

SECTION 4.3 STUDY SET

VOCABULARY

Fill in the blanks.

- The coefficients of $3x$ and $-3x$ are opposites.
- When the following equations are added, the variable y will be eliminated.

$$\begin{array}{r} 5x - 6y = 10 \\ -3x + 6y = 24 \\ \hline \end{array}$$

CONCEPTS

- In the following system, which terms have coefficients that are opposites? **$7y$ and $-7y$**
$$\begin{cases} 3x + 7y = -25 \\ 4x - 7y = 12 \end{cases}$$
- Fill in the blank. The objective of the elimination method is to obtain two equations whose sum will be one equation in one variable.

- Add each pair of equations.

$$2a + 2b = -6 \qquad x - 3y = 15$$

$$\begin{array}{l} \text{a. } \frac{3a - 2b = 2}{5a = -4} \qquad \text{b. } \frac{-x - y = -14}{-4y = 1} \end{array}$$

- Multiply both sides of $4x + y = 2$ by 3.
 $12x + 3y = 6$
- Multiply both sides of $x - 3y = 4$ by -2 .
 $-2x + 6y = -8$

- If the elimination method is used to solve
$$\begin{cases} 3x + 12y = 4 \\ 6x - 4y = 7 \end{cases}$$

- By what would we multiply the first equation to eliminate x ? **-2**
- By what would we multiply the second equation to eliminate y ? **3**

- Suppose the following system is solved using the elimination method and it is found that x is 2. Find the value of y . **1**

$$\begin{cases} 4x + 3y = 11 \\ 3x - 2y = 4 \end{cases}$$

- What algebraic step should be performed to

- Clear $\frac{2}{3}x + 4y = -\frac{4}{5}$ of fractions?

Multiply both sides by 15.

- Clear $0.2x - 0.9y = 6.4$ of decimals?

Multiply both sides by 10.

- Suppose $0 = 0$ is obtained when a system is solved by the elimination method. Does the system have a solution? Which of the following is a possible graph of the system?

Yes; ii

- Suppose $0 = 2$ is obtained when a system is solved by the elimination method. Does the system have a solution? Which of the following is a possible graph of the system?

No; iii

NOTATION

Complete the solution to solve the system.

- Solve:
$$\begin{cases} x + y = 5 \\ x - y = -3 \end{cases}$$

$$x + y = 5$$

$$x - y = -3$$

$$\underline{2x = 2}$$

$$x = 1$$

$$x + y = 5 \qquad \text{This is the first equation.}$$

$$1 + y = 5$$

$$y = 4$$

The solution is **$(1, 4)$** .

- Write each equation of the system in standard $Ax + By = C$ form:

$$\begin{cases} 7x + y + 3 = 0 \rightarrow 7x + y = -3 \\ 8x + 4 = -y \rightarrow 8x + y = -4 \end{cases}$$

GUIDED PRACTICE

Use the elimination (addition) method to solve each system.

$$13. \begin{cases} x + y = 5 \\ x - y = 1 \end{cases}$$

Eliminate y .

$$\begin{array}{r} x + y = 5 \\ x - y = 1 \\ \hline 2x = 6 \end{array}$$

$$\frac{2x}{2} = \frac{6}{2}$$
$$x = 3$$

$$x + y = 5 \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$3 + y = 5$$

$$3 + y - 3 = 5 - 3$$

$$y = 2$$

The solution is $(3, 2)$.

$$14. \begin{cases} x - y = 4 \\ x + y = 8 \end{cases}$$

Eliminate y .

$$\begin{array}{r} x - y = 4 \\ x + y = 8 \\ \hline 2x = 12 \end{array}$$

$$\frac{2x}{2} = \frac{12}{2}$$
$$x = 6$$

$$x + y = 8 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$6 + y = 8$$

$$6 + y - 6 = 8 - 6$$

$$y = 2$$

The solution is $(6, 2)$.

$$15. \begin{cases} x + y = 1 \\ x - y = 5 \end{cases}$$

Eliminate y .

$$\begin{array}{r} x + y = 1 \\ x - y = 5 \\ \hline 2x = 6 \end{array}$$

$$\frac{2x}{2} = \frac{6}{2}$$
$$x = 3$$

$$x + y = 1 \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$3 + y = 1$$

$$3 + y - 3 = 1 - 3$$

$$y = -2$$

The solution is $(3, -2)$.

$$16. \begin{cases} x - y = -5 \\ x + y = 1 \end{cases}$$

Eliminate y .

$$\begin{array}{r} x - y = -5 \\ x + y = 1 \\ \hline 2x = -4 \end{array}$$

$$\frac{2x}{2} = \frac{-4}{2}$$
$$x = -2$$

$$x + y = 1 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$-2 + y = 1$$

$$-2 + y + 2 = 1 + 2$$

$$y = 3$$

The solution is $(-2, 3)$.

$$17. \begin{cases} x + y = -5 \\ -x + y = -1 \end{cases}$$

Eliminate x .

$$\begin{array}{r} x + y = -5 \\ -x + y = -1 \\ \hline 2y = -6 \end{array}$$

$$\frac{2y}{2} = \frac{-6}{2}$$
$$y = -3$$

$$x + y = -5 \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$x + (-3) = -5$$

$$x - 3 + 3 = -5 + 3$$

$$x = -2$$

The solution is $(-2, -3)$.

$$18. \begin{cases} -x + y = -3 \\ x + y = 1 \end{cases}$$

Eliminate x .

$$\begin{array}{r} -x + y = -3 \\ x + y = 1 \\ \hline 2y = -2 \end{array}$$

$$\frac{2y}{2} = \frac{-2}{2}$$
$$y = -1$$

$$x + y = 1 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$x + (-1) = 1$$

$$x - 1 + 1 = 1 + 1$$

$$x = 2$$

The solution is $(2, -1)$.

$$19. \begin{cases} 4x + 3y = 24 \\ 4x - 3y = -24 \end{cases}$$

Eliminate y .

$$\begin{array}{r} 4x + 3y = 24 \\ 4x - 3y = -24 \\ \hline \end{array}$$

$$8x = 0$$

$$\frac{8x}{8} = \frac{0}{8}$$

$$x = 0$$

$$4x + 3y = 24 \quad \text{The 1st equation}$$

$$4(\mathbf{0}) + 3y = 24$$

$$3y = 24$$

$$\frac{3y}{3} = \frac{24}{3}$$

$$y = 8$$

The solution is $(0, 8)$.

$$20. \begin{cases} -9x + 5y = -9 \\ -9x - 5y = -9 \end{cases}$$

Eliminate y .

$$\begin{array}{r} -9x + 5y = -9 \\ -9x - 5y = -9 \\ \hline \end{array}$$

$$-18x = -18$$

$$\frac{-18x}{-18} = \frac{-18}{-18}$$

$$x = 1$$

$$-9x + 5y = -9 \quad \text{The 1st equation}$$

$$-9(\mathbf{1}) + 5y = -9$$

$$-9 + 5y + \mathbf{9} = -9 + \mathbf{9}$$

$$5y = 0$$

$$\frac{5y}{5} = \frac{0}{5}$$

$$y = 0$$

The solution is $(1, 0)$.

