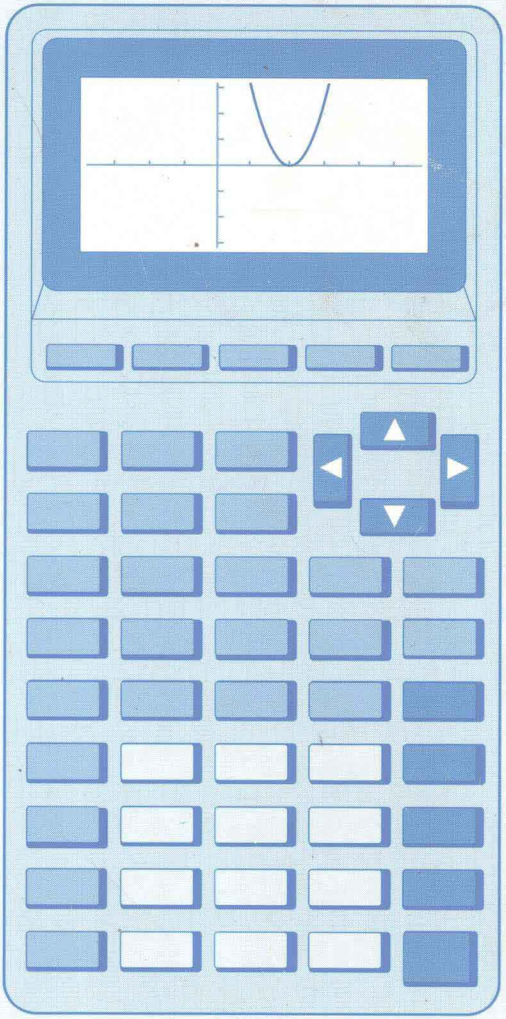
Graphing Calculator Keystroke Guide



to accompany the
HUBBARD / ROBINSON
Algebra Series

For use with:
TI-81, TI-82, TI-85
Casio fx-7700G, fx-9700GE, fx-7700GE
Hewlett-Packard HP-48G/48GX
Sharp EL-9200/9300

Benjamin N. Levy

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for the Hubbard/Robinson Algebra Series

Preface

This Guide provides keystroke-level calculator commands and instructions for all the *Key Words* in your algebra textbook. It does not replace the instruction manual that comes with the calculator. Refer to that manual to learn how to use additional capabilities that your calculator may have.

We use different typefaces to distinguish *keystrokes* that you press from the *text* of this guide. Thus MATH and ENTER will represent the *labels* on your calculator's keys.

Calculators have function keys that assume different behavior in different contexts. To clarify the effect expected from depressing a function key, we sometimes write F1 *[COMMAND]*, where F1 names the key and *[COMMAND]* represents its corresponding function in the current menu. In Chapter 7, since the HP-48G calculator has six white function keys, we write *[COMMAND]* to represent the function key below the menu item COMMAND.

For convenience, when you are asked to type a *number*, say 345.67, we shall express the keystrokes as 345.67, without any spaces between the individual keystokes, instead of writing 3 4 5 . 6 7.

The calculator manufacturers - Casio, Hewlett-Packard, Sharp, and Texas Instruments - have all been cooperative through the writing of this guide, and the author gratefully acknowledges their helpfulness.

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1.1 Getting started with the TI-81

1.1.1 Basics: Press the ON key to begin using your TI-81 calculator. If you need to adjust the display contrast, first press 2nd, then press and hold ▲ (the *up* arrow key) to increase the contrast or ▼ (the *down* arrow key) to decrease the contrast. As you press and hold ▲ or ▼, an integer between 0 (lightest) and 9 (darkest) appears in the upper right corner of the display. When you have finished with the calculator, turn it off to conserve battery power by pressing 2nd and then OFF.

Check the TI-81's settings by pressing MODE. If necessary, use the arrow keys to move the blinking cursor to a setting you want to change. Press ENTER to select a new setting. To start with, select the options along the left side of the MODE menu as illustrated in Figure 1.1: normal display, floating decimals, radian measure, function graphs, connected lines, sequential plotting, grid off, and rectangular coordinates. Details on alternative options will be given later in this guide as they are needed. For now, leave the MODE menu by pressing CLEAR.

