Chapter 12: Calculator Instructions:
TI-83+ and TI-84+

# Section 12.1: Calculator: Graphing Equations:

## Check that calculator is in “function” mode.

Press the MODE key.

A screen with showing settings will appear.
The fourth line on that screen shows **FUNC PAR POL SEQ**

**FUNC** should be the only item highlighted. **FUNC PAR POL SEQ**
If any other item is highlighted, use the left arrow key to move the cursor to select **FUNC** and press ENTER.

## Graphing a function when you know its equation:

Press the Y= key to access the equation editor

Enter the equation into the Y= equation editor as equation Y1

To insert the variable X into the equation, use the X, T, θ,n key

Press GRAPH if you want to graph in the current graphing window stored in your calculator

## Determining a Graphing Window

Here are some options to consider for determining the graphing window. The standard graphing window may work well for some graphs, but often will not work well for application problems. For application problems, the situation in the problem may provide clues to selecting an appropriate window; some guessing and trial and error may be involved.

### Standard Graphing Window

Press ZOOM arrow down to **6: Standard** and press ENTER
This sets the window to the standard graphing window with −10 ≤ x ≤ 10 and −10 ≤ y ≤ 10.
If you press WINDOW, after you have pressed ZOOM 6: Standard, it will show Xmin = −10, Xmax = 10, Ymin = −10 and Ymax = 10.

### Manually Selecting a Graphing Window:

Read the problem to see if the wording gives clues about an appropriate window such as giving values for points that are on the line or curve or stating some x or y values of interest in the problem.

To manually set a window, press WINDOW, input the desired viewing domain and range using Xmin, Xmax, Ymin and Ymax. Then press GRAPH

After looking at the graph, adjust the window as needed if it does not show an appropriate view.

**Example:**  It costs $3500 to produce 100 items and it costs $5500 to produce 200 items. Find and graph the cost function.

**Determining a window:**In this example x = the number of items and y = the cost.
The given information indicates that the x values should go up to or beyond 200 items and the y values should go up to or beyond $5500. In this context, only non-negative values of x and y are needed; the number of items produced and the production cost don’t make sense as negative numbers.

We might decide to select the graphing window as 0 ≤ x ≤ 250 , 0 ≤ y ≤ 6000.
Use Xmin =0, Xmax=250, Ymin=0 Ymax =6000.
Use Xscl and Yscl to specify the desired interval for the tick marks shown on each axis.

Press WINDOW and input the appropriate values for Xmin, Xmax, Ymin, Ymax.

Then press GRAPH

|  |  |
| --- | --- |
| Xmin=0 | minimum x value for the window |
| Xmax=250 | minimum x value for the window |
| Xscl=50 | select interval for tick marks shown on the x axis |
| Ymin=0 | minimum y value for the window |
| Ymax=6000 | minimum y value for the window |
| Yscl=1000 | interval for tick marks shown on the y axis |
| Xres=1 | keep this at 1; it affects the quality of the drawn graph  |

**Example:** Vijay invests $12000 at 5% interest for 10 years, with annual compounding.

**Determining a window:**The problem refers to a time period of 10 years, so Xmax should be at least 10.
We can select a higher value for x if we want we want the value x = 10 years to be more centered in the window.

We might decide to use 0 ≤ x ≤ 15, letting Xmax = 15.

Ymax should be at least as large as the amount Vijay will have at the end of 10 years, but in this case should be higher because we decided to include x values up to 15.
We can calculate 12000(1.05)10 = 19,547 and 12000(1.05)15 = 24,947.
It appears that an appropriate window would have 0 ≤ y ≤ 25000, so Ymax = 25000.

Press WINDOW and input the appropriate values for Xmin, Xmax, Ymin, Ymax.