$$21. \begin{cases} 2s + t = -2 \\ -2s - 3t = -6 \end{cases}$$

Eliminate s .

$$\begin{array}{r} 2s + t = -2 \\ -2s - 3t = -6 \\ \hline \end{array}$$

$$-2t = -8$$

$$\frac{-2t}{-2} = \frac{-8}{-2}$$

$$t = 4$$

$$2s + t = -2 \quad \text{The 1st equation}$$

$$2s + \mathbf{4} = -2$$

$$2s + 4 - \mathbf{4} = -2 - \mathbf{4}$$

$$2s = -6$$

$$\frac{2s}{2} = \frac{-6}{2}$$

$$s = -3$$

The solution is $(-3, 4)$.

$$22. \begin{cases} -2x + 4y = 12 \\ 2x + 4y = 28 \end{cases}$$

Eliminate x .

$$\begin{array}{r} -2x + 4y = 12 \\ 2x + 4y = 28 \\ \hline \end{array}$$

$$8y = 40$$

$$\frac{8y}{8} = \frac{40}{8}$$

$$y = 5$$

$$2x + 4y = 28 \quad \text{The 2nd equation}$$

$$2x + 4(\mathbf{5}) = 28$$

$$2x + 20 = 28$$

$$2x + 20 - \mathbf{20} = 28 - \mathbf{20}$$

$$2x = 8$$

$$\frac{2x}{2} = \frac{8}{2}$$

$$x = 4$$

The solution is $(4, 5)$.

$$23. \begin{cases} 5x - 4y = 8 \\ -5x - 4y = 8 \end{cases}$$

Eliminate x .

$$\begin{array}{r} 5x - 4y = 8 \\ -5x - 4y = 8 \\ \hline -8y = 16 \\ \frac{-8y}{-8} = \frac{16}{-8} \\ y = -2 \end{array}$$

$$5x - 4y = 8 \quad 1^{\text{st}} \text{ equation}$$

$$5x - 4(-2) = 8$$

$$\begin{array}{r} 5x + 8 = 8 \\ 5x + 8 - 8 = 8 - 8 \\ 5x = 0 \\ \frac{5x}{5} = \frac{0}{5} \\ x = 0 \end{array}$$

The solution is $(0, -2)$.

$$24. \begin{cases} 2r + s = -8 \\ -2r + 4s = 28 \end{cases}$$

Eliminate r .

$$\begin{array}{r} 2r + s = -8 \\ -2r + 4s = 28 \\ \hline 5s = 20 \\ \frac{5s}{5} = \frac{20}{5} \\ s = 4 \end{array}$$

$$2r + s = -8 \quad \text{The } 1^{\text{st}} \text{ equation}$$

$$2r + 4 = -8$$

$$2r + 4 - 4 = -8 - 4$$

$$\begin{array}{r} 2r = -12 \\ \frac{2r}{2} = \frac{-12}{2} \\ r = -6 \end{array}$$

The solution is $(-6, 4)$.

Use the elimination (addition) method to solve each system.

$$25. \begin{cases} x + 3y = -9 \\ x + 8y = -4 \end{cases}$$

Eliminate x .

Multiply both sides of the 1^{st} equation by -1 .

$$\begin{array}{r} -x - 3y = 9 \\ x + 8y = -4 \\ \hline 5y = 5 \\ \frac{5y}{5} = \frac{5}{5} \\ y = 1 \end{array}$$

$$x + 3y = -9 \quad \text{The } 1^{\text{st}} \text{ equation}$$

$$\begin{array}{r} x + 3(\mathbf{1}) = -9 \\ x + 3 - \mathbf{3} = -9 - \mathbf{3} \\ x = -12 \end{array}$$

The solution is $(-12, 1)$.

$$26. \begin{cases} x + 7y = -22 \\ x + 9y = -24 \end{cases}$$

Eliminate x .

Multiply both sides of the 1^{st} equation by -1 .

$$\begin{array}{r} -x - 7y = 22 \\ x + 9y = -24 \\ \hline 2y = -2 \\ \frac{2y}{2} = \frac{-2}{2} \\ y = -1 \end{array}$$

$$x + 7y = -22 \quad \text{The } 1^{\text{st}} \text{ equation}$$

$$\begin{array}{r} x + 7(-\mathbf{1}) = -22 \\ x - 7 + \mathbf{7} = -22 + \mathbf{7} \\ x = -15 \end{array}$$

The solution is $(-15, -1)$.

$$27. \begin{cases} 5c + 2d = -5 \\ 6c + 2d = -10 \end{cases}$$

Eliminate d .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} -5c - 2d = 5 \\ 6c + 2d = -10 \\ \hline c = -5 \end{array}$$

$$5c + 2d = -5 \quad \text{The 1st equation}$$

$$5(-5) + 2d = -5$$

$$-25 + 2d = -5$$

$$-25 + 2d + 25 = -5 + 25$$

$$2d = 20$$

$$\frac{2d}{2} = \frac{20}{2}$$

$$d = 10$$

The solution is $(-5, 10)$.

$$28. \begin{cases} 11c + 3d = -68 \\ 10c + 3d = -64 \end{cases}$$

Eliminate d .

Multiply both sides of the 2nd equation by -1 .

$$\begin{array}{r} 11c + 3d = -68 \\ -10c - 3d = 64 \\ \hline c = -4 \end{array}$$

$$11c + 3d = -68 \quad \text{The 1st equation}$$

$$11(-4) + 3d = -68$$

$$-44 + 3d = -68$$

$$-44 + 3d + 44 = -68 + 44$$

$$3d = -24$$

$$\frac{3d}{3} = \frac{-24}{3}$$

$$d = -8$$

The solution is $(-4, -8)$.

$$29. \begin{cases} 7x - y = 10 \\ 8x - y = 13 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} -7x + y = -10 \\ 8x - y = 13 \\ \hline x = 3 \end{array}$$

$$7x - y = 10 \quad \text{The 1st equation}$$

$$7(3) - y = 10$$

$$21 - y = 10$$

$$21 - y + y = 10 + y$$

$$21 - 10 = 10 + y - 10$$

$$11 = y$$

The solution is $(3, 11)$

$$30. \begin{cases} 6x - y = 4 \\ 9x - y = 10 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} -6x + y = -4 \\ 9x - y = 10 \\ \hline 3x = 6 \\ \frac{3x}{3} = \frac{6}{3} \\ x = 2 \end{array}$$

$$6x - y = 4 \quad \text{The 1st equation}$$

$$6(2) - y = 4$$

$$12 - y = 4$$

$$12 - y + y = 4 + y$$

$$12 - 4 = 4 + y - 4$$

$$8 = y$$

The solution is $(2, 8)$.

