

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> -x^5 - x^4 + 4·x^3 + 4·x^2 - 4·x ■ -x^5 - x^4 + 4·x^3 + 4·x^2 - 4·x Done ■ ClrGraph Done ■ Graph f(x) Done Graph f(x) </pre>					
MAIN	RAD AUTO	FUNC			5/30



F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> ■ d/dx(f(x)) -5·x^4 - 4·x^3 + 12·x^2 + 8·x d(f(x),x) </pre>					
MAIN	RAD AUTO	FUNC			1/30

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> d^2/dx^2(f(x)) -20·x^3 - 12·x^2 + 24·x + 8 zeros(-5·x^4 - 4·x^3 + 12·x^2 + 8·x) { sqrt(2) -sqrt(2) sqrt(14-2)/5 -sqrt(14)/5 } -20*x^3-12*x^2+24*x+8,x) </pre>					
MAIN	RAD AUTO	FUNC			7/30

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> { sqrt(2) -sqrt(2) sqrt(14-2)/5 -sqrt(14)/5 } ■ d^2/dx^2(f(x)) -20·x^3 - 12·x^2 + 24·x + 8 d(f(x),x,2) </pre>					
MAIN	RAD AUTO	FUNC			3/30

F1+ Tools	F2+ A13ebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<pre> d^2/dx^2 -20·x^3 - 12·x^2 + 24·x + 8 ■ zeros(-20·x^3 - 12·x^2 + 24·x + 8) { 1 sqrt(6-4)/5 -sqrt(6+4)/5 } -20*x^3-12*x^2+24*x+8,x) </pre>					
MAIN	RAD AUTO	FUNC			9/30

Each of the derivatives may be stored in y2(x), and y3(x). Choose different style to graph the functions.

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li><math>\frac{d^2}{dx^2}(f(x)) \rightarrow y3(x)</math> Done</li> <li><math>\frac{d}{dx}(f(x)) \rightarrow y2(x)</math> Done</li> <li><math>f(x) \rightarrow y1(x)</math> Done</li> </ul>					
f(x) → y1(x)					
MAIN RAD AUTO FUNC 6/30					
F1+ Tools	F2+ Zoom	F3 Trace	F4 ReGraph	F5 Math	F6+ Draw
MAIN RAD AUTO FUNC 8/30					

F1+ Tools	F2+ Zoom	F3 Edit	F4 ✓	F5 All	F6+ Style
<ul style="list-style-type: none"> <li>1: Line</li> <li>2: Dot</li> <li>3: Square</li> <li>4: Thick</li> <li>5: Animate</li> <li>6: Path</li> <li>7: Above</li> <li>8: Below</li> </ul>					
<ul style="list-style-type: none"> <li>√y1 = f(x)</li> <li>√y2 = <math>\frac{d}{dx}(f(x))</math></li> <li>√y3 = <math>\frac{d^2}{dx^2}(f(x))</math></li> </ul>					
y1(x) = f(x)					
MAIN RAD AUTO FUNC					

F1+ Tools	F2+ Zoom
<ul style="list-style-type: none"> <li>xmin = -5.</li> <li>xmax = 5.</li> <li>xsc1 = 1.</li> <li>ymn = -20.</li> <li>ymax = 20.</li> <li>ysc1 = 5.</li> <li>xres = 2.</li> </ul>	
MAIN RAD AUTO FUNC	

Use the TI-89 to solve systems of equations step by step.

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li>NewProb Done</li> <li><math>2 \cdot x + 3 \cdot y = 12 \rightarrow eq1</math></li> <li><math>2 \cdot x + 3 \cdot y = 12</math></li> <li><math>x - 2 \cdot y = -2 \rightarrow eq2</math></li> <li><math>x - 2 \cdot y = -2</math></li> </ul>					
x-2y = -2 → eq2					
MAIN RAD AUTO FUNC 3/30					
F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li>eq2   eq1 for x → eqy</li> <li><math>6 - \frac{7 \cdot y}{2} = -2</math></li> <li>solve(eqy, y) → soly</li> <li>y = 16/7</li> </ul>					
solve(eqy, y) → soly					
MAIN RAD AUTO FUNC 6/30					

