

**COLLEGE ALGEBRA AND TRIGONOMETRY**

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**EXPLORATIONS FOR THE TI-81 AND TI-82  
GRAPHICS CALCULATORS**

**NANCY HYDE**

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Broward Community College



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## PREFACE

This book was written to accompany and enhance a traditional course in College Algebra or College Algebra and Trigonometry. The use of the TI-81 or TI-82 graphics calculator is intended to reinforce and clarify the traditional algebraic techniques, rather than replace them. Use of this manual does not require previous experience with the graphics calculator. It attempts to provide both student and instructor with a very simple guide to utilizing the technology for the purpose of understanding mathematics. The introductory chapters give basic instruction in the use of the calculators. New calculator techniques are introduced as they are needed in the various activities. This is by no means comprehensive coverage of the capabilities of the TI-81/TI-82. It is comprehensive coverage of how the TI-81/TI-82 can be used in College Algebra and Trigonometry.

The Activities in the manual fall into two categories. Some are purely explorations that make use of the power of visualization to solidify algebraic techniques and concepts. The purpose of other activities is to show how to use the calculator as a tool to either facilitate or verify the algebra. The activities are designed to take 5 to 15 minutes. When appropriate, exercises are included for the purpose of practicing techniques. It is assumed that the student has some knowledge of the algebraic topic covered by the activity. The activities can be used as classroom demonstrations or as individual assignments. With the basics in hand, the instructions are such that students can complete the activities on their own or in groups with no assistance.

I hope you will find that using the TI-81/TI-82 in your College Algebra course is both enlightening and enjoyable.

I would like to thank the following people for their valuable suggestions and their support of this project: Jerome Kaufmann, Nancy Johnson, Broward Community College, Bill Jordan, Seminole Community College, and Joan Thomas, University of Oregon. Much thanks also to the PWS staff for their patience and help.

Nancy Hyde

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Note: For users of Kaufmann's *College Algebra*, Third Edition, *College Algebra and Trigonometry*, Third Edition, and *Trigonometry*, Second Edition, a correlation chart is provided at the end of the book.

# TI-81

## INTRODUCTION TO THE TI-81

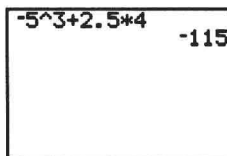
### GETTING STARTED

Take a moment to look at the TI-81 keyboard. Many of the keys are self explanatory such as the light gray numeric value keys in the lower center and the four bright blue basic operation keys down the right side. The light blue **2ND** key in the upper left corner must be pressed to access any function appearing in light blue above the left corner of a key. The **ON/OFF** key is in the lower left corner. Press it to turn on the calculator. Adjust the contrast by pressing **2ND** and holding down the up arrow **Δ** or down arrow **▽** until the flashing cursor is visible. To turn off the calculator press **2ND** **OFF**. To be certain that all settings are in the original state let us **RESET** the calculator. Turn on the calculator and press **2ND** **RESET**. (RESET is located above the **+**) Select **RESET** by pressing **2**. The screen will fade because the contrast has been reset. Adjust the contrast again by pressing **2ND** and holding down the up arrow **Δ** or down arrow **▽** until the flashing cursor is visible. Press **CLEAR**. The **CLEAR** key can be pressed to clear the screen at any time. Now we are ready to begin.

We are now on what is called the HOME screen. This is where all calculations will be done. The HOME screen can be accessed from any other screen by pressing **2ND** **QUIT**. This key is located in the right column above the **CLEAR** key.

### CALCULATING

Try a simple calculation. On the HOME screen enter  $-5^3 + 2.5 \times 4$ . Notice that the negative sign **(-)** on the bottom row is different from the subtraction sign **-** in the right column. They are not interchangeable. Probably the most common reason for an **ERROR** message on the TI-81 is the use of a subtraction sign in place of a negative sign. The black carat key **^** above the division **÷** key is for exponents. **ENTER** must be pressed to complete any operation.



The image shows a rectangular display screen from a TI-81 calculator. The screen is divided into two horizontal sections. The top section contains the expression  $-5^3 + 2.5 * 4$  in a monospaced font. The bottom section contains the result  $-115$  in the same font.