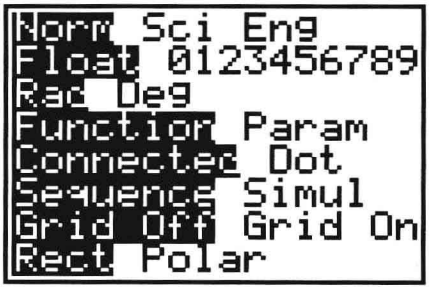

Figure 1.1: MODE menu

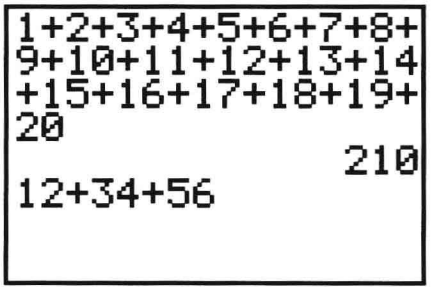

Figure 1.2: Home screen

1.1.2 Editing: One advantage of the TI-81 is that up to 8 lines are visible at one time, so you can *see* a long calculation. For example, type this sum (see Figure 1.2):

$$1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 + 11 + 12 + 13 + 14 + 15 + 16 + 17 + 18 + 19 + 20$$

Then press ENTER to see the answer, too.

Often we do not notice a mistake until we see how unreasonable an answer is. The TI-81 permits you to redisplay an entire calculation, edit it easily, then execute the *corrected* calculation.

Suppose you had typed 12 + 34 + 56 as in Figure 1.2 but had *not* yet pressed ENTER, when you realize that 34 should have been 74. Simply press ◀ (the *left* arrow key) as many times as necessary to move the blinking cursor left to 3, then type 7 to write over it. On the other hand, if 34 should have been 384, move the cursor back to 4, press INS (the cursor changes to a blinking underline) and then type 8 (inserts at the cursor position and other characters are pushed to the right). If the 34 should have been 3 only, move the cursor to 4 and press DEL to delete it.

Even if you had pressed ENTER, you may still edit the previous expression. Press 2nd and then ENTRY to *recall* the last expression that was entered. Now you can change it. If you have not pressed any key since the last ENTER, you can recall the previous expression by pressing ▲.

1.1.3 Key Functions: Most keys on the TI-81 offer access to more than one function, just as the keys on a computer keyboard can produce more than one letter ("g" and "G") or even quite different characters ("5" and "%"). The primary function of a key is indicated on the key itself, and you access that function by a simple press on the key.

To access the *second* function named in blue to the *left* above a key, first press 2nd (the cursor changes to a blinking ↑) and *then* press the key.

When you want to use a letter or other character named in gray to the *right* above a key, first press ALPHA (the cursor changes to a blinking **A**) and then the key.

The X|T key lets you enter the letter *X* easily without having to use the ALPHA key, so long as your calculator is set in FUNCTION mode (see Figure 1.1) for rectangular coordinates.

1.1.4 Order of Operations: The TI-81 performs calculations according to the standard algebraic rules. Working outwards from inner parentheses, calculations are performed from left to right. Powers and roots are evaluated first, followed by multiplications and divisions, and then additions and subtractions.

1.1.5 Repeated Operations with ANS: The result of your *last* calculation is always stored in memory location ANS and replaces any previous result. This makes it easy to use the answer from one computation in another computation. For example, press 30 + 15 ENTER so that 45 is the last result displayed. Then press 2nd ANS ÷ 9 ENTER and get 5 because $\frac{45}{9} = 5$.

With a function like division, you press the ÷ key *after* you enter an argument. For such functions, whenever you would start a new calculation with the previous answer followed by pressing the function key, you may press just the function key. So instead of 2nd ANS ÷ 9 in the previous example, you could have pressed simply ÷ 9 to achieve the same result. This technique also works for these functions: + - × x^2 ^ x^{-1}.