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li><math>2 \cdot x + 3 \cdot y = 12</math></li> <li><math>x - 2 \cdot y = -2 \rightarrow eq2</math></li> <li><math>x - 2 \cdot y = -2</math></li> <li>solve(eq1, x) → eq1 for x</li> <li><math>x = \frac{-3 \cdot (y - 4)}{2}</math></li> </ul>					
solve(eq1, x) → eq1 for x					
MAIN RAD AUTO FUNC 4/30					
F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li><math>6 - \frac{7 \cdot y}{2} = -2</math></li> <li>solve(eqy, y) → soly</li> <li>y = 16/7</li> <li>eq1 for x   soly → solx</li> <li>x = 18/7</li> </ul>					
eq1 for x   soly → solx					
MAIN RAD AUTO FUNC 7/30					

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li>solve(eq1, x) → eq1 for x</li> <li><math>x = \frac{-3 \cdot (y - 4)}{2}</math></li> <li>eq2   eq1 for x → eqy</li> <li><math>6 - \frac{7 \cdot y}{2} = -2</math></li> </ul>					
eq2   eq1 for x → eqy					
MAIN RAD AUTO FUNC 5/30					

**New Example – System of Equations**

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li>NewProb Done</li> <li><math>3 \cdot x + 4 \cdot y = 17</math></li> <li><math>3 \cdot x + 4 \cdot y = 17</math></li> <li><math>2 \cdot x - 3 \cdot y = 10</math></li> <li><math>2 \cdot x - 3 \cdot y = 10</math></li> </ul>					
2x-3y=10					
MAIN RAD AUTO FUNC 3/30					

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li>solve(3·x + 4·y = 17, x)</li> <li><math>x = \frac{-(4 \cdot y - 17)}{3}</math></li> <li>solve(2·x - 3·y = 10, y)   x →</li> <li>y = 4/17</li> </ul>					
...-3*y=10, y)   x = -(4*y-17)/3					
MAIN RAD AUTO FUNC 5/30					

F1+ Tools	F2+ Algebra	F3+ Calc	F4+ Other	F5 Pr3mid	F6+ Clean Up
<ul style="list-style-type: none"> <li>solve(2·x - 3·y = 10, y)   x →</li> <li>y = 4/17</li> <li><math>x = \frac{-(4 \cdot y - 17)}{3}   y = 4/17</math></li> <li>x = 91/17</li> </ul>					
x = -(4*y-17)/3   y=4/17					
MAIN RAD AUTO FUNC 6/30					

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
x =  $\frac{-(4 \cdot y - 17)}{3}$  | y = 4/17
x = 91/17
3 · x + 4 · y = 17 | x = 91/17 ar▶
true
2 · x - 3 · y = 10 | x = 91/17 ar▶
true
...y=17|x=91/17 and y=4/17
MAIN RAD AUTO FUNC 7/30

```

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
x = 91/17
3 · x + 4 · y = 17 | x = 91/17 ar▶
true
2 · x - 3 · y = 10 | x = 91/17 ar▶
true
2 · x - 3 · y = 10 | x = 91/17 and y = ...
MAIN RAD AUTO FUNC 8/30

```

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
simult  $\begin{bmatrix} 3 & 4 \\ 2 & -3 \end{bmatrix}, \begin{bmatrix} 17 \\ 10 \end{bmatrix}$ 
 $\begin{bmatrix} 91/17 \\ 4/17 \end{bmatrix}$ 
solve(3 · x + 4 · y = 17 and 2 · x - 3 · y = 10, (x, y))
MAIN RAD AUTO 30 30/30

```

## Converting from One Unit to Another

### Convert Units of Measure

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
1 · _mi ▶ _yd 1760. _yd
1 · _mi ▶ _ft 5280. _ft
1 · _mi ▶ _in 63360. _in
.5 · _acre ▶ _ft
21780. _ft2
.5 · _acre ▶ _ft
MAIN RAD AUTO 30 30/30

