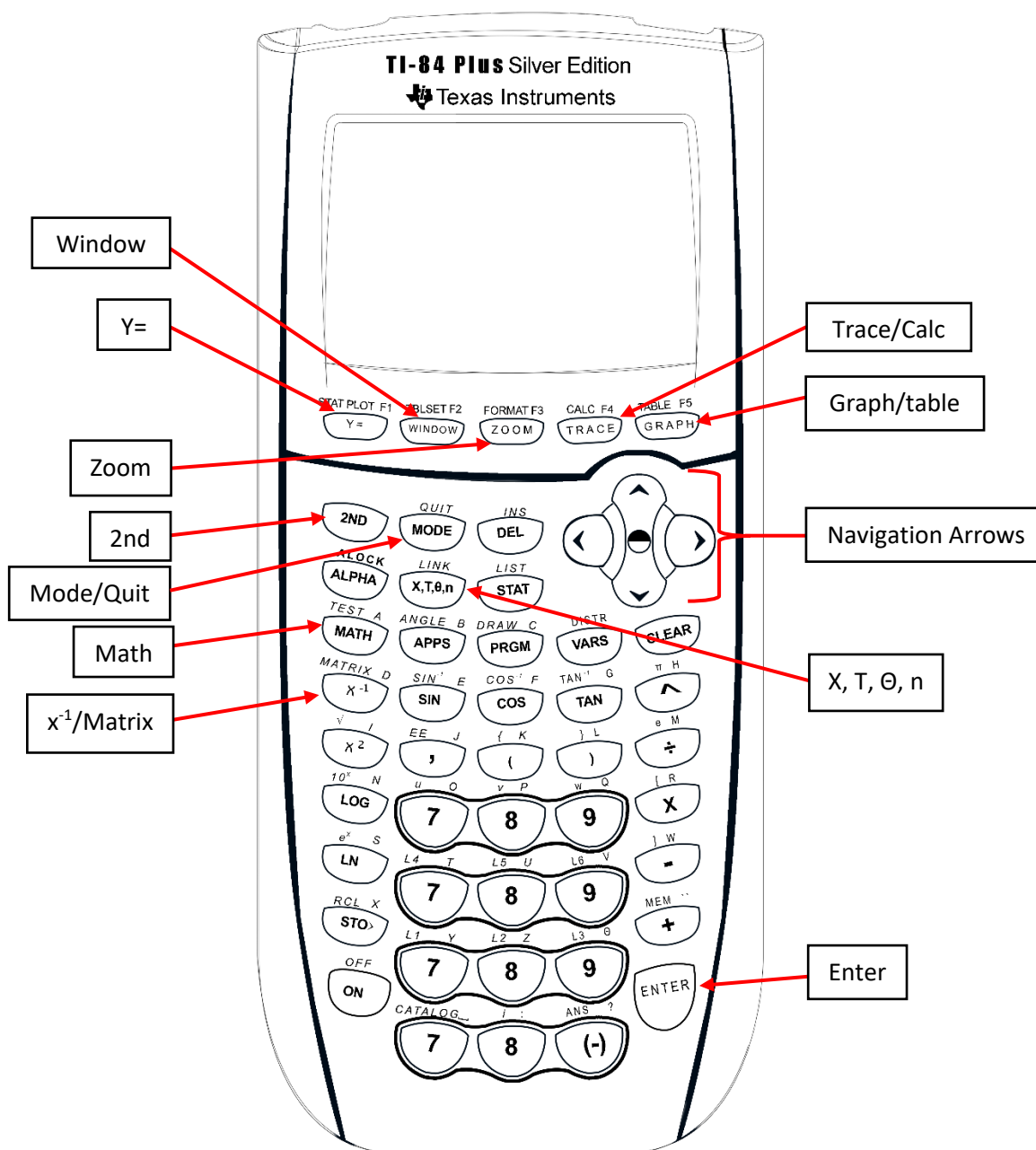# How to use a Graphing Calculator to Solve a System of Equations

A system of equations is a set of two or more equations with the same unknown variables. This handout will cover how to solve a system of equations with the TI-84 calculator by graphing, using the graph table, and using a matrix. The following image identifies important buttons that will be needed.

Solve by graphing the functions

The graphing method for solving systems of equations uses the graph intersect function. This method can only be used for equations with two variables. The solutions for this method are displayed visually on the graph.

- Begin by rearranging the equations to be in the form of $y =$:

$$\begin{cases} y + x = 7 \\ y - 1 = 2x \end{cases} \longrightarrow \begin{cases} y = -x + 7 \\ y = 2x + 1 \end{cases}$$
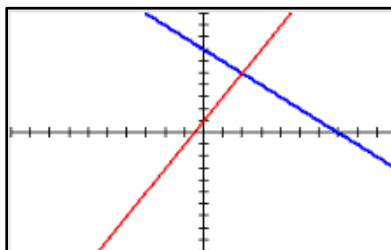
- Press the **y =** button on the calculator to open the function window.

```
Plot1  Plot2  Plot3
\Y1=
\Y2=
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```
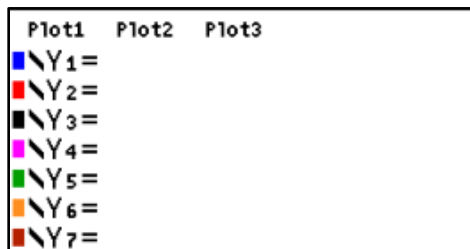
- Enter the first equation into "Y_1" and use the **X, T, θ, n** button when the variable is needed. Press **enter** or use the navigation arrows to move from one equation to the next.
- Enter the second equation into "Y_2."