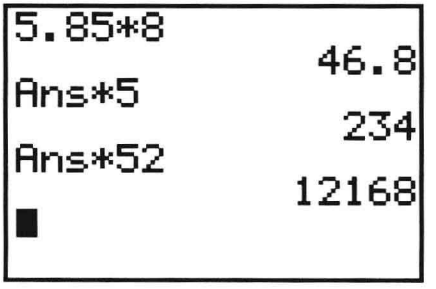

Figure 1.3: ANS variable

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Here is a situation where this is especially useful. Suppose a person makes $5.85 per hour and you are asked to calculate earnings for a day, a week, and a year. Execute the given keystrokes to find the person's incomes during these periods (results are shown above in Figure 1.3):

Pay period	*Keystrokes*	*Earnings*
8-hour day	5.85 × 8 ENTER	$46.80
5-day week	× 5 ENTER	$234
52-week year	× 52 ENTER	$12,168

1.1.6 The MATH Menu: Operators and functions associated with a scientific calculator are available either immediately from the keys of the TI-81 or by 2nd keys. You have direct key access to common arithmetic operations (x^2, 2nd $\sqrt{}$, x^{-1}, ^, 2nd ABS), exponential and logarithmic functions (LOG, 2nd 10^x, LN, 2nd e^x), and a famous constant (2nd π).

Additional mathematical operations and functions are available from the MATH menu (Figure 1.4). Press MATH to see the various options. You will learn in your algebra textbook how to apply many of them. To leave the MATH menu and take no other action, press 2nd QUIT or just CLEAR.

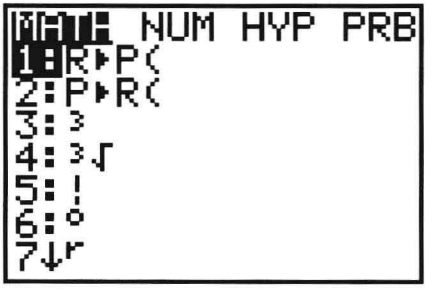

Figure 1.4: MATH menu

Note that you can select a sub-menu from the MATH menu by pressing either ◀ or ▶. But to get to the PRB sub-menu, it is easier to press ◀ *once* than to press ▶ *three* times.

1.2 Key Words

1.2.1 Negative: The TI-81 distinguishes between *subtraction* and the *negative sign*. If you wish to enter a negative number, it is necessary to use the (-) key. For example, when the temperature falls to 7° below zero, press (-) 7 to represent it.

You would evaluate $-5-(4\cdot-3)$ by pressing (-) 5 – (4 × (-) 3) ENTER to get 7 (as shown in Figure 1.5).

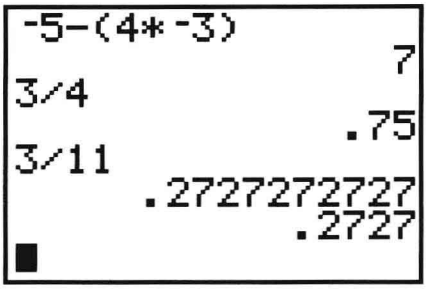

Figure 1.5: ***Negative*** and ***Decimal***

1.2.2 Decimal: Change $\frac{3}{4}$ to its decimal representation by pressing 3 ÷ 4 ENTER. Change $\frac{3}{11}$ by pressing 3 ÷ 11 ENTER. These are illustrated in Figure 1.5.

You can limit the number of decimal places that your calculator displays. For example, to restrict the display to *four* decimal places, change the second line in the MODE menu (Figure 1.6) from FLOAT to 4. Find the decimal representation of $\frac{3}{11}$ once again to see the difference. While the TI-81 now displays only four decimal places, it still retains more digits in memory and uses all the digits it knows in calculations.