The established order of operations is always in effect. Notice the keys located in the left column for taking the reciprocal  $x^{-1}$ , absolute value,  $\boxed{2ND} \boxed{ABS}$ , squaring  $x^2$ , and square root,  $\boxed{2ND} \boxed{\sqrt{\phantom{x}}}$ . The absolute value and square root operations will be performed on the value immediately following the operation symbol.

### EXAMPLE 1

Calculate: a)  $\sqrt{90}$     b)  $|-14.62|$     c)  $(58)^2$     d)  $(1.8)^{-1}$

### SOLUTION

First clear the HOME screen by pressing  $\boxed{CLEAR}$ .

- a) Press  $\boxed{2ND} \boxed{\sqrt{\phantom{x}}} \boxed{9} \boxed{0} \boxed{ENTER}$ .  
 b) Press  $\boxed{2ND} \boxed{ABS} \boxed{(-)} \boxed{14.62} \boxed{ENTER}$   
 c) Press  $\boxed{58} \boxed{x^2} \boxed{ENTER}$   
 d) Press  $\boxed{1.8} \boxed{x^{-1}} \boxed{ENTER}$

$\sqrt{90}$ 9.486832981	abs -14.62 14.62	$58^2$ 3364	$1.8^{-1}$ .5555555556
----------------------------	---------------------	----------------	---------------------------

Variables are accessible on the TI-81 by pressing  $\boxed{ALPHA}$  and the key with the desired variable located in the upper right corner. The  $\boxed{X/T}$  key will give the variable X or T (depending on the MODE setting) without using the  $\boxed{ALPHA}$  key. The value of a variable will be 0 until some value is assigned to it. To store a value in a variable, type the value to be stored, press  $\boxed{STO\>}$  the variable  $\boxed{ENTER}$ .

### EXAMPLE 2

Store 88.4 in Z.

### SOLUTION

Press  $\boxed{88.4} \boxed{STO\>} \boxed{Z} \boxed{ENTER}$ .

(Notice when the  $\boxed{STO\>}$  key is pressed the cursor changes to  $\boxed{A}$  to indicate that you are in alpha mode)

To retrieve the variable Z press  $\boxed{ALPHA} \boxed{Z} \boxed{ENTER}$ .

88.4→Z	88.4
Z	88.4

### EXAMPLE 3

Evaluate  $5b^2$  for  $b = 6.89$ .

#### SOLUTION

Press **6.89** **STO→** **B** **ENTER**. Now 6.89 is stored in b. Press **5** **ALPHA** **B** **x<sup>2</sup>** **ENTER**.

6.89→B	6.89
5B <sup>2</sup>	237.3605

### GRAPHING

The five black keys across the top are for graphing. The **Y=** key will access a screen where up to 4 equations can be entered. Pressing the arrow keys **▽** will allow you to move the cursor around on the **Y=** screen. In function mode all functions must be in terms of **X**. Any other variable will be viewed as the constant value assigned to it. To delete an equation on the **Y=** screen move the cursor to the line that is to be deleted and press **CLEAR**.

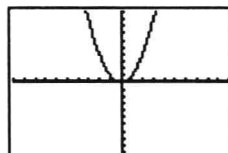
### EXAMPLE 4

Graph  $y = x^2$ .

#### SOLUTION

Press **Y=**. Once on the **Y=** screen move the cursor to the Y<sub>1</sub> line and press **X/T** **x<sup>2</sup>**. Now press **GRAPH**.