```
Plot1  Plot2  Plot3
\Y1=-X+7
\Y2=2X+1
\Y3=
\Y4=
\Y5=
\Y6=
\Y7=
```
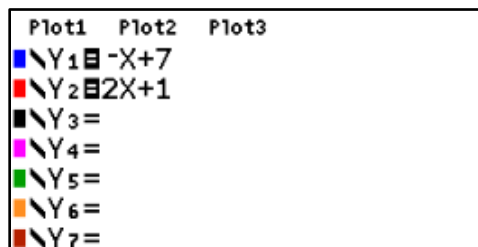
- Press **graph.**

  - It may be necessary to zoom in or out of the graph window to see the intersection. To do this, press **Zoom** and then either select "2: Zoom In" or "3: Zoom Out." Use the navigation arrows to move the cursor to the intersection and press **enter.**

- o The view of the graph can also be changed by pressing **window** and changing the "xmin," "xmax," "ymin," and "ymax" values.
- Press **2nd** then **trace** to pull up the graph calculate window.
- Use the navigation arrow keys to select the "5: intersect" function and press **enter**.
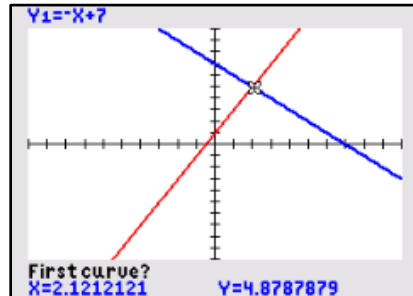
- Press **enter** 3 times until the screen displays the coordinates of intersection closest to the cursor.
  - o If there is no intersection, there is no solution.
  - o For systems with multiple intersections, follow the steps above to reselect the "5: intersect" function. Use the arrow keys to move the cursor close to the second intersection and then press **enter** 3 times.
- The x and y coordinates of the solution will be displayed at the bottom of the screen.
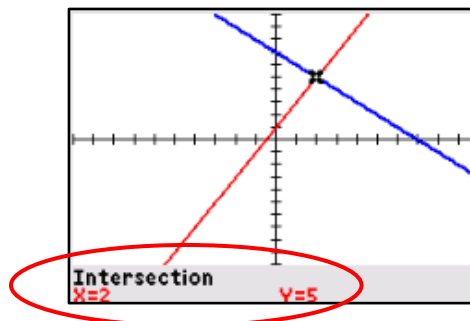
Solution:

$$x = 2 \quad y = 5$$

Solve by using the graph table

Similar to the first method, using the graph table to solve the system of equations only works for systems with two variables. Furthermore, this method only works for solving systems with whole number solutions.

- Arrange the equations to be in the form of $y =$:

$$\begin{cases} y + x = 7 \\ y - 1 = 2x \end{cases} \longrightarrow \begin{cases} y = -x + 7 \\ y = 2x + 1 \end{cases}$$

- Press the **y =** button on the calculator to open the function window.

```
Plot1  Plot2  Plot3
■\Y1=
■\Y2=
■\Y3=
■\Y4=
■\Y5=
■\Y6=
■\Y7=
```

- Enter the first equation into "Y_1" and use the **X, T, θ, n** button when the variable is needed.
- Enter the second equation into "Y_2."

```
Plot1  Plot2  Plot3
■\Y1=-X+7
■\Y2=2X+1
■\Y3=
■\Y4=
■\Y5=
■\Y6=
■\Y7=
```

- Press **2nd** then **graph** to pull up the table of points.

X	Y_1	Y_2
0	7	1
1	6	3
2	5	5
3	4	7
4	3	9
5	2	11

- Scroll through the table using the navigation arrow keys and look for entries with the same Y_1 and Y_2 values. These are the location(s) of the intersection(s).
  - If there is no entry with the same Y_1 and Y_2 values, there is either no solution or the solution is not a whole number. If either situation exists, use the graphing method discussed earlier or the matrix method discussed in the next section.

X	Y_1	Y_2
0	7	1
1	6	3
2	5	5
3	4	7
4	3	9
5	2	11

Solution:

$x = 2 \quad y = 5$

Solving using a matrix

Another method for solving a system of equations involves putting equations into an augmented matrix. An augmented matrix is a rectangular array of numbers where each row

represents a different equation, and each column represents the coefficient of each variable with the last column listing the solutions. Matrices can be used to solve systems of equations with two or more variables. For more information on matrices, refer to the [Solving Systems of Linear Equations Using Matrices](#) handout.

- Write the system of equations as an augmented matrix.
  - Arrange the equations so all variables are on the left of the equal sign and constants are on the right. The variables should be in the same order for each equation.

$$\begin{cases} x + 5z = y - 6 \\ -z = -3x - 3y + 10 \\ x + 3y + 2z = 5 \end{cases} \longrightarrow \begin{cases} x - y + 5z = -6 \\ 3x + 3y - z = 10 \\ x + 3y + 2z = 5 \end{cases}$$

  - Create the matrix by taking the coefficient of each variable and entering them into each row with the last column representing the constants. Use a 0 if a variable is missing from one of the equations.

$$\begin{bmatrix} 1 & -1 & 5 & -6 \\ 3 & 3 & -1 & 10 \\ 1 & 3 & 2 & 5 \end{bmatrix}$$

- On the calculator, press **2nd** then $\mathbf{x^{-1}}$ to pull up the matrices window.

