Solving Systems of Linear Equations on a Graphing Calculator

Solving systems of linear equations using pencil and paper can be time consuming. Here we will specifically be looking at how to solve a system of three linear equations with three unknown using a graphing calculator. The directions shown here are for either a TI-83 or TI-84 graphing calculator. If you have a different type of calculator, I suggest searching the web or asking your instructor.

First, let’s look at the notation used:

- **MATH** means to push the button labeled MATH on the calculator.
- **3 → ENTER** means to push the 3 button followed by the ENTER button.
- **→** means to push the right arrow button on your calculator.

Here we will be solving systems of linear equations using a matrix. In particular, we will be transforming the matrix into reduced row echelon form.

Let’s consider the following problem. Solve:

\[
\begin{align*}
2x + 3y - z &= 1 \\
4x + y - 3z &= 11 \\
3x - 2y + 5z &= 21
\end{align*}
\]

The first thing we need to do is to get the problem into our calculator. To enter this problem into the calculator we need to create a matrix.

Press **2nd → x⁻¹** Note: written above the x⁻¹ button is MATRX meaning matrix. We are in the correct place if we look across the top of the screen and see the words NAMES, MATH, EDIT.

Now we need to edit the matrix, so press → or ← until the word EDIT is highlighted at the top of the screen. Now press ↑ or ↓ until the 1: on the left side of the screen is highlighted and finally press **ENTER**. At this point we are telling the calculator that we are going to edit matrix A. We can edit any of the matrices, but let’s use matrix A.

Next we need to tell the calculator what size matrix to create. In this example, we need to create a matrix that has 3 rows and 4 columns, so press **3 → ENTER** then **4 → ENTER**. This will create a matrix with 3 rows and 4 columns.

Now it is time to enter the equations into the matrix we just created.

First row press: **2 → ENTER → 3 → ENTER → -1 → ENTER → 1 → ENTER**.
Second row press: **4 → ENTER → 1 → ENTER → -3 → ENTER → 11 → ENTER**.
Third row enter: **3 → ENTER → -2 → ENTER → 5 → ENTER → 21 → ENTER**.

Now it’s a good time to double check and make sure we entered all the values correctly because if we entered one value incorrectly we will get the wrong answer. Use the arrow keys to move around in the matrix to make sure the values are entered correctly. Also make sure that we use the negative button for the negative numbers, not the subtraction button.
Now that we have all of the information typed into the calculator it is time to solve the problem. To find the solution we need to do the following.

We need to get back to the “home” screen, so press \[\text{2nd} \to \text{MODE}\]. Note: printed above the MODE button is QUIT which will take us back to our “home” screen.

Now press the \[\text{CLEAR}\] to clear the “home” screen.

To begin finding the solution we need to go back into the matrix, press \[\text{2nd} \to x^{-1}\] to enter the matrix.

This time we do not want to edit the matrix, we want to do some math. Press \[\rightarrow\] or \[\leftarrow\] until the word MATH is highlighted at the top of the screen. On this page we have several options to choose from. Press \[\uparrow\] or \[\downarrow\] until \text{rref(} is highlighted and then press \[\text{ENTER}\]. We should immediately be send back to our “home” screen and we should see \text{rref(} on the screen, \text{rref} stands for reduced row echelon form and is a way to solve systems of linear equations.

Next we need to tell the calculator which matrix to use, so press \[\text{2nd} \to x^{-1}\] to go back into the matrix. Now NAMES and 1: should both be highlighted on the screen and if this is where you entered the matrix just press \[\text{ENTER}\].

Once again we should jump back to the “home” screen and see \text{rref([A]} and all that remains to find the answer is to press \[\text{ENTER}\].

On the “home” screen we should see the matrix shown below and the answer can be read directly from the matrix.

\[
\begin{bmatrix}
1 & 0 & 0 & 4 \\
0 & 1 & 0 & -2 \\
0 & 0 & 1 & 1
\end{bmatrix}
\]

\[x = 4\]
\[y = -2\]
\[z = 1\]

For additional practice to solving the problem given below.

\[3x - 2y + z = -9\]
Solve: \[5x + 3y - 2z = -8\]
\[4x + y - 3z = -19\]

Answer: \((-2, 4, 5)\)

To solve other size systems of linear equations, all we need to do is adjust the size of the matrix used. The rest of the steps will remain the same. For example, if we needed to solve a system of two equations with two unknowns we would need to use a \(2 \times 3\) matrix instead of a \(3 \times 4\) matrix.

Note: If the final answer is written as decimals, we can always press \[\text{MATH} \to \text{ENTER} \to \text{ENTER}\] and the answer will be turned into fractions.