Y <sub>1</sub> =X <sup>2</sup>
Y <sub>2</sub> =
Y <sub>3</sub> =
Y <sub>4</sub> =



The **RANGE** key sets the viewing window of the coordinate plane vertically and horizontally. A STANDARD viewing window is considered to be  $[-10,10]$  for  $x$  and  $[-10,10]$  for  $y$ . Press **RANGE** to check the viewing window. The viewing window can be set to any

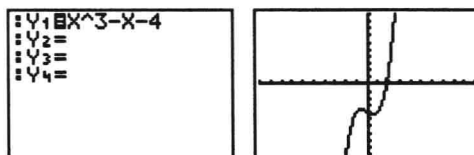
desired size by manually entering values for **Xmin**, **Xmax**, **Ymin**, **Ymax**. The **Xscl** and **Yscl** values set the scale of the marks on the x and y axes respectively. If you do not wish any scale marks to appear set the **scl** to 0. Use the arrow keys to move around on the **[RANGE]** screen. The **[ZOOM]** key can be used to set viewing windows quickly. The STANDARD viewing window can be set by pressing **[ZOOM]** **[6]**. The viewing window must always be considered in achieving a satisfactory view of the graph.

#### EXAMPLE 5

Graph the equation  $y = x^3 - x - 4$ .

#### SOLUTION

Set the standard viewing window from the **[ZOOM]** menu by pressing **[ZOOM]** **[6]**. Enter the function by pressing **[Y=]** and entering the expression. Press **[GRAPH]**.



Press **[TRACE]**. A flashing cursor appears on the curve and the coordinates of the point are shown. The left and right arrows will move the cursor along the curve showing the coordinates as it moves. Notice that the x values chosen by the cursor are not "friendly". The viewing window is 95 pixels across and 63 pixels from top to bottom. If we wish to have "friendly" values chosen for x then  $\frac{X_{\max} - X_{\min}}{95}$  must be "friendly". Press the **[RANGE]** key. Move the cursor using the arrow keys and let **Xmin** = -4.8 and **Xmax** = 4.7. Now **[TRACE]**. The cursor moves in increments of 0.1. We can make the cursor move in whatever increment we wish by letting  $\frac{X_{\max} - X_{\min}}{95}$  equal the desired increment. Setting a range where x is [-4.8, 4.7] and y is [-3.2, 3.1] is referred to as a "friendly window". We will often refer to the "friendly window" in later activities.

#### EVALUATING FUNCTIONS/EXPRESSIONS

On the TI-81 there are various methods for evaluating an expression or function. Using **[TRACE]** as described above is one method.

#### EXAMPLE 6

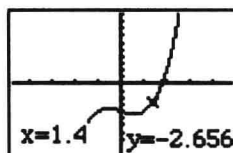
Calculate the value of the expression  $x^3 - x - 4$  for  $x = 1.4$ .

### SOLUTION

The expression is the same as graphed previously. By setting "friendly" x values we can evaluate the expression when x is 1.4 by tracing to the appropriate point.

```
RANGE
Xmin=-4.8
Xmax=4.7
Xscl=1
Ymin=-10
Ymax=10
Yscl=1
Xres=1
```

```
Y1=BX^3-X-4
Y2=
Y3=
Y4=
```



Thus the value of the expression is  $-2.656$ .

A second method of evaluating is to **STORE** the desired value in X and calculate the value of Y<sub>1</sub>. This is done from the HOME screen after the function is entered in Y<sub>1</sub> on the **Y=** screen.

### EXAMPLE 7

Using the expression defined above calculate the value of the expression when  $x = \sqrt{5}$ .

### SOLUTION

Press **2ND** **QUIT** to return to the Home screen.

Press **2ND**  **$\sqrt{\phantom{x}}$**  **5** **STO>** **X/T** **ENTER**. This will store  $\sqrt{5}$  in X.

Now press **2ND** **Y-VARS**. Press **1** for Y<sub>1</sub>.

Y<sub>1</sub> will appear on the Home screen. Press **ENTER**. The value of Y<sub>1</sub> is calculated.

```
√5→X
Y1      2.236067978
        4.94427191
```

The value of the expression is 4.94427191.

A convenient feature of the TI-81 allows you to access the last calculated answer in two ways. If an operation key is pressed that requires a value before it, the previous answer will be assumed. For example, if you now wanted to add 15 to the previous result press **+** **15** **ENTER**. The TI-81 recalls the previous answer and adds 15.

$\sqrt{5 \times X}$	2.236067978
$Y_1$	4.94427191
$\text{Ans} + 15$	19.94427191

Another way to access the previous answer is to press **2ND** **ANS** (located above the **(-)** key).

