

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -1 & -1 & -1 \\ -2 & -1 & -2 \\ -6 & -3 & -7 \end{bmatrix} \begin{bmatrix} -17 \\ 2 \\ 14 \end{bmatrix} = \begin{bmatrix} 1 \\ 4 \\ -2 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -1 & -1 & -1 \\ -2 & -1 & -2 \\ -6 & -3 & -7 \end{bmatrix} \begin{bmatrix} 3 \\ 5 \\ -5 \end{bmatrix} = \begin{bmatrix} -3 \\ -1 \\ 2 \end{bmatrix}$$

TECHNOLOGY: Inverting Matrices

We can also use a graphing utility to find the inverse of a matrix. When using a TI-84 Plus, first define the matrix whose inverse we want to find. Then, enter the matrix on the home screen, press x^{-1} , and press **enter**.

To show the answer in fraction form, press **math** and select \blacktriangleright **Frac**. If we defined matrix A to be $\begin{bmatrix} 7 & 4 \\ 1 & 2 \end{bmatrix}$, we would find its inverse as shown in Figure 1.

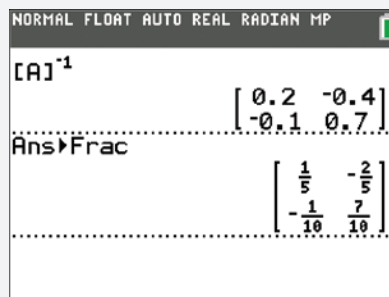


FIGURE 1

11.5 EXERCISES

PRACTICE

Write each of the following systems of equations as a single matrix equation. See Example 1.

- $$\begin{cases} 14x - 5y = 7 \\ x + 9y = 2 \end{cases}$$
- $$\begin{cases} x - 5 = 9y \\ 3y - 2x = 8 \end{cases}$$
- $$\begin{cases} -6 - 2y = x \\ 9x + 14 = 3y \end{cases}$$
- $$\begin{cases} x - y = 5 \\ 2 - z = x \\ z - 3y = 4 \end{cases}$$
- $$\begin{cases} 3x_1 - 7x_2 + x_3 = -4 \\ x_1 - x_2 = 2 \\ 8x_2 + 5x_3 = -3 \end{cases}$$
- $$\begin{cases} x_3 = x_2 \\ x_2 = x_1 \\ x_1 = x_3 \end{cases}$$
- $$\begin{cases} \frac{3x - 8y}{5} = 2 \\ y - 2 = 0 \end{cases}$$
- $$\begin{cases} x - 7y = 5 \\ \frac{6 + x}{2} = 3y - 2 \end{cases}$$
- $$\begin{cases} 4x = 3y - 9 \\ 13 - 2x = -4y \end{cases}$$

$$10. \begin{cases} -\frac{7}{3}y = \frac{5-x}{6} \\ x-5(y-3) = -2 \end{cases} \quad 11. \begin{cases} 2x-y = -3z \\ y-x = 17 \\ 2+z+4x = 5y \end{cases} \quad 12. \begin{cases} 2x_1 - 3x_3 = 7 \\ x_2 - 10x_3 = 0 \\ 2x_1 - x_2 + x_3 = 1 \end{cases}$$

Find the inverse of each of the following matrices, if possible. See Examples 2 and 3.

$$13. \begin{bmatrix} 0 & 4 \\ -5 & -1 \end{bmatrix} \quad 14. \begin{bmatrix} -2 & -2 \\ -1 & 2 \end{bmatrix} \quad 15. \begin{bmatrix} 3 & 4 \\ -4 & -5 \end{bmatrix}$$

$$16. \begin{bmatrix} -1 & -1 \\ -\frac{1}{4} & -\frac{1}{2} \end{bmatrix} \quad 17. \begin{bmatrix} -\frac{1}{5} & 0 \\ \frac{1}{5} & \frac{1}{2} \end{bmatrix} \quad 18. \begin{bmatrix} -7 & 2 \\ 7 & -2 \end{bmatrix}$$