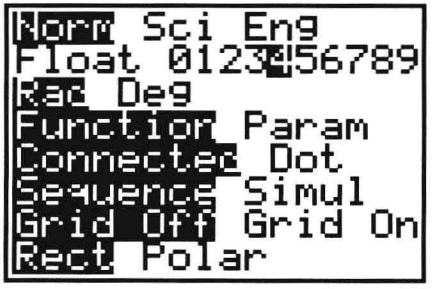

Figure 1.6: Changing the number of decimal places displayed

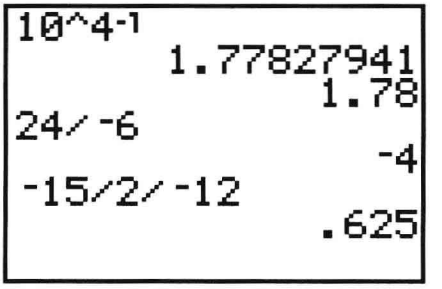

Figure 1.7: ***Decimal*** and ***Divide***

To calculate $\sqrt[4]{10}$, enter $10^{\frac{1}{4}}$ by pressing 10 ^ 4 x^{-1} ENTER. Round the result to two decimal places by changing the second line in the MODE menu (Figure 1.6) from FLOAT to 2. Then press ENTER once more for the two-place approximation (Figure 1.7).

1.2.3 Divide: Calculate the quotient $24 \div (-6)$ by pressing 24 ÷ (-) 6 ENTER (shown in Figure 1.7). Then find $\frac{-15}{2} \div (-12)$ by pressing (-) 15 ÷ 2 ÷ (-) 12 ENTER.

1.2.4 Square Root: To calculate $\sqrt{25}$, press 2nd √ 25 ENTER and get 5. Evaluate $-\sqrt{121}$ by (-) 2nd √ 121 ENTER and get -11.

1.2.5 Test: Relational operators, in the TEST menu (Figure 1.8), allow you to compare two quantities. A relation evaluates to 1 if it is true, and to 0 if false. For example, test the inequality $\frac{37}{38} < \frac{38}{39}$. Press 37 ÷ 38 2nd TEST 5 38 ÷ 39 ENTER (Figure 1.9). Since the inequality is true, the relation evaluates to 1.

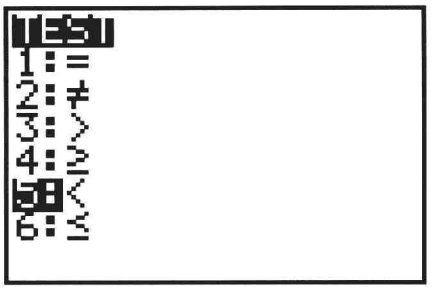

Figure 1.8: TEST menu

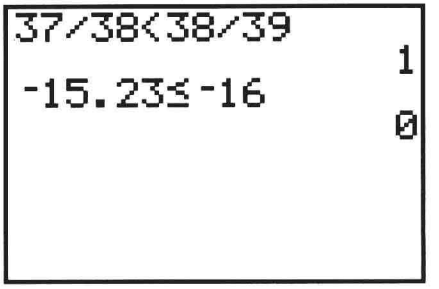

Figure 1.9: Testing inequalities

Now test whether $-15.23 \le -16$ by pressing (-) 15.23 2nd TEST 6 (-) 16 ENTER (Figure 1.9). This inequality is false, so the relation evaluates to 0.

Check whether $x = 2$ is a solution of $5 - x^2 = 3x - (2x + 1)$ by assigning the value 2 to the variable x (press 2 STO▸ X|T ENTER as in Figure 1.10) and then evaluating the equation $5 - x^2 = 3x - (2x + 1)$ (press 5 − X|T x^2 2nd TEST 1 3 X|T − (2 X|T + 1) ENTER). Since $x = 2$ *is* a solution, the equation evaluates to 1.

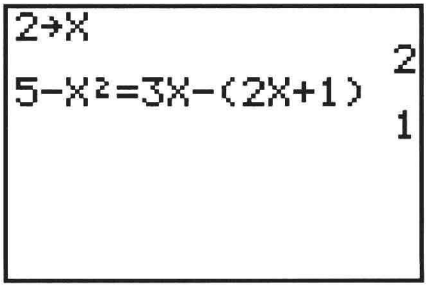

Figure 1.10: Checking $x = 2$ in $5 - x^2 = 3x - (2x + 1)$

To test (0, -3) in the inequality $y \le 4x - 3$, first enter the inequality itself as Y_1 by pressing Y= CLEAR ALPHA Y 2nd TEST 6 4 X|T − 3. Then store 0 for x and -3 for y. Finally, evaluate the inequality for the

current values of x and y by pressing 2nd Y-VARS 1 ENTER. Since (0, -3) *is* a solution of $y \le 4x - 3$, the inequality evaluates to 1.