### EDITING

If you make an error while you are typing, it can be corrected by typing over it. Simply move the cursor using the arrow keys until it is on top of the incorrect character. Type the correct character. If you have already pressed **ENTER**, the last entry can be recalled by either pressing the up arrow **▲** or by pressing **2ND** **ENTRY** (located over the **ENTER** key). A character can be inserted or deleted by moving the cursor to the desired position, pressing **INS** and the desired insertion or **DEL** to delete what is under the cursor.

# TI-82

## INTRODUCTION TO THE TI-82

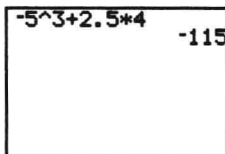
### GETTING STARTED

Take a moment to look at the TI-82 keyboard. Many of the keys are self explanatory such as the light gray numeric value keys in the lower center and the four dark blue basic operation keys down the right side. The light blue **2ND** key in the upper left corner must be pressed to access any function appearing in light blue above the left corner of a key. The **ON/OFF** key is in the lower left corner. Press it to turn on the calculator. Adjust the contrast by pressing **2ND** and holding down the up arrow **▲** or down arrow **▼** until the flashing cursor is visible. To turn off the calculator press **2ND** **OFF**. To be certain that all settings are in the original state let us **RESET** the calculator. Turn on the calculator and press **2ND** **MEM**. (MEM is located above the **+**) Select **RESET** by pressing **3** and then **2**. The screen will fade because the contrast has been reset. Adjust the contrast again by pressing **2ND** and holding down the up arrow **▲** or down arrow **▼** until the flashing cursor is visible. Press the **CLEAR** key. **CLEAR** can be pressed to clear the screen at any time. Now we are ready to begin.

We are now on what is called the HOME screen. This is where all calculations will be done. The HOME screen can be accessed from any other screen by pressing **2ND** **QUIT**. This key is located above the **MODE** key to the right of **2ND**.

### CALCULATING

Try a simple calculation. On the HOME screen enter  $-5^3 + 2.5 \times 4$ . Notice that the negative sign **(-)** on the bottom row is different from the subtraction sign **-** in the right column. They are not interchangeable. Probably the most common reason for an **ERROR** message on the TI-82 is the use of a subtraction sign in place of a negative sign. The black carat key **^** above the division **÷** key is for exponents. **ENTER** must be pressed to complete any operation.



The image shows a TI-82 calculator screen with a black border. Inside the screen, the expression  $-5^3 + 2.5 \times 4$  is displayed on the top line, and the result  $-115$  is displayed on the bottom line. The numbers and symbols are in a monospaced font.

The established order of operations is always in effect. Notice the keys located in the left column for taking the reciprocal  $x^{-1}$ , absolute value, **2ND** **ABS**, squaring,  $x^2$ , and square root, **2ND**  $\sqrt{\phantom{x}}$ . The absolute value and square root operations will be performed on the value immediately following the operation symbol.

### EXAMPLE 1

Calculate: a)  $\sqrt{90}$     b)  $|-14.62|$     c)  $(58)^2$     d)  $(1.8)^{-1}$

### SOLUTION

First clear the HOME screen by pressing **CLEAR**.

a) Press **2ND**  $\sqrt{\phantom{x}}$  **9** **0** **ENTER**.

b) Press **2ND** **ABS** **(-)** **14.62** **ENTER**

c) Press **58**  $x^2$  **ENTER**

d) Press **1.8**  $x^{-1}$  **ENTER**

$\sqrt{90}$ 9.486832981	abs -14.62 14.62	$58^2$ 3364	$1.8^{-1}$ .555555556
----------------------------	---------------------	----------------	--------------------------

The TI-82 has the ability to work with fractions. Add  $\frac{1}{3} + \frac{1}{4}$  by pressing **1** **+** **3** **+** **1** **+** **4** **MATH**. Choose 1:  $\triangleright$  **FRAC** by pressing **1**. Press **ENTER**. You should now have a result of  $\frac{7}{12}$ . Any decimal numeral that represents a rational number can be converted to a fraction using this feature under the **MATH** menu.