Then press GRAPH

|  |  |
| --- | --- |
| Xmin=0 | minimum x value for the window |
| Xmax=15 | minimum x value for the window |
| Xscl=1 | select interval for tick marks shown on the x axis |
| Ymin=0 | minimum y value for the window |
| Ymax=25000 | minimum y value for the window |
| Yscl=5000 | interval for tick marks shown on the y axis |
| Xres=1 | keep this as 1  |

### Adjusting the Graphing Window:

Once we’ve guessed at an initial window, we can adjust the window as needed by trial and error. Press WINDOW and enter new values for Xmin, Xmax, Ymin, Ymax to find a better view.
It usually takes a few tries, but it gets easier with more experience.

Use the ZOOM menu to Zoom In or Zoom Out to adjust the window. Y Zoom In or Zoom Out repeatedly, if needed. Zoom adjusts the x and y boundaries in the window proportionally, zooming in or out by a “zoom factor” of 4 (default value). The “zoom factor” can be changed by pressing ZOOM, selecting the **MEMORY** menu and selecting **4: SetFactors**

Press ZOOM: use **2:Zoom In** or **3:Zoom Out** to adjust the view.
After pressing **2:Zoom In** or **3:Zoom Out** , the press ENTER.

The calculator will show the graph in the current graphing window with the cursor located at the center .

* To zoom in or zoom out with the graphing window centered at the same location, press ENTER.
* To move the center to a different location when zooming in or out, use the arrow keys to move the cursor to the point you want at the center of your graph. Press ENTER when the cursor is located at the desired center of the window, and your calculator will zoom as instructed.

## Finding an intersection of two lines or curves

Press Y= and enter the functions into Y1 and Y2, using the X,T,θ,n key to enter the variable X

Graph the functions in a window that shows the point where they intersect.

If the intersection of the two functions does not show in the window, adjust the graphing window to see the intersection point. Adjust the window manually or Zoom Out, as per instructions above.

If the intersection of the two functions is visible in the window, continue below:

Press 2nd CALC

Select **5: Intersect** from the menu and press enter

The screen shows both functions. A point on the graph of equation Y1 is highlighted showing the prompt **First curve?** Press ENTER to select that function.

Next, a point on the graph of equation Y2 is highlighted showing the prompt **Second curve?** Press ENTER to select that function.

The prompt **Guess?** will appear. Use the right and left arrow keys to move the cursor along the line until it is near the point of intersection; press ENTER.

The screen will show the estimated coordinates of the intersection point.

# Section 12.2: Calculator: Matrices

## Entering a matrix into the calculator:

Press 2nd MATRIX. The screen will display the Matrix menu. Use the right arrow key twice to select the **EDIT** menu. From the **EDIT** menu, use the down arrow to move the cursor to select the matrix name desired from the menu, and press ENTER.

The matrix input screen will appear.

**Dimensions:**Enter the dimensions of the matrix size as rows × columns.
The cursor is positioned to the left of the ×. Type the number of rows to the left of the ×, press ENTER and the cursor will move to the right of the ×. Type the number of columns to the right of the × and press ENTER again. The shape of the matrix adjusts on the screen to show the requested number of rows and columns.

Check that the shape matches the desired matrix; if it does not, then return to the top row and adjust the dimensions. If the matrix is too large to fit the screen, use the arrow keys to scroll right or down to see the remaining rows and columns.

**Matrix Entries:**
Input the matrix entries, press ENTER after each.
The cursor scrolls through the matrix by moving across each row from left to right and then down to the next row. Using the arrow keys to move the cursor instead of pressing ENTER may result in a value not being stored in the calculator memory.

After entering all data, proofread the matrix. Use the arrow keys to move the cursor to the proper position if any entries need correction. Press ENTER after each correction.

**Example:**  Suppose we want to input the matrix

After following the instructions above, the matrix edit screen would show

MATRIX [C] 2 x 3



## Using Matrix Names

Matrices are indicated by a capital letter between square brackets, such as [A] or [C].