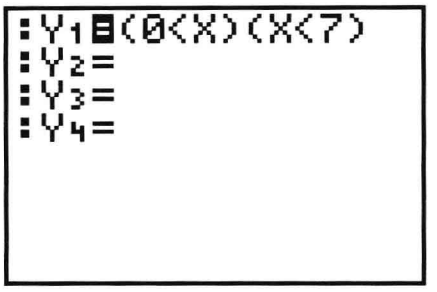

Figure 1.11: $(0 < x)(x < 7)$ for Y_1 in Y= list

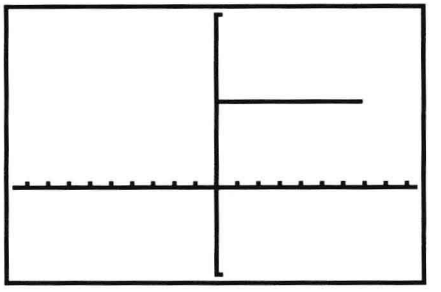

Figure 1.12: Number line for $\{x \mid 0 < x < 7\}$

To make a number line graph for $\{x \mid 0 < x < 7\}$, set the TI-81 to Dot mode and enter $(0 < x)(x < 7)$ for Y_1 by pressing Y= CLEAR (0 2nd TEST 5 X|T) (X|T 2nd TEST 5 7). A good viewing rectangle has a range that extends from -9.5 to 9.5 horizontally and from -1 to 2 vertically. Press GRAPH to see it (Figure 1.12).

1.2.6 Absolute Value: For $|-5|$, press 2nd ABS (-) 5 ENTER and get 5; for $-|8|$, press (-) 2nd ABS 8 ENTER and get -8; and for $-|-7|$, press (-) 2nd ABS (-) 7 ENTER and get -7.

1.2.7 Add: Calculate the sum $-12+7$ by pressing (-) 12 + 7 ENTER and get -5. Then find $20+(-8)$ by pressing 20 + (-) 8 ENTER and get 12.

1.2.8 Subtract: Evaluate the difference $9-17$ by pressing 9 – 17 ENTER and get -8. To calculate $8-(-12)$, just press 8 – (-) 12 ENTER and get 20 (see Figure 1.13).

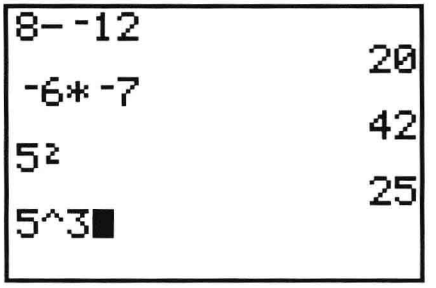

Figure 1.13: ***Subtract***, ***Multiply***, and ***Exponent***

1.2.9 Multiply: Find the product $(-6)(-7)$ by pressing (-) 6 × (-) 7 ENTER and get 42 (as in Figure 1.13).

1.2.10 Exponent: Here's how to evaluate exponential expressions with your TI-81. For squares, use the x^2 key. So to find 5^2, press 5 x^2 ENTER and get 25 (see Figure 1.13).

To evaluate a third power like 5^3, press 5 ^ 3 ENTER and get 125. You can also get a cube from the MATH menu; press these keys for 5^3: 5 MATH 3 ENTER.

For all other powers, you must use the ^ key. So for $(-3)^4$, press ((-) 3) ^ 4 ENTER and get 81; and for -3^4, press (-) 3 ^ 4 ENTER and get -81.