$$31. \begin{cases} 3a - b = -9 \\ 4a - b = -17 \end{cases}$$

Eliminate b .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} -3a + b = 9 \\ 4a - b = -17 \\ \hline a = -8 \end{array}$$

$3a - b = -9$ The 1st equation

$$\begin{array}{r} 3(-8) - b = -9 \\ -24 - b = -9 \\ -24 - b + b = -9 + b \\ -24 = -9 + b \\ -24 + 9 = -9 + b + 9 \\ -15 = b \end{array}$$

The solution is $(-8, -15)$.

$$32. \begin{cases} -7x - y = 22 \\ 4x - y = -44 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} 7x + y = -22 \\ 4x - y = -44 \\ \hline 11x = -66 \\ \frac{11x}{11} = \frac{-66}{11} \\ x = -6 \end{array}$$

$4x - y = -44$ The 2nd equation

$$\begin{array}{r} 4(-6) - y = -44 \\ -24 - y = -44 \\ -24 - y + y = -44 + y \\ -24 = -44 + y \\ -24 + 44 = -44 + y + 44 \\ 20 = y \end{array}$$

The solution is $(-6, 20)$.

Use the elimination (addition) method to solve each system.

$$33. \begin{cases} 7x + 4y = 14 \\ 3x - 2y = -20 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 2.

$$\begin{array}{r} 7x + 4y = 14 \\ 6x - 4y = -40 \\ \hline 13x = -26 \\ \frac{13x}{13} = \frac{-26}{13} \\ x = -2 \end{array}$$

$7x + 4y = 14$ The 1st equation

$$\begin{array}{r} 7(-2) + 4y = 14 \\ -14 + 4y = 14 \\ -14 + 4y + 14 = 14 + 14 \\ 4y = 28 \\ \frac{4y}{4} = \frac{28}{4} \\ y = 7 \end{array}$$

The solution is $(-2, 7)$.

$$34. \begin{cases} 5x - 14y = 32 \\ -x - 6y = 20 \end{cases}$$

Eliminate x .

Multiply both sides of the 2nd equation by 5.

$$\begin{array}{r} 5x - 14y = 32 \\ -5x - 30y = 100 \\ \hline -44y = 132 \\ \frac{-44y}{-44} = \frac{132}{-44} \\ y = -3 \end{array}$$

$-x - 6y = 20$ The 2nd equation

$$\begin{array}{r} -x - 6(-3) = 20 \\ -x + 18 = 20 \\ -x + 18 - 18 = 20 - 18 \\ -x = 2 \\ \frac{-x}{-1} = \frac{2}{-1} \\ x = -2 \end{array}$$

The solution is $(-2, -3)$.

$$35. \begin{cases} 7x - 50y = -43 \\ x + 3y = 4 \end{cases}$$

Eliminate x .

Multiply both sides of the 2nd equation by -7 .

$$\begin{array}{r} 7x - 50y = -43 \\ -7x - 21y = -28 \\ \hline -71y = -71 \\ \frac{-71y}{-71} = \frac{-71}{-71} \\ y = 1 \end{array}$$

$$x + 3y = 4 \quad \text{The 2nd equation}$$

$$x + 3(\mathbf{1}) = 4$$

$$x + 3 - \mathbf{3} = 4 - \mathbf{3}$$

$$x = 1$$

The solution is $(1, 1)$.

$$36. \begin{cases} x - 2y = -1 \\ 12x + 11y = 23 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by -12 .

$$\begin{array}{r} -12x + 24y = 12 \\ 12x + 11y = 23 \\ \hline 35y = 35 \\ \frac{35y}{35} = \frac{35}{35} \\ y = 1 \end{array}$$

$$x - 2y = -1 \quad \text{The 1st equation}$$

$$x - 2(\mathbf{1}) = -1$$

$$x - 2 + \mathbf{2} = -1 + \mathbf{2}$$

$$x = 1$$

The solution is $(1, 1)$.

$$37. \begin{cases} 9a + 16b = -36 \\ 7a + 4b = 48 \end{cases}$$

Eliminate b .

Multiply both sides of the 2nd equation by -4 .

$$\begin{array}{r} 9a + 16b = -36 \\ -28a - 16b = -192 \\ \hline -19a = -228 \\ \frac{-19a}{-19} = \frac{-228}{-19} \\ a = 12 \end{array}$$

$$7a + 4b = 48 \quad \text{The 2nd equation}$$

$$7(\mathbf{12}) + 4b = 48$$

$$84 + 4b = 48$$

$$84 + 4b - \mathbf{84} = 48 - \mathbf{84}$$

$$4b = -36$$

$$\frac{4b}{4} = \frac{-36}{4}$$

$$b = -9$$

The solution is $(12, -9)$.

$$38. \begin{cases} 4a + 7b = -24 \\ 9a + b = 64 \end{cases}$$

Eliminate b .

Multiply both sides of the 2nd equation by -7 .

$$\begin{array}{r} 4a + 7b = -24 \\ -63a - 7b = -448 \\ \hline -59a = -472 \\ \frac{-59a}{-59} = \frac{-472}{-59} \\ a = 8 \end{array}$$

$$9a + b = 64 \quad \text{The 2nd equation}$$

$$9(\mathbf{8}) + b = 64$$

$$72 + b = 64$$

$$72 + b - \mathbf{72} = 64 - \mathbf{72}$$

$$b = -8$$

The solution is $(8, -8)$.

$$39. \begin{cases} 8x + 12y = -22 \\ 3x - 2y = 8 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 6.

$$\begin{array}{r} 8x + 12y = -22 \\ 18x - 12y = 48 \\ \hline 26x = 26 \\ \frac{26x}{26} = \frac{26}{26} \\ x = 1 \end{array}$$

$$3x - 2y = 8 \quad \text{The 2nd equation}$$

$$3(\mathbf{1}) - 2y = 8$$

$$3 - 2y = 8$$

$$3 - 2y - \mathbf{3} = 8 - \mathbf{3}$$

$$-2y = 5$$

$$\frac{-2y}{-2} = \frac{5}{-2}$$

$$y = -\frac{5}{2}$$

The solution is $\left(1, -\frac{5}{2}\right)$.

$$40. \begin{cases} 3x + 2y = 45 \\ 5x - 4y = 20 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 2.

$$\begin{array}{r} 6x + 4y = 90 \\ 5x - 4y = 20 \\ \hline 11x = 110 \\ \frac{11x}{11} = \frac{110}{11} \\ x = 10 \end{array}$$

$$3x + 2y = 45 \quad \text{The 1st equation}$$

$$3(\mathbf{10}) + 2y = 45$$

$$30 + 2y = 45$$

$$30 + 2y - \mathbf{30} = 45 - \mathbf{30}$$

$$2y = 15$$

$$\frac{2y}{2} = \frac{15}{2}$$

$$y = \frac{15}{2}$$

The solution is $\left(10, \frac{15}{2}\right)$.

$$41. \begin{cases} 6x + 5y + 29 = 0 \\ 2x = 3y - 5 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 6x + 5y = -29 \\ 2x - 3y = -5 \end{cases}$$

Eliminate x .