$$19. \begin{bmatrix} -2 & -4 & -2 \\ 1 & -4 & 1 \\ 4 & -3 & 4 \end{bmatrix} \quad 20. \begin{bmatrix} -3 & 0 & -4 \\ 2 & 5 & 4 \\ 1 & -5 & -2 \end{bmatrix} \quad 21. \begin{bmatrix} -\frac{5}{11} & -\frac{8}{11} & 1 \\ \frac{13}{11} & \frac{12}{11} & -2 \\ -\frac{2}{11} & -\frac{1}{11} & 0 \end{bmatrix}$$

$$22. -\frac{1}{31} \begin{bmatrix} 17 & -8 & -2 \\ 1 & 5 & 9 \\ -6 & 1 & 8 \end{bmatrix} \quad 23. \begin{bmatrix} -1 & 2 & -1 \\ 0 & 3 & -1 \\ 0 & 4 & -1 \end{bmatrix} \quad 24. \begin{bmatrix} -1 & 0 & -1 \\ -\frac{3}{2} & \frac{1}{2} & -\frac{3}{2} \\ -\frac{1}{2} & 0 & -\frac{1}{4} \end{bmatrix}$$

$$25. \begin{bmatrix} -\frac{6}{5} & -\frac{2}{5} & -1 \\ \frac{3}{5} & \frac{1}{5} & 1 \\ 1 & 0 & 1 \end{bmatrix} \quad 26. \begin{bmatrix} 2 & -2 & 1 \\ -2 & 2 & -3 \\ 1 & 0 & 2 \end{bmatrix} \quad 27. \begin{bmatrix} 0 & 1 & 1 \\ 1 & 1 & 0 \\ 0 & 1 & 2 \end{bmatrix}$$

$$28. \begin{bmatrix} 9 & 8 & 7 \\ 6 & 5 & 4 \\ 3 & 2 & 1 \end{bmatrix} \quad 29. \begin{bmatrix} \frac{2}{3} & \frac{8}{9} & \frac{1}{9} \\ -\frac{1}{3} & \frac{2}{9} & -\frac{2}{9} \\ -\frac{1}{3} & -\frac{7}{9} & -\frac{2}{9} \end{bmatrix} \quad 30. \begin{bmatrix} -3 & -3 & -4 \\ 0 & \frac{1}{4} & \frac{1}{2} \\ 2 & 2 & 3 \end{bmatrix}$$

For each pair of matrices, determine if either matrix is the inverse of the other.

$$31. \begin{bmatrix} -5 & -2 \\ -7 & 4 \end{bmatrix}, \begin{bmatrix} 10 & 4 \\ 14 & -8 \end{bmatrix} \quad 32. \begin{bmatrix} 9 & -18 \\ 3 & 12 \end{bmatrix}, \begin{bmatrix} -3 & -6 \\ -1 & -4 \end{bmatrix}$$

$$33. \begin{bmatrix} -6 & -1 & 1 \\ 4 & -1 & -2 \\ 1 & -1 & -1 \end{bmatrix}, \begin{bmatrix} -1 & -2 & 3 \\ 2 & 5 & -8 \\ -3 & -7 & 10 \end{bmatrix} \quad 34. \begin{bmatrix} -1 & 4 & 5 \\ 3 & -11 & -17 \\ 4 & -17 & -19 \end{bmatrix}, \begin{bmatrix} -80 & -9 & -13 \\ -11 & -1 & -2 \\ -7 & -1 & -1 \end{bmatrix}$$

$$35. \begin{bmatrix} 2 & 0 & -1 \\ 3 & 4 & 2 \\ 1 & 1 & -3 \end{bmatrix}, \begin{bmatrix} 4 & 0 & -2 \\ 6 & 8 & 4 \\ 2 & 2 & -6 \end{bmatrix} \quad 36. \begin{bmatrix} -7 & 0 & -2 \\ -10 & -1 & -2 \\ -7 & -1 & -1 \end{bmatrix}, \begin{bmatrix} -1 & 2 & -2 \\ 4 & -7 & 6 \\ 3 & -7 & 7 \end{bmatrix}$$