```

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
60 · _mi ▶ _ft 88. _ft
1 · _hr ▶ _s
2 · _mi ▶ _mi 4. _mi
30 · _min ▶ _hr
2 · _mi ▶ _ft
30 · _min ▶ _s
2 · _mi / (30 · _min) ▶ _ft / _s
MAIN RAD AUTO 30 1/30

```

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
2 · _mi ▶ _mi 4. _mi
30 · _min ▶ _hr
2 · _mi ▶ _ft
30 · _min ▶ _s
5.86667 · _ft
2 · _mi / (30 · _min) ▶ _ft / _s
MAIN RAD AUTO 30 30/30

```

### Convert a Temperature Value

```

F1+ F2+ F3+ F4+ F5+ F6+
Tools Algebra Calc Other Pr3mid Clean Up
tmpCnv(0 · _°C, _°F) 32. _°F
tmpCnv(212 · _°F, _°C) 100. _°C
tmpCnv(70 · _°F, _°C) 21.1111 · _°C
tmpCnv(80 · _°F, _°C)
MAIN RAD AUTO 30 29/30

```

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Web Site: [www.mc3.edu/gen/faculty/RHOFMANN](http://www.mc3.edu/gen/faculty/RHOFMANN)

## Two Variable Statistics Example:

Mrs. O purchased a item in 1955 for \$1200. Its value was \$1800 in 1960, \$2500 in 1965, and \$3100 in 1970. If the value of the item were to appreciate according to the same pattern through 2000, estimate the value of the antique in the year 2000. Input the following data and fit a curve.

Go to the application key (APPS), choose 6:Data/Matrix Editor, choose 3:New from the submenu. Input the years in c1, input the value of the items in c2. Choose F5:Calc. Under the Calculation Type, choose 5:LinReg. For the x category, input c1, use c2 for y. At the Store RegEQ submenu, choose y1(x). Press ENTER to keep all the selections made. Notice the box with the regression equation and the correlation coefficient. Press F2 Plot Setup, then press F1 Define. Choose Scatter for Plot Type; Cross for Mark; c1 for x, and c2 for y. Press ENTER. Make sure all other plots are turned off as well as all functions, other than y1(x). Choose 9:ZoomData from F2 Zoom menu. To find the value in year 2000, use y1(2000).

APPLICATIONS

- 1:Home
- 2:Y= Editor
- 3:Window Editor
- 4:Graph
- 5:Table
- 6:Data/Matrix Editor
- 7:Program Editor
- 8:Text Editor

NewProb

MAIN	RAD	AUTO	FUNC
F1+ Tools	F2 Plot Setup	F3 Cell	F4 Header
F5 Calc	F6 Util	F7 Stat	
DATA			
1	c1	c2	c3
2	1955	1200	
3	1960	1800	
4	1965	2500	
	1970	3100	

r4c2=3100

MAIN RAD AUTO FUNC

F1+ Tools F2 Zoom F3 Trace F4 ReGraph F5 Math F6 Draw F7 Fen

STAT VARS

DATA

y=a·x+b

a =128.

b =249050.

corr =.999512

R2 =.999024

Enter=OK

MAIN RAD AUTO FUNC

APPLICATIONS

- 1:Home
- 2:Y= Editor
- 3:Window Editor
- 4:Graph
- 5:Table
- 6:Data/Matrix Editor
- 7:Program Editor
- 8:Text Editor

NewProb

MAIN	RAD	AUTO	FUNC
F1+ Tools	F2 Plot Setup	F3 Cell	F4 Header
F5 Calc	F6 Util	F7 Stat	
main\mrso Plot 1			
Plot Type	Scatter		
Mark	Box		
X	c1		
Y	c2		
Free and Categories?	NO		

Enter=SAVE

MAIN RAD AUTO FUNC

main\mrso Calculate

Calculation Type

- 1:OneVar
- 2:TwoVar
- 3:CubicReg
- 4:ExpReg
- 5:LinReg
- 6:LnReg
- 7:MedMed
- 8:PowerReg

Enter=SAVE

MAIN RAD AUTO FUNC

main\mrso Calculate

Calculation Type

LinReg

X c1

Y c2

Store RegEQ to y1(x)

Free and Categories? NO

Enter=SAVE

MAIN RAD AUTO FUNC

F1+ Tools F2 Zoom F3 Trace F4 ReGraph F5 Math F6 Draw F7 Fen

Plot 1

xc:1965. yc:2500.