This is a single symbol and must be selected from the Matrix menu any time a matrix is needed.

If we type three characters **[** followed by **A** followed by **]** the calculator will not interpret the three symbol sequence [A] as a matrix and will not call up the matrix.
We MUST use the Matrix menu that shows the matrix names to call up a matrix.

## Calling a Matrix to the home screen or to use in a calculation

To call a matrix back to the screen to view or use in a calculation, at any time after editing, use the MATRIX menu to enter the matrix name.

Press 2nd MATRIX. Use the down arrow to select the name of the matrix and press ENTER.

This selects a matrix name to use only. It does not permit editing the matrix. To edit the matrix, arrow right over to the EDIT menu as described earlier.

**Example:** To view matrix C that we entered earlier, the procedure is:

2nd MATRIX arrow down to 3: [C] and press ENTER ; the Matrix Menu screen shows:

|  |
| --- |
| NAMES MATH EDIT1: [A] 2: [B] **3: [C]** 4: [D] 5: [E]  |

Arrow down to use the curser to select 3: [C] , press ENTER; the home screen shows

|  |
| --- |
| [C] |

Press ENTER again; the screen shows

|  |
| --- |
| [C] |

## **Matrix Transpose**

Transposing a matrix means switching the rows and columns. Columns become rows and rows become columns. If an r x c matrix had r rows and c columns, its transpose will dimension c x r with c rows and r columns

Enter the matrix into the calculator using the MATRIX EDIT screen.

Press 2nd MATRIX and use down arrow key to select matrix name from the **NAMES** menu.

Press 2nd MATRIX and use down arrow key to select t the **MATH** menu; use down arrow key to select **2:T**. Press ENTER
The screen shows the command such as **[A]T**. Press ENTER

The calculator will display the transpose obtained by interchanging rows and columns

To store this matrix for later use, press the STO> key and access the matrix names list to select the name of the matrix to store it to.

## **Error Messages**

ERR: DIM MISMATCH or ERR: INVALID DIM indicate a matrix operation that is not permissible due to the dimensions of the matrix or matrices. ERR: SINGULAR MATRIX indicates a square matrix that does not have an inverse.

## Matrix Arithmetic

Use arithmetic keys + , −, × for matrix addition and subtraction, scalar multiplication and matrix multiplication. Use the matrix names menu to insert the matrix names. Press ENTER after you have completed the command for your calculation. To store answer for later use, press the STO> key and use matrix names menu to select the name of the matrix to store it to.

**Example: Scalar Multiplication :**

3\*2nd MATRIX **1:[A]** STO > 2nd MATRIX **3: [C]**  ENTER
**Screen shows:** 3[A] →[C] and shows the matrix that results from this operation.
**What the calculator does:** Multiplies each entry in matrix A by 3. Stores result in Matrix C

**Example: Matrix Addition**

2nd MATRIX **1:[A]** + 2nd MATRIX **2:[B]** STO**>** 2nd MATRIX **3: [C]**  ENTER
**Screen shows:** [A] +[B] →[C] and shows the matrix that results from this operation.
**What the calculator does:** Adds entries in matrices A and B. Stores the result in matrix C

**Matrix Subtraction:** see matrix addition above; use subtraction operation – instead of +

**Example: Several operations in the same step: 4A−3B**

4\* 2nd MATRIX **1:[A]** − 3\* 2nd MATRIX **2:[B]** STO> 2nd MATRIX **3: [C]**  ENTER
**Screen shows:** 4\*[A] − 3\*[B] →[C]

**What the calculator does:** Performs scalar multiplication and subtraction to find matrix 4A − 3B . Stores the result in matrix C

**Example: Several operations in the same step:**  4(A+B)

4\*( 2nd MATRIX **1:[A]** +2nd MATRIX **2:[B]** ) STO> 2nd MATRIX **3: [C]**  ENTER
**Screen shows:** 4\*([A]+[B]) →[C]