Solve the following systems by the inverse matrix method, if possible. If the inverse matrix method doesn't apply, use any other method to determine if the system is inconsistent or dependent. See Example 4.

$$37. \begin{cases} -2x - 2y = 9 \\ -x + 2y = -3 \end{cases} \quad 38. \begin{cases} 3x + 4y = -2 \\ -4x - 5y = 9 \end{cases} \quad 39. \begin{cases} -2x + 3y = 1 \\ 4x - 6y = -2 \end{cases}$$

$$40. \begin{cases} -2x + 4y = 5 \\ x - 4y = -3 \end{cases} \quad 41. \begin{cases} -5x = 10 \\ 2x + 2y = -4 \end{cases} \quad 42. \begin{cases} -3x + y = 2 \\ 9x - 3y = 5 \end{cases}$$

$$43. \begin{cases} 8x + 2y = 26 \\ -16x - 2y = -90 \end{cases} \quad 44. \begin{cases} 3x - 7y = -2 \\ -6x + 14y = 4 \end{cases} \quad 45. \begin{cases} 3y = 15 \\ 8x + 4y = 20 \end{cases}$$

$$46. \begin{cases} 4y + 3z = -254 \\ 2x - 2y - z = 100 \\ -x + y - 2z = 155 \end{cases} \quad 47. \begin{cases} 2x - y - 3z = -10 \\ 2y - z = 11 \\ -x + 4z = 0 \end{cases} \quad 48. \begin{cases} 3y - 4z = 15 \\ x + 2y - 3z = 9 \\ -x - y + 2z = -5 \end{cases}$$

Solve the following sets of systems by the inverse matrix method. See Example 5.

$$49. \begin{cases} x + 2y - z = 2 \\ 3x + 3y - z = -5 \\ 4x + 4y - z = 1 \end{cases} \quad \begin{cases} x + 2y - z = 1 \\ 3x + 3y - z = 1 \\ 4x + 4y - z = 1 \end{cases} \quad \begin{cases} x + 2y - z = 0 \\ 3x + 3y - z = 1 \\ 4x + 4y - z = 1 \end{cases}$$

$$50. \begin{cases} -x - y - 2z = 4 \\ x + 3y + 3z = 0 \\ -3y - 2z = 9 \end{cases} \quad \begin{cases} -x - y - 2z = 1 \\ x + 3y + 3z = 0 \\ -3y - 2z = 0 \end{cases} \quad \begin{cases} -x - y - 2z = -2 \\ x + 3y + 3z = -3 \\ -3y - 2z = 1 \end{cases}$$

$$51. \begin{cases} -x + z = 6 \\ -x + 3y + 2z = -11 \\ 2x - 4y - 3z = 13 \end{cases} \quad \begin{cases} -x + z = -2 \\ -x + 3y + 2z = 2 \\ 2x - 4y - 3z = -1 \end{cases} \quad \begin{cases} -x + z = -4 \\ -x + 3y + 2z = 2 \\ 2x - 4y - 3z = 0 \end{cases}$$

TECHNOLOGY

Using a graphing utility, find the inverse of each of the following matrices, if possible. Round your answers to three decimal places if necessary.

$$52. \begin{bmatrix} -7 & 3 \\ -1 & 2 \end{bmatrix} \quad 53. \begin{bmatrix} -6 & 2 \\ -5 & 5 \end{bmatrix} \quad 54. \begin{bmatrix} -2 & 0 & 2 \\ 2 & -3 & 1 \\ 1 & -2 & 3 \end{bmatrix}$$

$$55. \begin{bmatrix} 2.3 & 7.8 \\ -3.4 & 1.6 \end{bmatrix} \quad 56. \begin{bmatrix} 4.5 & -9.4 & 6.9 \\ 8.6 & -2.8 & 1.2 \\ 3.1 & 0.3 & -7.0 \end{bmatrix} \quad 57. \begin{bmatrix} 38 & -44 & 72 \\ -93 & 16 & 29 \\ 65 & 23 & -19 \end{bmatrix}$$