MAIN RAD AUTO FUNC

NEW

Type: Data

Folder: main

Variable: mrso

Enter=OK

ESC=CANCEL

MAIN RAD AUTO FUNC

F1+ Tools F2 Zoom

xmi 3:ZoomOut

xma 4:ZoomDec

xsc 5:ZoomSqr

ymi 6:ZoomStd

yma 7:ZoomTrig

ysc 8:ZoomInt

xre 9:ZoomData

HzZoomFit

MAIN RAD AUTO FUNC

main\mrso Calculate

Calculation Type

LinReg

X c1

Y c2

Store RegEQ to y1(x)

Free and Categories? NO

Enter=SAVE

ESC=CANCEL

MAIN RAD AUTO FUNC

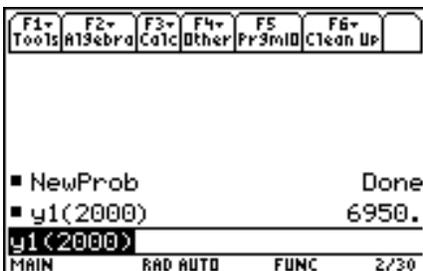
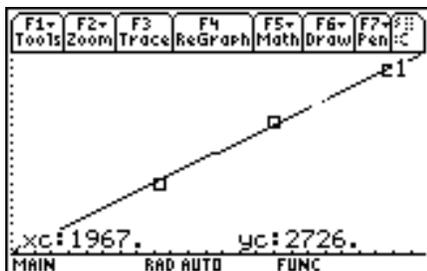
USE AND TO OPEN CHOICES

F1+ Tools F2 Zoom F3 Trace F4 ReGraph F5 Math F6 Draw F7 Fen

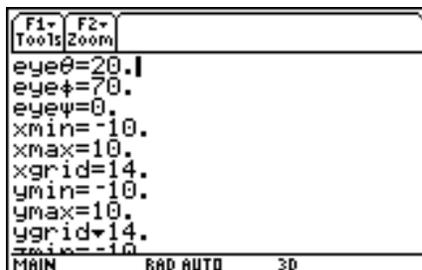
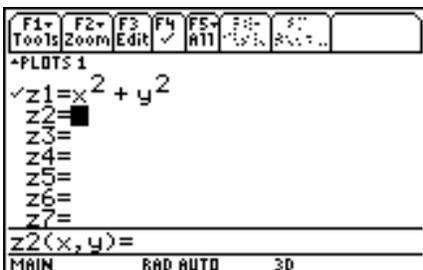
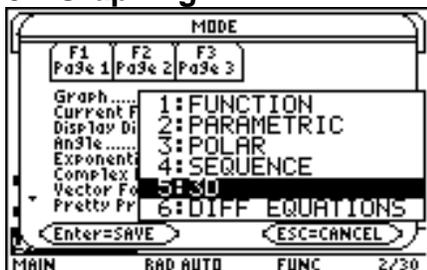
Plot 1

xc:1965. yc:2500.

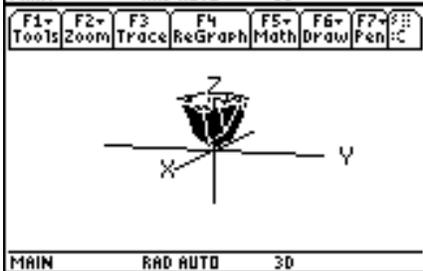
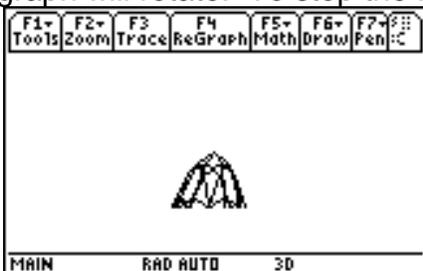
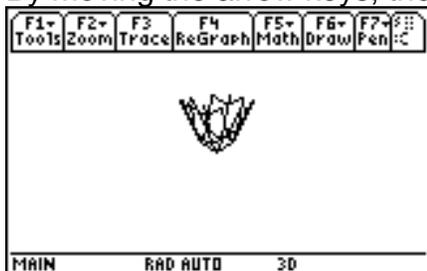
MAIN RAD AUTO FUNC