```
NAMES MATH EDIT
1:[A]
2:[B]
3:[C]
4:[D]
5:[E]
6:[F]
7:[G]
```
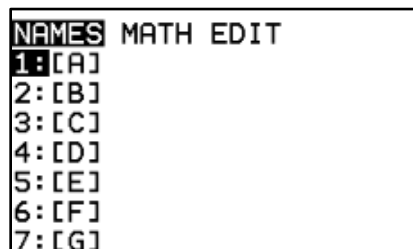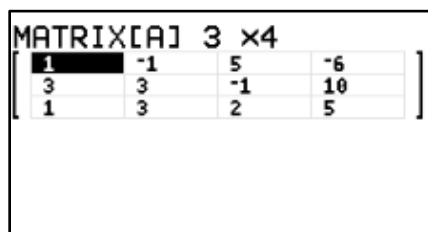
- Use the right arrow key to navigate to the "EDIT" menu.
- Select the matrix to be edited and press the **enter** button. For this example, the first matrix, "1: [A]," is selected.

```
NAMES MATH EDIT
1:[A]
2:[B]
3:[C]
4:[D]
5:[E]
6:[F]
7:[G]
```
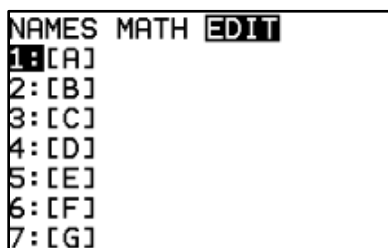
- Type in the matrix size. The size is the number of rows by the number of columns. For example, this system of equations creates a 3 by 4 matrix.

```
MATRIX[A] 3 ×4
[ 0    0    0    0 ]
[ 0    0    0    0 ]
[ 0    0    0    0 ]
```
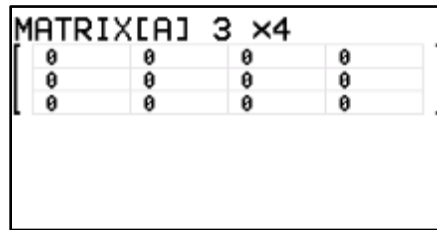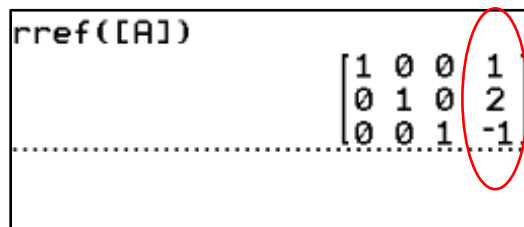
- Using the navigation arrow keys, move to the first entry of the matrix. Fill out the matrix by typing in the corresponding values for each place and pressing **enter** after each value.

```
MATRIX[A] 3 ×4
[ 1    -1    5    -6 ]
[ 3     3   -1    10 ]
[ 1     3    2     5 ]
```

- Press **2nd** then **mode** to return to the home window.
- Press **2nd** then x^{-1} and use the right arrow to navigate to the "MATH" menu.
- Scroll down and select "B: rref(," then press **enter.**

```
NAMES MATH EDIT
8↑Matr▶list(
9:List▶matr(
0:cumSum(
A:ref(
B:rref(
C:rowSwap(
```
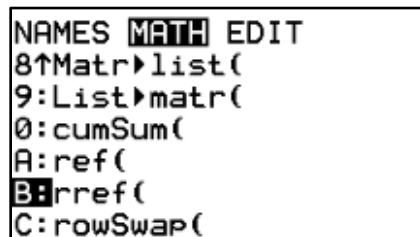
- Press **2nd** then x^{-1} and select "1: [A]" from the "NAMES" menu.
- Press **enter** to display the reduced matrix. Convert the matrix back to equation form to determine the solution.

```
rref([A])
         [ 1  0  0   1 ]
         [ 0  1  0   2 ]
         [ 0  0  1  -1 ]
```

Solutions:

$x = 1$

$y = 2$

$z = -1$