**What the calculator does:** Adds matrices A and B to find matrix A+B then performs scalar multiplication using the matrix sum to find 4(A+B). Stores the result in matrix C

**Example: Matrix Multiplication:** AB

2nd MATRIX **1:[A** \*2nd MATRIX **2:[B]** STO > 2nd MATRIX **3: [C]**  ENTER
**Screen shows:** [A]\*[B] →[C]

**What the calculator does:** Uses matrix multiplication to multiply matrix A by matrix B to find the matrix product AB. Stores the result in matrix C

**Example: Raise a Matrix to a power:** A4

2nd MATRIX **1:[A** ^4 ] STO > 2nd MATRIX**3: [C]**  ENTER
**Screen shows:** [A] ^4→[C]

**What the calculator does:** Calculates A4 as A\*A\*A\*A . Stores the result in matrix C

## **Matrix Inverse**

Enter the matrix into the calculator using the MATRIX EDIT screen.

Press 2nd MATRIX and use down arrow key to select matrix name from the **NAMES** menu.

Press the *x*−1 key (for inverse). Press ENTER

The screen shows the command such as **[A]−1**. Press ENTER Calculator will display the inverse.

To store this matrix for later use, press the STO> key and access the matrix names list to select the name of the matrix to store it to

## Row Operations: calculator commands

The commands below explain the row operations that are built into the calculator.
They are on the 2nd MATRIX **MATH** menu.

Be careful to enter the information into the command exactly as explained below.
If information is put in the wrong order, the calculator will do exactly what it is told to do and give an incorrect answer for what was intended; the calculator follows commands but cannot read read minds to know what was intended if the information is not entered correctly.

To store the resulting matrix for later use, press the STO> key and access the matrix names menu to select the name of the matrix to store the result.

**rowSwap(matrixname, row r, row s)** interchanges (swaps) row r and row s

Example: rowSwap ([A],2,3)
uses matrix A and interchanges row 2 and row 3.

**row+( matrixname, row r, row s)** adds each entry in row r to the corresponding entry in row s and stores the result in row s

Example: row+( [A] 3,2)
adds row 3 to row 2 and stores the result in row 2.

**\*row(constant, matrixname, row r)**  multiplies all entries in row r by a constant number

Example: \*row (5, [A])
 multiplies every entry in matrix A by the number 5.

Example: \*row (−8, [A])
multiplies every entry in matrix A by the number −8.

**\*row+( constant, matrixname, row r, row s)**  multiplies row r by a constant and adds the
resulting row to row s, storing the result in row s.

Example \*row+(−4, [A],2,3)
uses matrix A; it multiplies row 2 by the constant *(*−4) and adds this result to row 3, storing the result in row 3.

## **Reduced Row Echelon Form**

This finds Reduced Row Echelon form in one easy fast step. However in many cases your instructor may require you to show step by step work, so be sure you use this only if the work is not required to be shown. But, even if you need to do the work to show step by step work, this command is helpful for checking your answer.

Enter the matrix into the calculator using the MATRIX EDIT screen.

Press 2nd QUIT.Press 2nd MATRIX ; use the right arrow key to select the **MATH** menu, use down arrow to move the cursor to select **rref(** . Press ENTER.
Press 2nd MATRIX ; use down arrow to select matrix name from **NAMES** menu. Press ENTER

Close the parentheses ) . Press ENTER

The home screen will show a command such as: **rref ([A])**.
 Press ENTER

The screen will display reduced row echelon form of this matrix.

# Section 12.3: Finance App: TVM Solver Instructions

The Finance App has many functions built into it. We examine only the TVM (Time Value of Money) solver here. The TVM Solver is useful for most problems in this textbook.

To learn to use the other functions in the Finance app, search on the internet for instructions for the other functions or consult the Texas Instruments calculator manual. Each function has its own syntax for entering required information. Any errors in the syntax will result in an error in the answer. If using these functions, be careful to use correct syntax and order of the inputs.