### 3D Graphing



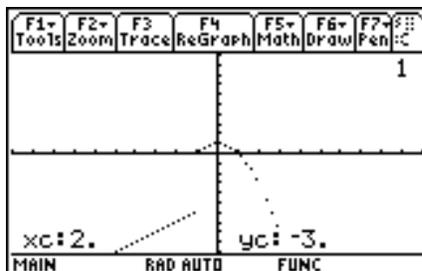
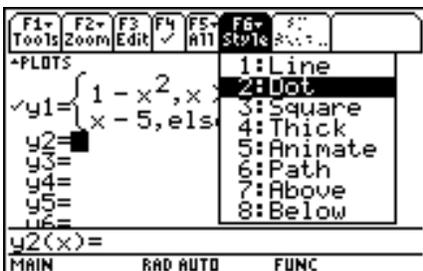
By moving the arrow keys, the graph will rotate. To stop the rotation, press ENTER.



### OTHER GRAPHING TECHNIQUES

Piecewise Functions:

$$\text{Graph: } f(x) = \begin{cases} 1 - x^2 & x > -1 \\ x - 5 & \text{otherwise} \end{cases}$$



## Script Using the Text Editor

Save your example as a script.

The first screenshot shows the calculator's main screen with a script being edited: `solve(a*x^2+b*x+c=0,x)`. The second screenshot shows the 'SAVE COPY AS' dialog box with 'Type: Text', 'Folder: main', and 'Variable: load'. The third screenshot shows the 'APPLICATIONS' menu with '9:Text Editor' selected, and the script being saved as 'this is a script'. Below this, the script content is shown: `C:2+a`, `C:3+b`, `C:-4+c`, and `C:solve(a*x^2+b*x+c=0,x)`. The final screenshot shows the calculator displaying the solution:  $x = \frac{-(\sqrt{41} + 3)}{4}$  or  $x = \frac{\sqrt{41} - 3}{4}$ .

If you are starting on the script page: Press the APPS key and choose 9:Text Editor, then 3:New.

Use F2 to generate a command line and Enter to generate a comment line. Press F3 to view the Script. Press F4 to execute each line in the script one a time.

Use F3 to clear the split screen.

## Animation

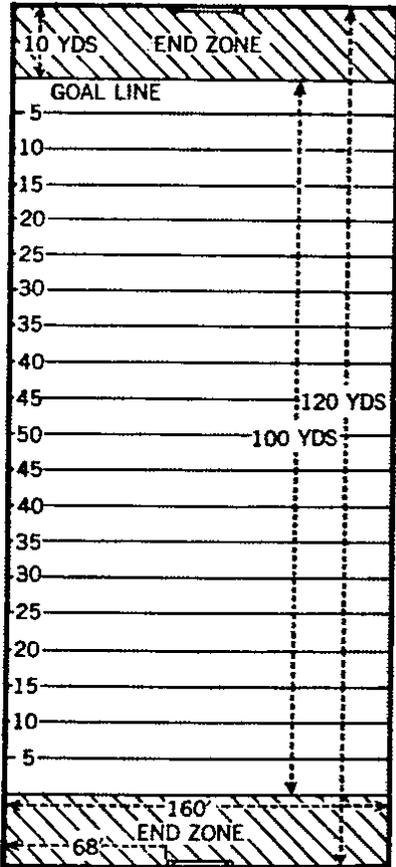
Animate a small circle moving along the inside of a larger circle.

The first screenshot shows the calculator's main screen with a script being edited: `cygenc()`, `Prgm`, `!script to generate pictures`, `For n,1,7,1:ClrGraph`, `Graph 4*cos(t),4*sin(t),t`, `(n-1)*pi/3+k`, `Graph 3*cos(k)+1*cos(t),3*sin(k)+1*sin(t),t`, `StoPic #("jcpic"&string(n))`, `EndFor`, `!play back DyclePic "jcpic",7,.3,2,-1`, `EndPrgm`. The second screenshot shows the calculator displaying the animation of a small circle moving along the inside of a larger circle. The script content is shown: `cygenc()`, `CyclePic "jcpic",7,.3,2,-1`. The final screenshot shows the calculator displaying the animation of a small circle moving along the inside of a larger circle.

