

To solve a system of equations using matrices, do the following:

- Write each equation in the system in standard form.
- Create an *augmented matrix* that represents the coefficients and constants of the system.
 - The matrix will have the same number of rows as equations.
 - The matrix will have one more column than variables.
 - It helps to put a dashed line between the coefficient and constant columns.
 - Remember to include zero for any missing terms.
- Enter the matrix into the calculator
 - Press [2nd], [x^{-1}] to get to the Matrix screen.
 - Select the EDIT menu and choose one of the matrix variables.
 - Enter the number of rows and columns at the top.
 - Enter the matrix's elements, one row at a time.
- Perform the *reduced-row echelon form*, or *rref*, command.
 - From the Home screen, press [2nd], [x^{-1}] to get to the Matrix screen.
 - Select the EDIT menu and choose B:rref(.
 - Press [2nd], [x^{-1}] to go back to the Matrix screen.
 - From the Names menu, select the matrix variable that represents the system.
 - Press [ENTER].
- Interpret the system's solution from the resulting matrix.
 - If the last row is all zeros, there are *infinitely many solutions*.
 - If the last row is all zeros except for the last number, there is *no solution*.
 - Otherwise, the last column will be the *unique solution*.

Here are a few examples:

$$\begin{cases} x - 2y + 3z = 9 \\ -x + 3y = -4 \\ 2x - 5y + 5z = 17 \end{cases} \Rightarrow \left[\begin{array}{ccc|c} 1 & -2 & 3 & 9 \\ -1 & 3 & 0 & -4 \\ 2 & -5 & 5 & 17 \end{array} \right] \Rightarrow \left[\begin{array}{ccc|c} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 1 & 2 \end{array} \right] \Rightarrow \begin{matrix} x = 1 \\ y = -1 \\ z = 2 \end{matrix}$$

$$\begin{cases} x - 3y + z = 1 \\ 2x - y - 2z = 2 \\ x + 2y - 3z = -1 \end{cases} \Rightarrow \left[\begin{array}{ccc|c} 1 & -3 & 1 & 1 \\ 2 & -1 & -2 & 2 \\ 1 & 2 & -3 & -1 \end{array} \right] \Rightarrow \left[\begin{array}{ccc|c} 1 & 0 & -1.4 & 0 \\ 0 & 1 & -0.8 & 0 \\ 0 & 0 & 0 & 1 \end{array} \right] \Rightarrow \text{no solution}$$

$$\begin{cases} x + y - 3z = -1 \\ y - z = 0 \\ -x + 2y = 1 \end{cases} \Rightarrow \left[\begin{array}{ccc|c} 1 & 1 & -3 & -1 \\ 0 & 1 & -1 & 0 \\ -1 & 2 & 0 & 1 \end{array} \right] \Rightarrow \left[\begin{array}{ccc|c} 1 & 0 & -2 & -1 \\ 0 & 1 & -1 & 0 \\ 0 & 0 & 0 & 0 \end{array} \right] \Rightarrow \text{infinitely many solutions}$$