Multiply both sides of the 2nd equation by -3 .

$$\begin{array}{r} 6x + 5y = -29 \\ -6x + 9y = 15 \\ \hline 14y = -14 \\ \frac{14y}{14} = \frac{-14}{14} \\ y = -1 \end{array}$$

$$2x + 5 = 3y \quad \text{The 2nd equation}$$

$$2x + 5 = 3(-\mathbf{1})$$

$$2x + 5 = -3$$

$$2x + 5 - \mathbf{5} = -3 - \mathbf{5}$$

$$2x = -8$$

$$\frac{2x}{2} = \frac{-8}{2}$$

$$x = -4$$

The solution is $(-4, -1)$.

$$42. \begin{cases} 3x = 20y + 1 \\ 4x + 5y - 33 = 0 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 3x - 20y = 1 \\ 4x + 5y = 33 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 4.

$$\begin{array}{r} 3x - 20y = 1 \\ 16x + 20y = 132 \\ \hline 19x = 133 \\ \frac{19x}{19} = \frac{133}{19} \\ x = 7 \end{array}$$

$$3x - 1 = 20y \quad \text{The 1st equation}$$

$$3(\mathbf{7}) - 1 = 20y$$

$$21 - 1 = 20y$$

$$20 = 20y$$

$$\frac{20}{20} = \frac{20y}{20}$$

$$1 = y$$

The solution is $(7, 1)$.

$$43. \begin{cases} c = d - 9 \\ 5c = 3d - 35 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} c - d = -9 \\ 5c - 3d = -35 \end{cases}$$

Eliminate c .

Multiply both sides of the 1st equation by -5 .

$$\begin{array}{r} -5c + 5d = 45 \\ 5c - 3d = -35 \\ \hline 2d = 10 \\ \frac{2d}{2} = \frac{10}{2} \\ d = 5 \end{array}$$

$$c = d - 9 \quad \text{The 1st equation}$$

$$c = 5 - 9$$

$$c = -4$$

The solution is $(-4, 5)$.

$$44. \begin{cases} a = b + 7 \\ 3a - 15 = 5b \end{cases}$$

Write both equations in standard form.

$$\begin{cases} a - b = 7 \\ 3a - 5b = 15 \end{cases}$$

Eliminate a .

Multiply both sides of the 1st equation by -3 .

$$\begin{array}{r} -3a + 3b = -21 \\ 3a - 5b = 15 \\ \hline -2b = -6 \\ \frac{-2b}{-2} = \frac{-6}{-2} \\ b = 3 \end{array}$$

$$a = b + 7 \quad \text{The 1st equation}$$

$$a = 3 + 7$$

$$a = 10$$

The solution is $(10, 3)$.

Use the elimination (addition) method to solve each system.

$$45. \begin{cases} 4x + 3y = 7 \\ 3x - 2y = -16 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 2.

Multiply both sides of the 2nd equation by 3.

$$\begin{array}{r} 8x + 6y = 14 \\ 9x - 6y = -48 \\ \hline 17x = -34 \\ \frac{17x}{17} = \frac{-34}{17} \\ x = -2 \end{array}$$

$$4x + 3y = 7 \quad \text{The 1st equation}$$

$$4(-2) + 3y = 7$$

$$-8 + 3y + 8 = 7 + 8$$

$$3y = 15$$

$$\frac{3y}{3} = \frac{15}{3}$$

$$y = 5$$

The solution is $(-2, 5)$

$$46. \begin{cases} 3x - 2y = 20 \\ 2x + 7y = 5 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 7.

Multiply both sides of the 2nd equation by 2.

$$\begin{array}{r} 21x - 14y = 140 \\ 4x + 14y = 10 \\ \hline 25x = 150 \\ \frac{25x}{25} = \frac{150}{25} \\ x = 6 \end{array}$$

$$2x + 7y = 5 \quad \text{The 2nd equation}$$

$$2(6) + 7y = 5$$

$$12 + 7y = 5$$

$$12 + 7y - 12 = 5 - 12$$

$$7y = -7$$

$$\frac{7y}{7} = \frac{-7}{7}$$

$$y = -1$$

The solution is $(6, -1)$.

$$47. \begin{cases} 5a + 8b = 2 \\ 11a - 3b = 25 \end{cases}$$

Eliminate b .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by 8.

$$\begin{array}{r} 15a + 24b = 6 \\ 88a - 24b = 200 \\ \hline 103a = 206 \\ 103a = 206 \\ \hline \mathbf{103} \quad \mathbf{103} \\ a = 2 \end{array}$$

$$5a + 8b = 2 \quad \text{The 1st equation}$$

$$5(\mathbf{2}) + 8b = 2$$

$$10 + 8b - \mathbf{10} = 2 - \mathbf{10}$$

$$8b = -8$$

$$\frac{8b}{\mathbf{8}} = \frac{-8}{\mathbf{8}}$$

$$b = -1$$

The solution is $(2, -1)$

$$48. \begin{cases} 7a - 5b = 24 \\ 12a + 8b = 8 \end{cases}$$

Eliminate b .

Multiply both sides of the 1st equation by 8.

Multiply both sides of the 2nd equation by 5.

$$\begin{array}{r} 56a - 40b = 192 \\ 60a + 40b = 40 \\ \hline 116a = 232 \\ 116a = 232 \\ \hline \mathbf{116} \quad \mathbf{116} \\ a = 2 \end{array}$$

$$7a - 5b = 24 \quad \text{The 1st equation}$$

$$7(\mathbf{2}) - 5b = 24$$

$$14 - 5b - \mathbf{14} = 24 - \mathbf{14}$$

$$-5b = 10$$

$$\frac{-5b}{\mathbf{-5}} = \frac{10}{\mathbf{-5}}$$

$$b = -2$$

The solution is $(2, -2)$

$$49. \begin{cases} 2x + 11y = -10 \\ 5x + 4y = 22 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 5.

Multiply both sides of the 2nd equation by -2 .

$$\begin{array}{r} 10x + 55y = -50 \\ -10x - 8y = -44 \\ \hline 47y = -94 \\ 47y = -94 \\ \hline \mathbf{47} \quad \mathbf{47} \\ y = -2 \end{array}$$

$$5x + 4y = 22 \quad \text{The 2nd equation}$$

$$5x + 4(-\mathbf{2}) = 22$$

$$5x - 8 + \mathbf{8} = 22 + \mathbf{8}$$

$$5x = 30$$

$$\frac{5x}{\mathbf{5}} = \frac{30}{\mathbf{5}}$$

$$x = 6$$

The solution is $(6, -2)$

$$50. \begin{cases} 3x + 4y = 12 \\ 4x + 5y = 17 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 4.