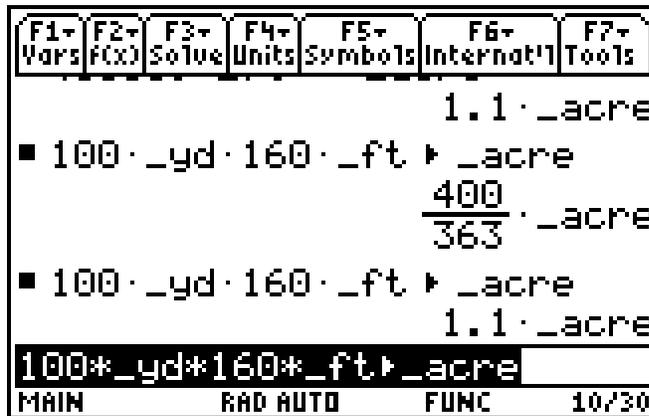
# How Big is an Acre?

Note: 1 acre = 43560 sq. ft.

Is an Intercollegiate football field larger or smaller than an acre?



Random House Dictionary 2<sup>nd</sup> Edition, 1987



## Transformations on the TI-89

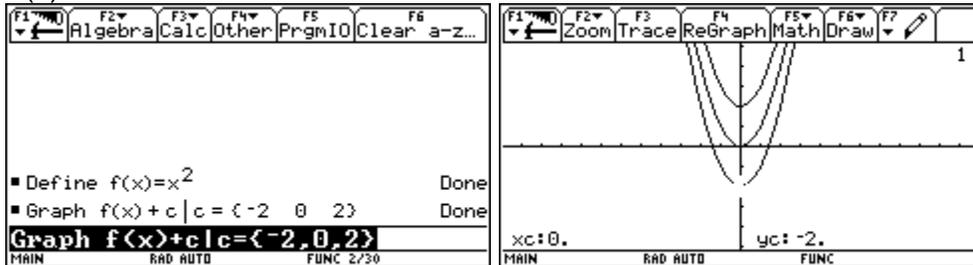
This is a lab to be completed using your TI-89. On a separate paper, answer the questions in complete sentences and draw the graphs neatly. Be sure to number your answers.

Part A: On the same axis, graph the following functions on your TI-89:

$$f(x) = x^2$$

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

$$h(x) = x^2 - 2$$



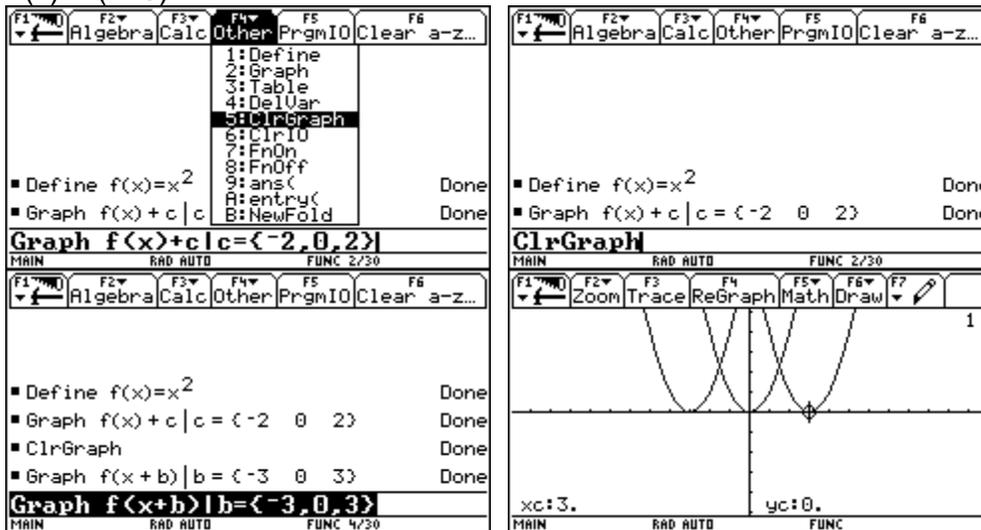
1. Describe what happens to a graph when a basic function,  $f(x)$  has a positive constant added to it, i.e.,  $f(x) + c$ .
2. Describe what happens to a graph when a basic function,  $f(x)$  has a positive constant subtracted from it, i.e.,  $f(x) - c$ .
3. Without using your calculator, predict what your sketch of the graph  $y = x^2 + 4$  would look like. Draw the graph using a pencil and paper.
4. Without using your calculator, predict what your sketch of the graph  $y = x^2 - 4$  would look like. Draw the graph using a pencil and paper.