## Accessing the Time Value of Money calculator in the Finance APP:

Press 2nd App

Use down arrow to select **Finance** (usually at or near the top of the list of apps)

Select **1:TVM Solver** from the menu; press ENTER

In the TVM solver enter all the known values. If the value is not known or does not apply to the problem, enter 0 (exception to entering 0 is P/Y and C/Y – see below).

## Use of Signs to Indicate Direction of Flow of Money:

The calculator uses sign to denote the direction of flow of money.
Visualize the calculation as a transaction occurring between two entities A and B.

* If A lends B $1000, then the present value PV of $1000 is positive from the point of view of B, as money coming in; then the payments PMT that B makes to A to repay the loan will appear as negative, indicating money B pays out.
* However if you view the transaction from the point of view of A, then $1000 would be negative as money paid out by A, and the periodic payments made by B to repay the loan would be positive as they represent money flowing in to A.

It is not important which viewpoint you adopt, but it is important to be internally consistent about the signs showing the correct direction for the flow of money in the transaction.

## Variables used by the TVM solver screen

N = the total number of compounding periods (N = nt using the notation of this textbook)

I% = enter the interest rate expressed as a percent

PV = present value

PMT = periodic payment

FV = future value (accumulated value)

P/Y = number of payments per year

C/Y = number of compounding periods per year

PMT: END BEGIN – highlight to indicate whether payments are made at the end of beginning of a payment period.

## Finding the solution after entering all input

Use arrow keys to move the cursor to highlight the variable you want to calculate.
Press ALPHA ENTER to Solve.
The calculator will calculate the value of the variable that is highlighted

# Section 12.4: Finance App: TVM Solver Examples

**Example: To calculate the future (accumulated) value of an investment of $3000 invested at 4.2% interest compounded quarterly for 5 years.**

N = 20 (there are 4x5 = 20 compounding periods total in this example)

I% = 4.2

PV = 3000

PMT = 0 (the problem does not have any periodic payments)

FV = input 0 for now; we will solve for this soon.

P/Y = 4

C/Y = 4

PMT: END BEGIN

Use arrow keys to move cursor to highlight FV;
Press ALPHA ENTER to solve.
The calculator will then show the value for FV.

**Example: To calculate the present value needed now to accumulate to $8000 at the end of 5 years if invested at 4.2% interest compounded quarterly.**

N = 20 (there are 4x5 = 20 compounding periods total in this example)

I% = 4.2

PV = input 0 for now; we will solve for this soon

PMT = 0 (the problem does not have any periodic payments)

FV = 8000

P/Y = 4

C/Y = 4

PMT: END BEGIN

Use arrow keys to move cursor to highlight PV;
Press ALPHA ENTER to solve.
The calculator will then show the value for PV.

**Example: To calculate the present value now of periodic payments of $500 monthly for 10 years invested at 6% interest compounded monthly, assuming payments are made at the end of each period.**

N = 120 (there are 12x10 = 120 compounding periods total in this example)

I% = 6

PV = input 0 for now; we will solve for this soon.

PMT = 500

FV = 0

P/Y = 12

C/Y = 12

PMT: END BEGIN

Use arrow keys to move cursor to highlight PV;
Press ALPHA ENTER to solve.
The calculator will then show the value for PV.

**Finance App: TVM Solver Examples, continued**

**Example: Find the accumulated (future) value at the end of 10 years of periodic payments of $500 monthly for 10 years invested at 6% interest compounded monthly, assuming payments are made at the end of each period.**

N = 120 (there are 12x10 = 120 compounding periods total in this example)

I% = 6

PV = 0

PMT = 500

FV = input 0 for now; we will solve for this soon.

P/Y = 12

C/Y = 12

PMT: END BEGIN

Use arrow keys to move cursor to highlight FV;
Press ALPHA ENTER to solve.
The calculator will then show the value for FV.