Multiply both sides of the 2nd equation by -3 .

$$\begin{array}{r} 12x + 16y = 48 \\ -12x - 15y = -51 \\ \hline y = -3 \end{array}$$

$$4x + 5y = 17 \quad \text{The 2nd equation}$$

$$4x + 5(-\mathbf{3}) = 17$$

$$4x - 15 + \mathbf{15} = 17 + \mathbf{15}$$

$$4x = 32$$

$$\frac{4x}{\mathbf{4}} = \frac{32}{\mathbf{4}}$$

$$x = 8$$

The solution is $(8, -3)$.

$$51. \begin{cases} 7x = 21 - 6y \\ 4x + 5y = 12 \end{cases}$$

Write the 1st equation in standard form.

$$\begin{cases} 7x + 6y = 21 \\ 4x + 5y = 12 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 4.

Multiply both sides of the 2nd equation by -7 .

$$\begin{array}{r} 28x + 24y = 84 \\ -28x - 35y = -84 \\ \hline -11y = 0 \\ -11y = 0 \\ \hline -11 = -11 \\ y = 0 \end{array}$$

$$7x = 21 - 6y \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$7x = 21 - 6(0)$$

$$7x = 21$$

$$\frac{7x}{7} = \frac{21}{7}$$

$$x = 3$$

The solution is (3, 0).

$$52. \begin{cases} -4x = -3y - 13 \\ -6x + 8y = -16 \end{cases}$$

Write the 1st equation in standard form.

$$\begin{cases} -4x + 3y = -13 \\ -6x + 8y = -16 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by -2 .

$$\begin{array}{r} -12x + 9y = -39 \\ 12x - 16y = 32 \\ \hline -7y = -7 \\ -7y = -7 \\ \hline -7 = -7 \\ y = 1 \end{array}$$

$$-4x = -3y - 13 \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$-4x = -3(1) - 13$$

$$-4x = -3 - 13$$

$$-4x = -16$$

$$\frac{-4x}{-4} = \frac{-16}{-4}$$

$$x = 4$$

The solution is (4, 1).

$$53. \begin{cases} 4x - 7y + 32 = 0 \\ 5x = 4y - 2 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 4x - 7y = -32 \\ 5x - 4y = -2 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 5.

Multiply both sides of the 2nd equation by -4 .

$$\begin{array}{r} 20x - 35y = -160 \\ -20x + 16y = 8 \\ \hline -19y = -152 \\ -19y = -152 \\ \hline -19 = -19 \\ y = 8 \end{array}$$

$$5x = 4y - 2 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$5x = 4(8) - 2$$

$$5x = 32 - 2$$

$$5x = 30$$

$$\frac{5x}{5} = \frac{30}{5}$$

$$x = 6$$

The solution is (6, 8).

$$54. \begin{cases} 6x = -3y \\ 5x + 15 = 5y \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 6x + 3y = 0 \\ 5x - 5y = -15 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 5.

Multiply both sides of the 2nd equation by 3.

$$\begin{array}{r} 30x + 15y = 0 \\ 15x - 15y = -45 \\ \hline 45x = -45 \\ 45x = -45 \\ \hline 45 = 45 \\ x = -1 \end{array}$$

$$6x = -3y \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$6(-1) = -3y$$

$$-6 = -3y$$

$$\frac{-6}{-3} = \frac{-3y}{-3}$$

$$2 = y$$

$$2 = y$$

The solution is (-1, 2).

$$55. \begin{cases} 9x + 21 = 3y \\ 4x = 7y + 19 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 9x - 3y = -21 \\ 4x - 7y = 19 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 7.

Multiply both sides of the 2nd equation by -3 .

$$\begin{array}{r} 63x - 21y = -147 \\ -12x + 21y = -57 \\ \hline 51x = -204 \\ \frac{51x}{51} = \frac{-204}{51} \\ x = -4 \end{array}$$

$$9x + 21 = 3y \quad \text{The 1st equation}$$

$$\begin{array}{r} 9(-4) + 21 = 3y \\ -36 + 21 = 3y \\ -15 = 3y \\ \frac{-15}{3} = \frac{3y}{3} \\ -5 = y \end{array}$$

The solution is $(-4, -5)$.

$$56. \begin{cases} 7x + 11 = 4y \\ 4x = 7y + 22 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 7x - 4y = -11 \\ 4x - 7y = 22 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 7.

Multiply both sides of the 2nd equation by -4 .

$$\begin{array}{r} 49x - 28y = -77 \\ -16x + 28y = -88 \\ \hline 33x = -165 \\ \frac{33x}{33} = \frac{-165}{33} \\ x = -5 \end{array}$$

$$7x + 11 = 4y \quad \text{The 1st equation}$$

$$\begin{array}{r} 7(-5) + 11 = 4y \\ -35 + 11 = 4y \\ -24 = 4y \\ \frac{-24}{4} = \frac{4y}{4} \\ -6 = y \end{array}$$

The solution is $(-5, -6)$.

Use the elimination (addition) method to solve each system.

$$57. \begin{cases} \frac{3}{5}s + \frac{4}{5}t = 1 \\ -\frac{1}{4}s + \frac{3}{8}t = 1 \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 5\left(\frac{3}{5}s\right) + 5\left(\frac{4}{5}t\right) = 5(1) \\ 8\left(-\frac{1}{4}s\right) + 8\left(\frac{3}{8}t\right) = 8(1) \end{cases}$$

$$\begin{cases} 3s + 4t = 5 \\ -2s + 3t = 8 \end{cases}$$

Eliminate s .

Multiply both sides of the 1st equation by 2.

Multiply both sides of the 2nd equation by 3.

$$\begin{array}{r} 6s + 8t = 10 \\ -6s + 9t = 24 \\ \hline 17t = 34 \end{array}$$

$$17t = 34$$

$$\frac{17t}{17} = \frac{34}{17}$$

$$t = 2$$

$$3s + 4t = 5 \quad \text{The 1st equation}$$

$$3s + 4(2) = 5$$

$$3s + 8 - 8 = 5 - 8$$

$$3s = -3$$

$$\frac{3s}{3} = \frac{-3}{3}$$

$$s = -1$$

The solution is $(-1, 2)$.

$$58. \begin{cases} \frac{1}{2}x + \frac{4}{7}y = -1 \\ 5x - \frac{4}{5}y = -10 \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 14\left(\frac{1}{2}x\right) + 14\left(\frac{4}{7}y\right) = 14(-1) \\ 5(5x) - 5\left(\frac{4}{5}y\right) = 5(-10) \end{cases}$$

$$\begin{cases} 7x + 8y = -14 \\ 25x - 4y = -50 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 2.

$$\begin{array}{r} 7x + 8y = -14 \\ \underline{50x - 8y = -100} \\ 57x = -114 \\ \frac{57x}{57} = \frac{-114}{57} \\ x = -2 \end{array}$$

$$5x - \frac{4}{5}y = -10 \quad \text{The 2nd equation}$$

$$5(-2) - \frac{4}{5}y = -10$$

$$-10 - \frac{4}{5}y + \mathbf{10} = -10 + \mathbf{10}$$

$$-\frac{4}{5}y = 0$$

$$-\frac{\mathbf{5}}{\mathbf{4}}\left(-\frac{4}{5}y\right) = -\frac{\mathbf{5}}{\mathbf{4}}(0)$$

$$y = 0$$

The solution is $(-2, 0)$.

$$59. \begin{cases} \frac{1}{2}s - \frac{1}{4}t = 1 \\ \frac{1}{3}s + t = 3 \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 4\left(\frac{1}{2}s\right) - 4\left(\frac{1}{4}t\right) = 4(1) \\ 3\left(\frac{1}{3}s\right) + 3(t) = 3(3) \end{cases}$$

$$\begin{cases} 2s - t = 4 \\ s + 3t = 9 \end{cases}$$

Eliminate s .