Part B: On the same axis, graph the following functions on the TI-89:

$$f(x) = x^2$$

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

$$h(x) = (x+3)^2$$



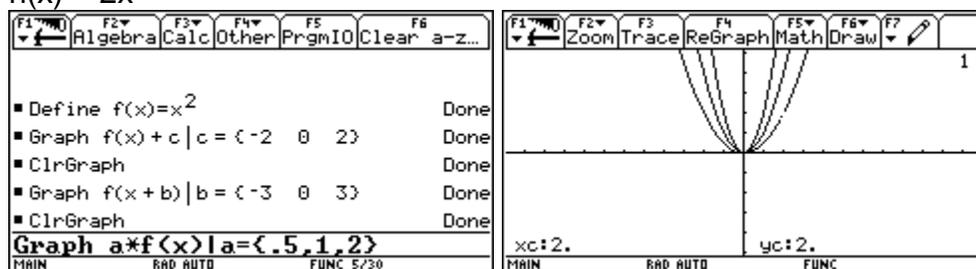
- Describe what happens to a graph when the argument of a basic function, the  $x$  of the  $f(x)$  has a positive constant added to it, i.e.,  $f(x + b)$ .
- Describe what happens to a graph when the argument of a basic function, the  $x$  of the  $f(x)$  has a positive constant subtracted from it, i.e.,  $f(x - b)$ .
- Without using your calculator, predict what your sketch of the graph  $y = (x + 4)^2$  would look like. Draw the graph using a pencil and paper.
- Without using your calculator, predict what your sketch of the graph  $y = (x - 4)^2$  would look like. Draw the graph using a pencil and paper.

Part C: On the same axis, graph the following functions on the TI-89:

$$f(x) = .5x^2$$

$$g(x) = x^2$$

$$h(x) = 2x^2$$



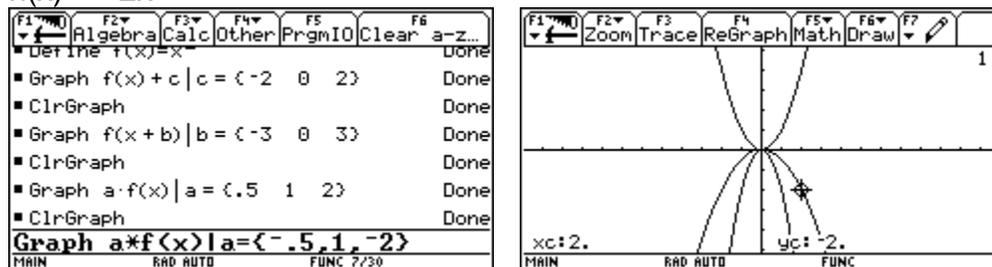
- Describe what happens to the graph of a function when the function is multiplied by a positive constant greater than 1, i.e.,  $a \cdot f(x)$ .
- Describe what happens to the graph of a function when the function is multiplied by a positive constant less than 1, i.e.,  $a \cdot f(x)$ .
- Without using your calculator, predict what your sketch of the graph  $y = 4x^2$  would look like. Draw the graph using a pencil and paper.
- Without using your calculator, predict what your sketch of the graph  $y = .25x^2$  would look like. Draw the graph using a pencil and paper.