**Example: To calculate the amount of a quarterly payment needed into a sinking fund for 4 years in order to accumulate to a future value of $50000 at the end of 4 years, if invested at 7.5% compounded quarterly, assuming payments are made at the end of each quarter.**

N = 16 (there are 4x4 = 16 compounding periods total in this example)

I% = 7.5

PV = 0

PMT = input 0 for now; we will solve for this soon

FV = 50000

P/Y = 4

C/Y = 4

PMT: END BEGIN

Use arrow keys to move cursor to highlight PMT;
Press ALPHA ENTER to solve.
The calculator will then show the value for PMT.

**Finance App: TVM Solver Examples, continued**

**Example: To calculate the amount of a monthly payment needed at the end of each month for 15 years in order to repay a mortgage loan of $150000, if the loan interest rate is 5.3% compounded monthly.**

N = 180 (there are 12x15 = 180 compounding periods total in this example)

I% = 5.3

PV = 150000

PMT = input 0 for now; we will solve for this soon

FV = 0

P/Y = 12

C/Y = 12

PMT: END BEGIN

Use arrow keys to move cursor to highlight PMT;
Press ALPHA ENTER to solve.
The calculator will then show the value for PMT.

**Example: To calculate the outstanding balance at the end of 10 years for a 30 year mortgage with monthly payments of $2300, if the loan interest rate is 4.7% compounded monthly.**

Note that the mortgage has a loan period of 30 years. We are asked to find the outstanding balance at the end of 10 years. The mortgage still has 30−10=20 years of payments remaining; t = 20 for this situation. The outstanding balance is the present value of the remaining 20 years of payments.

N = 240 (there are 12x20 = 240 compounding periods total in this example)

I% = 4.7

PV = input 0 for now ; we will solve for this soon.

PMT = 2300 (the problem does not have any periodic payments)

FV =0

P/Y = 12

C/Y = 12

PMT: END BEGIN

Use arrow keys to move cursor to highlight PV;
Press ALPHA ENTER to solve.
The calculator will then show the value for PV.

# Section 12.5: Calculator: Factorials, Combinations, Permutations

Factorials, Combinations, and Permutations are found on the MATH PRB menu

Press MATH. Use right arrow key to move cursor to select PRB (probability ) menu at the top of the screen. This menu contains the following items useful for combinatorics and probability:

2:nPr permutations

3:nCr combinations

4:! factorial

**Example: Find 6!**

 6 MATH PRB 4:!

 Screen shows 6!

 Press ENTER. The answer is 720

**Example: Find 8!/3!**

 (8 MATH PRB 4:!)\* (3 MATH PRB 4:!)

 Screen shows 8!/3!

 Press ENTER. The answer is 6720

**Example: Find 8P5**

 8 MATH PRB 2:nPr 5

 Screen shows 8P5

 Press ENTER. The answer is 6720

**Example: Find 8C5**

 8 MATH PRB 3:nCr 5

 Screen shows 8C5

 Press ENTER. The answer is 56

**Example: Find 8C5 using factorials and the definition of 8C5** instead of the 8C5 key.
Note that the parentheses in the denominator are crucial for correct evaluation.

 (8 MATH PRB 4:!) **/** ( 3 MATH PRB 4:!\* 5 MATH PRB 4:!)

 Screen shows 8!**/**(3!\*5!)

 Press ENTER. The answer is 56

**Example:** Find  ** .** In the calculator, do**.**Note that the parentheses in the denominator are crucial for correct evaluation.
This example is the number of different (unique) arrangements of the string of letters

AABBBCCCC.

 (9 MATH PRB 4:!) **/** (2 MATH PRB 4:! \* 3 MATH PRB 4:! \* 4 MATH PRB 4:!)

 Screen shows 9!**/**(2! \*3! \*4!)

 Press ENTER. The answer is 1260