Multiply both sides of the 2nd equation by -2 .

$$\begin{array}{r} 2s - t = 4 \\ \underline{-2s - 6t = -18} \\ -7t = -14 \\ \frac{-7t}{-7} = \frac{-14}{-7} \\ t = 2 \end{array}$$

$$\frac{1}{3}s + t = 3 \quad \text{The 2nd equation}$$

$$\frac{1}{3}s + (\mathbf{2}) = 3$$

$$\frac{1}{3}s + \mathbf{2} - \mathbf{2} = 3 - \mathbf{2}$$

$$\frac{1}{3}s = 1$$

$$\frac{\mathbf{3}}{\mathbf{1}}\left(\frac{1}{3}s\right) = \mathbf{3}(1)$$

$$s = 3$$

The solution is $(3, 2)$.

$$60. \begin{cases} \frac{2}{5}x + y = 1 \\ \frac{4}{5}x - y = -1 \end{cases}$$

Eliminate y .

$$\begin{array}{r} \frac{2}{5}x + y = 1 \\ \frac{4}{5}x - y = -1 \\ \hline \end{array}$$

$$\frac{6}{5}x = 0$$

$$\frac{5}{6} \left(\frac{6}{5}x \right) = \frac{5}{6}(0)$$

$$x = 0$$

$$\frac{2}{5}x + y = 1 \quad \text{The 1st equation}$$

$$\frac{2}{5}(0) + y = 1$$

$$y = 1$$

The solution is $(0, 1)$.

$$61. \begin{cases} x - \frac{4}{3}y = \frac{1}{3} \\ 2x + \frac{3}{2}y = \frac{1}{2} \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 3(x) - 3\left(\frac{4}{3}y\right) = 3\left(\frac{1}{3}\right) \\ 2(2x) + 2\left(\frac{3}{2}y\right) = 2\left(\frac{1}{2}\right) \end{cases}$$

$$\begin{cases} 3x - 4y = 1 \\ 4x + 3y = 1 \end{cases}$$

$$4x + 3y = 1$$

Eliminate y .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by 4.

$$9x - 12y = 3$$

$$16x + 12y = 4$$

$$\begin{array}{r} 25x = 7 \end{array}$$

$$\frac{25x}{25} = \frac{7}{25}$$

$$x = \frac{7}{25}$$

$$4x + 3y = 1 \quad \text{The 2nd equation}$$

$$4\left(\frac{7}{25}\right) + 3y = 1$$

$$\frac{28}{25} + 3y = 1$$

$$\frac{28}{25} + 3y - \frac{28}{25} = \frac{25}{25} - \frac{28}{25}$$

$$3y = -\frac{3}{25}$$

$$\frac{1}{3}(3y) = -\frac{3}{25}\left(\frac{1}{3}\right)$$

$$y = -\frac{1}{25}$$

The solution is $\left(\frac{7}{25}, -\frac{1}{25}\right)$.

$$62. \begin{cases} x + y = -\frac{1}{4} \\ x - \frac{y}{2} = -\frac{3}{2} \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 4(x) + 4(y) = 4\left(-\frac{1}{4}\right) \\ 2(x) - 2\left(\frac{y}{2}\right) = 2\left(-\frac{3}{2}\right) \end{cases}$$

$$\begin{cases} 4x + 4y = -1 \\ 2x - y = -3 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 4.

$$\begin{array}{r} 4x + 4y = -1 \\ \underline{8x - 4y = -12} \\ 12x = -13 \\ \frac{12x}{12} = \frac{-13}{12} \\ x = -\frac{13}{12} \end{array}$$

$2x - y = -3$ The 2nd equation

$$\begin{array}{r} 2\left(-\frac{13}{12}\right) - y = -3 \\ -\frac{13}{6} - y = -3 \\ -\frac{13}{6} - y + \frac{13}{6} = -\frac{18}{6} + \frac{13}{6} \\ -y = -\frac{5}{6} \\ -1(-y) = -1\left(-\frac{5}{6}\right) \\ y = \frac{5}{6} \end{array}$$

The solution is $\left(-\frac{13}{12}, \frac{5}{6}\right)$.

$$63. \begin{cases} 4a + 7b = 2 \\ 9a - 3b = 1 \end{cases}$$

Eliminate b .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by 7.

$$\begin{array}{r} 12a + 21b = 6 \\ \underline{63a - 21b = 7} \\ 75a = 13 \\ \frac{75a}{75} = \frac{13}{75} \\ a = \frac{13}{75} \end{array}$$

$9a - 3b = 1$ The 2nd equation

$$9\left(\frac{13}{75}\right) - 3b = 1$$

$$\frac{39}{25} - 3b = 1$$

$$\frac{39}{25} - 3b - \frac{39}{25} = \frac{25}{25} - \frac{39}{25}$$

$$-3b = -\frac{14}{25}$$

$$-\frac{1}{3}(-3b) = -\frac{1}{3}\left(-\frac{14}{25}\right)$$

$$b = \frac{14}{75}$$

The solution is $\left(\frac{13}{75}, \frac{14}{75}\right)$.

$$64. \begin{cases} 5a - 7b = 6 \\ 7a - 6b = 8 \end{cases}$$

Eliminate b .

Multiply both sides of the 1st equation by -6 .

Multiply both sides of the 2nd equation by 7.

$$-30a + 42b = -36$$

$$\underline{49a - 42b = 56}$$

$$19a = 20$$

$$\frac{19a}{19} = \frac{20}{19}$$

$$a = \frac{20}{19}$$

$$7a - 6b = 8 \quad \text{The 2nd equation}$$

$$7\left(\frac{20}{19}\right) - 6b = 8$$

$$\frac{140}{19} - 6b = 8$$

$$\frac{140}{19} - 6b - \frac{140}{19} = \frac{152}{19} - \frac{140}{19}$$

$$-6b = \frac{12}{19}$$

$$-\frac{1}{6}(-6b) = -\frac{1}{6}\left(\frac{12}{19}\right)$$

$$b = -\frac{2}{19}$$

$$\text{The solution is } \left(\frac{20}{19}, -\frac{2}{19}\right).$$

Use the elimination (addition) method to solve each system. If there is no solution, or infinitely many solutions, so indicate.

$$65. \begin{cases} 3x - 5y = -29 \\ 3x - 5y = 15 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by -1 .

$$-3x + 5y = 29$$

$$\underline{3x - 5y = 15}$$

$$0 = 44 \quad \text{The variables drop out.}$$

False

No solution.

$$66. \begin{cases} 2a - 3b = -6 \\ 2a - 3b = 8 \end{cases}$$

Eliminate a .