Part D: On the same axis, graph the following functions on the TI-89:

$$f(x) = -.5x^2$$

$$g(x) = x^2$$

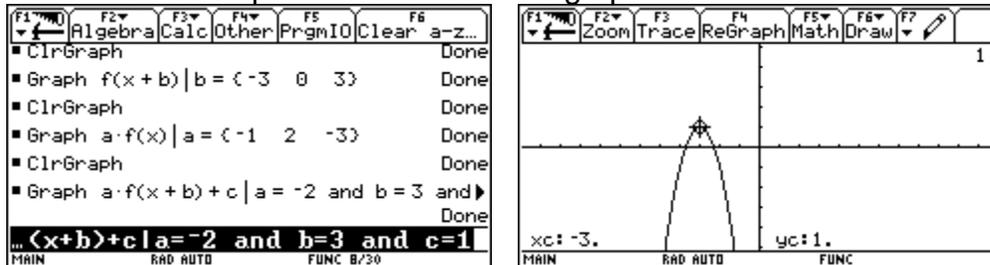
$$h(x) = -2x^2$$



- Describe what happens to the graph of a function when the function is multiplied by a negative constant, i.e.,  $a \cdot f(x)$ .

14. Without using your calculator, predict what your sketch of the graph  $y = -4x^2$  would look like. Draw the graph using a pencil and paper.

Part D: Use the general form of a function  $a \cdot f(x + b) + c$ , and let  $a = -2$ ,  $b = 3$  and  $c = 1$ . Notice how each parameter affects the graph.



15. Now go back and make the original  $f(x) = \text{abs}(x)$ . Display the graphs of

- $f(x + 2)$
- $f(x) + 3$
- $4 \cdot f(x)$
- $.25 \cdot f(x)$
- $-f(x)$

16. Now go back and make the original  $f(x) = x^3$ . Display the graphs of

- $f(x + 2)$
- $f(x) + 3$
- $4 \cdot f(x)$
- $.25 \cdot f(x)$
- $-f(x)$



## Inverse Functions

Define  $f(x)$ . Solve  $y=f(x)$  for  $x$ . Define  $g(y)$ . Interchange  $x$  and  $y$  by writing  $g(x)$ .

Check using composition of functions.

Discuss the appearance of  $|x|$  in the  $f(g(x))$

```

F1+  F2+  F3+  F4+  F5  F6+
Tools Algebra Calc Other Pr3mID Clean Up

■ Define f(x) = √(x+1) Done
■ solve(y = f(x), x)
  x = y^2 - 1 and y ≥ 0
■ Define g(y) = y^2 - 1 | y ≥ 0
  Done
...fine g(y)=y^2-1 | y≥0
MAIN      RAD AUTO      FUNC      4/30
    
```

```

F1+  F2+  F3+  F4+  F5  F6+
Tools Algebra Calc Other Pr3mID Clean Up

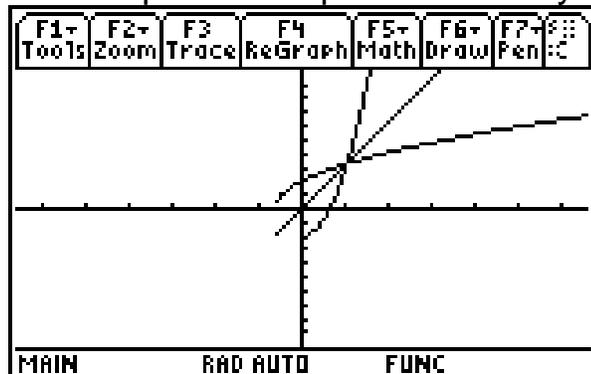
■ Define g(y) = y^2 - 1 | y ≥ 0
  Done
■ g(f(x))
  x
■ f(g(x))
  |x|
■ f(g(x)) | x > 0
  x
f(g(x)) | x > 0
MAIN      RAD AUTO      FUNC      7/30
    
```

```

F1+  F2+  F3  F4  F5+  F6+  F7
Tools Zoom 3: / 2: 3: 4: 5: 6: ...

+PLOTS
✓y1=f(x)
✓y2=g(x)
✓y3=f(g(x))
✓y4=g(f(x))
y5=
y6=
y7=
y4(x)=g(f(x))
MAIN      * RAD AUTO      FUNC
    
```

ZoomSqr. Zoom square to note symmetry about the line  $y=x$ .



Try a second function.

$$f(x) = \frac{1}{2x+1}$$

$$f(x) = x^2$$