1.2.11 Reciprocal: Enter a number, then press the x^{-1} key to calculate its reciprocal. So the reciprocal of -12 is found by pressing (-) 12 x^{-1} ENTER. For the reciprocal of 4.2, just press 4.2 x^{-1} ENTER. These two calculations are shown in Figure 1.14.

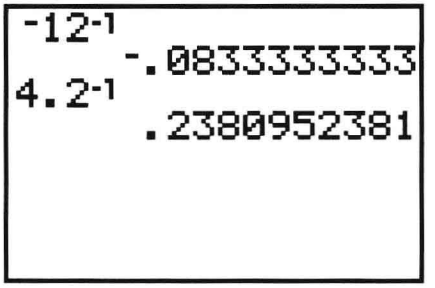

Figure 1.14: ***Reciprocal***

1.2.12 Store: Suppose you want $x = -3$. Press (-) 3 STO▸ X ENTER to store the value -3 in memory location X (see Figure 1.15). The STO▸ key prepares the TI-81 for an alphabetical entry, so it is *not* necessary to press ALPHA also. Now whenever you use X in an expression, the calculator will substitute the value -3 until you make a change by storing *another* number in X.

The contents of any memory location may be revealed by typing just its letter name and then ENTER. Hence to see what value X currently has, press ALPHA X ENTER. And the TI-81 retains memorized values even when it is turned off, so long as its batteries are good.

1.2.13 Evaluate: To evaluate the expression $5x + 2(1 - x)$ for $x = -3$, first store -3 in memory location X. Next enter the expression $5x + 2(1 - x)$ with these keystrokes as shown in Figure 1.15 below: 5 X|T + 2 (1 − X|T) ENTER.

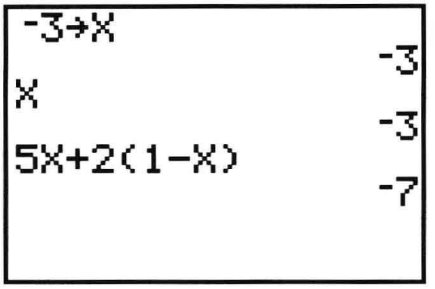

Figure 1.15: ***Store*** and ***Evaluate***

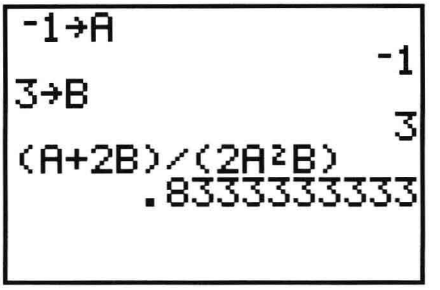

Figure 1.16: Evaluate $\frac{a+2b}{2a^2b}$ for a = -1 and b = 3

To evaluate $\frac{a+2b}{2a^2b}$ when a = -1 and b = 3, first store -1 in memory location A and 3 in B. Then press (ALPHA A + 2 ALPHA B) ÷ (2 ALPHA A x² ALPHA B) ENTER (see Figure 1.16).

1.2.14 Alpha: To use the letter y in a formula, press ALPHA Y. All 26 letters of the alphabet are available for use in this way.

For example, evaluate the formula $L = \frac{P-2W}{2}$ for $P = 110.4$ and $W = 20.7$. First store 110.4 for P and 20.7 for W. Then evaluate $\frac{P-2W}{2}$ by pressing (ALPHA P – 2 ALPHA W) ÷ 2 ENTER.

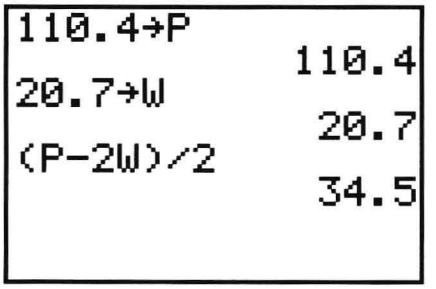

Figure 1.17: Evaluate $L = \frac{P-2W}{2}$ for $P = 110.4$ and $W = 20.7$

When your calculator is in rectangular mode, the X|T key lets you enter the letter x easily without having to use ALPHA X.

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