Multiply both sides of the 1st equation by -1 .

$$-2a + 3b = 6$$

$$\underline{2a - 3b = 8}$$

$$0 = 14 \quad \text{Both variables are eliminated.}$$

False

No solution.

$$67. \begin{cases} 3x - 16 = 5y \\ -3x + 5y - 33 = 0 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 3x - 5y = 16 \\ -3x + 5y = 33 \end{cases}$$

Eliminate x .

$$3x - 5y = 16$$

$$\underline{-3x + 5y = 33}$$

$$0 = 49 \quad \text{The variables drop out.}$$

False

No solution.

$$68. \begin{cases} 2x + 5y - 13 = 0 \\ -2x + 13 = 5y \end{cases}$$

Write both equations in standard form

$$\begin{cases} 2x + 5y = 13 \\ -2x - 5y = -13 \end{cases}$$

$$2x + 5y = 13$$

$$\underline{-2x - 5y = -13}$$

$$0 = 0 \quad \text{The variables drop out.}$$

True

The system has infinitely many solutions.

$$69. \begin{cases} 0.4x - 0.7y = -1.9 \\ -4x + 7y = 19 \end{cases}$$

Multiply the 1st equation by 10.

$$\begin{cases} 4x - 7y = -19 \\ -4x + 7y = 19 \\ \hline 4x - 7y = -19 \\ -4x + 7y = 19 \\ \hline 0 = 0 \end{cases}$$

$0 = 0$ The variables drop out.

True

The system has infinitely many solutions.

$$70. \begin{cases} 0.1x + 2y + 0.2 = 0 \\ -x - 20y = 2 \end{cases}$$

Write the 1st equations in standard form.

$$\begin{cases} 0.1x + 2y = -0.2 \\ -x - 20y = 2 \end{cases}$$

Multiply the 1st equation by 10.

$$\begin{cases} x + 20y = -2 \\ -x - 20y = 2 \\ \hline x + 20y = -2 \\ -x - 20y = 2 \\ \hline 0 = 0 \end{cases}$$

$0 = 0$ The variables drop out.

True

The system has infinitely many solutions.

$$71. \begin{cases} \frac{x-6y}{2} = 7 \\ -x + 6y + 14 = 0 \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} \frac{x-6y}{2} = 7 \\ -x + 6y = -14 \end{cases}$$

Multiply both sides of the 1st equation by 2.

$$\begin{cases} 2\left(\frac{x-6y}{2}\right) = 2(7) \\ -x + 6y = -14 \end{cases}$$

$$\begin{cases} x - 6y = 14 \\ -x + 6y = -14 \\ \hline x - 6y = 14 \\ -x + 6y = -14 \\ \hline 0 = 0 \end{cases}$$

$0 = 0$ The variables drop out.

True

The system has infinitely many solutions.

$$72. \begin{cases} -9x + \frac{y}{2} = 7 \\ 18x = y \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} -9x + \frac{y}{2} = 7 \\ 18x - y = 0 \end{cases}$$

Multiply both sides of the 1st equation by 2.

$$\begin{cases} 2(-9x) + 2\left(\frac{y}{2}\right) = 2(7) \\ 18x - y = 0 \end{cases}$$

$$\begin{cases} -18x + y = 14 \\ 18x - y = 0 \end{cases}$$

$$\begin{cases} -18x + y = 14 \\ 18x - y = 0 \\ \hline 0 = 14 \end{cases}$$

$0 = 14$ The variables drop out.

False

No solution.

TRY IT YOURSELF

Solve the system by either the substitution or the elimination (addition) method if possible.

$$73. \begin{cases} y = -3x + 9 \\ y = x + 1 \end{cases}$$

$$y = -3x + 9 \quad \begin{array}{l} \text{The 1}^{\text{st}} \text{ equation} \\ \text{Substitute for } y. \end{array}$$

$$(x + 1) = -3x + 9$$

$$x + 1 + 3x = -3x + 9 + 3x$$

$$4x + 1 = 9$$

$$4x + 1 - 1 = 9 - 1$$

$$4x = 8$$

$$\frac{4x}{4} = \frac{8}{4}$$

$$x = 2$$

$$y = x + 1 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$y = 2 + 1$$

$$y = 3$$

The solution is (2, 3).

$$74. \begin{cases} x = 5y - 4 \\ x = 9y - 8 \end{cases}$$

$$x = 9y - 8 \quad \begin{array}{l} \text{The 2}^{\text{nd}} \text{ equation} \\ \text{Substitute for } x. \end{array}$$

$$(5y - 4) = 9y - 8$$

$$5y - 4 - 5y = 9y - 8 - 5y$$

$$-4 = 4y - 8$$

$$-4 + 8 = 4y - 8 + 8$$

$$4 = 4y$$

$$\frac{4y}{4} = \frac{4}{4}$$

$$y = 1$$

$$x = 9y - 8 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$x = 9(1) - 8$$

$$x = 9 - 8$$

$$x = 1$$

The solution is (1, 1).

$$75. \begin{cases} 4x + 6y = 5 \\ 8x - 9y = 3 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by 2.

$$12x + 18y = 15$$

$$16x - 18y = 6$$

$$\frac{16x - 18y}{28x} = \frac{6}{21}$$

$$\frac{28x}{28} = \frac{21}{28}$$

$$x = \frac{3}{4}$$

$$4x + 6y = 5 \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$4\left(\frac{3}{4}\right) + 6y = 5$$

$$3 + 6y = 5$$

$$3 + 6y - 3 = 5 - 3$$

$$6y = 2$$

$$\frac{6y}{6} = \frac{2}{6}$$

$$y = \frac{1}{3}$$

The solution is $\left(\frac{3}{4}, \frac{1}{3}\right)$.

$$76. \begin{cases} 3a + 4b = 36 \\ 6a - 2b = -21 \end{cases}$$

Eliminate b .