Variables are accessible on the TI-82 by pressing **ALPHA** and the key with the desired variable located in the upper right corner. The **X T  $\theta$**  key will give the variable X or T or  $\theta$  (depending on the MODE setting) without using the **ALPHA** key. The value of a variable will be 0 until some value is assigned to it. To store a value in a variable, type the value to be stored, press **STO $\triangleright$**  **ALPHA** the variable **ENTER**.

### EXAMPLE 2

Store 88.4 in Z.

### SOLUTION

Press **88.4** **STO>** **ALPHA** **Z** **ENTER**.

To retrieve the variable **Z** press **ALPHA** **Z** **ENTER**.

88.4→Z	88.4
Z	88.4

### EXAMPLE 3

Evaluate  $5b^2$  for  $b = 6.89$ .

### SOLUTION

Press **6.89** **STO>** **ALPHA** **B** **ENTER**. Now 6.89 is stored in b.

Press **5** **ALPHA** **B** **x<sup>2</sup>** **ENTER**.

6.89→B	6.89
5B <sup>2</sup>	237.3605

### GRAPHING

The five black keys across the top are for graphing. The **Y=** key will access a screen where up to 10 equations can be entered. Pressing the arrow keys **▽** will allow you to move the cursor around on the **Y=** screen. In function mode all functions must be in terms of **X**. Any other variable will be viewed as the constant value assigned to it. To delete an equation on the **Y=** screen move the cursor to the line that is to be deleted and press **CLEAR**.

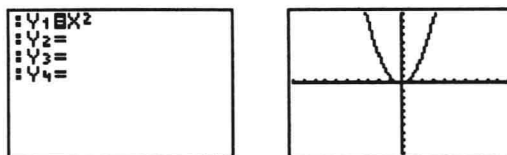
### EXAMPLE 4

Graph  $y = x^2$ .

### SOLUTION

Press **Y=**. Once on the **Y=** screen move the cursor to the  $Y_1$  line and press **XTθ** **x<sup>2</sup>**. Now press **GRAPH**.





The **WINDOW** key sets the viewing window of the coordinate plane vertically and horizontally. Press **WINDOW** to check the viewing window. The viewing window can be set to any desired size by manually entering values for **Xmin**, **Xmax**, **Ymin**, **Ymax**. The **Xscl** and **Yscl** values set the scale of the marks on the x and y axes respectively. If you do not wish any scale marks to appear set the **scl** to 0. Use the arrow keys to move around on the **WINDOW** screen. A STANDARD viewing window is considered to be  $[-10,10]$  for x and  $[-10,10]$  for y. The **ZOOM** key can be used to set viewing windows quickly. The STANDARD viewing window can be set by pressing **ZOOM** **6**. The viewing window must always be considered in achieving a satisfactory view of the graph.

#### EXAMPLE 5

Graph the equation  $y = x^3 - x - 4$ .

#### SOLUTION

Set the standard viewing window from the **ZOOM** menu by pressing **ZOOM** **6**. Enter the equation by pressing **Y=** and entering the expression. Press **GRAPH**.



Press **TRACE**. A flashing cursor appears on the curve and the coordinates of the point are shown. The left and right arrows will move the cursor along the curve showing the coordinates as it moves. Notice that the x values chosen by the cursor are not "friendly". The viewing window is 94 pixels across and 62 pixels from top to bottom. If we wish to have "friendly" values chosen for x then  $\frac{X_{\max} - X_{\min}}{94}$  must be "friendly". Press the **WINDOW** key. Move the cursor using the arrow keys and let **Xmin** = -4.7 and **Xmax** = 4.7. Now **TRACE**. The cursor moves in increments of 0.1. We can make the cursor move in whatever increment we wish by letting  $\frac{X_{\max} - X_{\min}}{94}$  equal the desired increment. Choosing **4** **Decimal** from the **ZOOM** menu will automatically set a window where x is  $[-4.7, 4.7]$  and y is  $[-3.1, 3.1]$ . This is referred to as a "friendly window". We will often refer to the "friendly window" in later activities.