Multiply both sides of the 2nd equation by 2.

$$\begin{array}{r} 3a + 4b = 36 \\ 12a - 4b = -42 \\ \hline 15a = -6 \\ \frac{15a}{15} = \frac{-6}{15} \\ a = -\frac{2}{5} \end{array}$$

$3a + 4b = 36$ The 1st equation

$$\begin{aligned} 3\left(-\frac{2}{5}\right) + 4b &= 36 \\ -\frac{6}{5} + 4b &= 36 \\ -\frac{6}{5} + 4b + \frac{6}{5} &= \frac{180}{5} + \frac{6}{5} \\ 4b &= \frac{186}{5} \\ \frac{1}{4}(4b) &= \frac{1}{4}\left(\frac{186}{5}\right) \\ b &= \frac{93}{10} \end{aligned}$$

The solution is $\left(-\frac{2}{5}, \frac{93}{10}\right)$.

$$77. \begin{cases} 6x - 3y = -7 \\ y + 9x = 6 \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} 6x - 3y = -7 \\ 9x + y = 6 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 3.

$$\begin{array}{r} 6x - 3y = -7 \\ 27x + 3y = 18 \\ \hline 33x = 11 \\ \frac{33x}{33} = \frac{11}{33} \\ x = \frac{1}{3} \end{array}$$

$$6x - 3y = -7 \quad \text{1st equation}$$

$$\begin{aligned} 6\left(\frac{1}{3}\right) - 3y &= -7 \\ 2 - 3y &= -7 \\ 2 - 3y - 2 &= -7 - 2 \\ -3y &= -9 \\ \frac{-3y}{-3} &= \frac{-9}{-3} \\ y &= 3 \end{aligned}$$

The solution is $\left(\frac{1}{3}, 3\right)$.

$$78. \begin{cases} 9x + 4y = 31 \\ y - 5 = 6x \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} 9x + 4y = 31 \\ -6x + y = 5 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by -4 .

$$\begin{array}{r} 9x + 4y = 31 \\ 24x - 4y = -20 \\ \hline 33x = 11 \\ \frac{33x}{33} = \frac{11}{33} \\ x = \frac{1}{3} \end{array}$$

$$-6x + y = 5 \quad \text{The 2nd equation.}$$

$$\begin{aligned} -6\left(\frac{1}{3}\right) + y &= 5 \\ -2 + y &= 5 \\ -2 + y + 2 &= 5 + 2 \\ y &= 7 \end{aligned}$$

The solution is $\left(\frac{1}{3}, 7\right)$.

$$79. \begin{cases} 4x - 8y = 36 \\ 3x - 6y = 27 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by -4 .

$$\begin{cases} 12x - 24y = 108 \\ -12x + 24y = -108 \end{cases}$$

$$\begin{array}{r} 12x - 24y = 108 \\ -12x + 24y = -108 \\ \hline \end{array}$$

$$0 = 0 \quad \begin{array}{l} \text{The variables} \\ \text{drop out.} \end{array}$$

True

The system has infinitely many solutions.

$$80. \begin{cases} 2x + 4y = 15 \\ 3x = 8 - 6y \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} 2x + 4y = 15 \\ 3x + 6y = 8 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by -2 .

$$\begin{cases} 6x + 12y = 45 \\ -6x - 12y = -16 \end{cases}$$

$$\begin{array}{r} 6x + 12y = 45 \\ -6x - 12y = -16 \\ \hline \end{array}$$

$$0 = 29 \quad \begin{array}{l} \text{The variables} \\ \text{drop out.} \end{array}$$

False

No solution.

$$81. \begin{cases} x = y \\ 0.1x + 0.2y = 1.0 \end{cases}$$

Multiply both sides of the 2nd equation by 10.

$$\begin{cases} x = y \\ x + 2y = 10 \end{cases}$$

$$x + 2y = 10 \quad \begin{array}{l} \text{The 2}^{\text{nd}} \text{ equation} \\ \text{Substitute for } y. \end{array}$$

$$x + 2(x) = 10$$

$$3x = 10$$

$$\frac{3x}{3} = \frac{10}{3}$$

$$x = \frac{10}{3}$$

$$x = y \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$\frac{10}{3} = y$$

The solution is $\left(\frac{10}{3}, \frac{10}{3}\right)$.

$$82. \begin{cases} x = y \\ 0.4x - 0.8y = -0.5 \end{cases}$$

Multiply both sides of the 2nd equation by 10.

$$\begin{cases} x = y \\ 4x - 8y = -5 \end{cases}$$

$$4x - 8y = -5 \quad \begin{array}{l} \text{The 2}^{\text{nd}} \text{ equation} \\ \text{Substitute for } x. \end{array}$$

$$4(y) - 8y = -5$$

$$-4y = -5$$

$$\frac{-4y}{-4} = \frac{-5}{-4}$$

$$y = \frac{5}{4}$$

$$x = y \quad \text{The 1}^{\text{st}} \text{ equation}$$

$$x = \frac{5}{4}$$

The solution is $\left(\frac{5}{4}, \frac{5}{4}\right)$.

$$83. \begin{cases} 9x - 10y = 0 \\ 9x - 3y = 63 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} -9x + 10y = 0 \\ 9x - 3y = 63 \\ \hline 7y = 63 \\ \frac{7y}{7} = \frac{63}{7} \\ y = 9 \end{array}$$

$9x - 10y = 0$ The 1st equation

$$9x - 10(\mathbf{9}) = 0$$

$$9x - 90 + \mathbf{90} = 0 + \mathbf{90}$$

$$9x = 90$$

$$\frac{9x}{\mathbf{9}} = \frac{90}{\mathbf{9}}$$

$$x = 10$$

The solution is (10, 9).

$$84. \begin{cases} 8x - 9y = 0 \\ 8x - 12y = -24 \end{cases}$$

Eliminate x .

Multiply both sides of the 1st equation by -1 .

$$\begin{array}{r} -8x + 9y = 0 \\ 8x - 12y = -24 \\ \hline -3y = -24 \\ \frac{-3y}{-3} = \frac{-24}{-3} \\ y = 8 \end{array}$$

$8x - 9y = 0$ The 1st equation.

$$8x - 9(\mathbf{8}) = 0$$

$$8x - 72 = 0$$

$$8x - 72 + \mathbf{72} = 0 + \mathbf{72}$$

$$8x = 72$$

$$\frac{8x}{\mathbf{8}} = \frac{72}{\mathbf{8}}$$

$$x = 9$$

The solution is (9,8).

$$85. \begin{cases} \frac{m}{4} + \frac{n}{3} = -\frac{1}{12} \\ \frac{m}{2} - \frac{5}{4}n = \frac{7}{4} \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 12\left(\frac{m}{4}\right) + 12\left(\frac{n}{3}\right) = 12\left(-\frac{1}{12}\right) \\ 4\left(\frac{m}{2}\right) - 4\left(\frac{5}{4}n\right) = 4\left(\frac{7}{4}\right) \end{cases}$$

$$\begin{cases} 3m + 4n = -1 \\ 2m - 5n = 7 \end{cases}$$

Eliminate n .

Multiply both sides of the 1st equation by 5.

Multiply both sides of the 2nd equation by 4.

$$15m + 20n = -5$$

$$\underline{8m - 20n = 28}$$

$$23m = 23$$

$$\frac{23m}{\mathbf{23}} = \frac{23}{\mathbf{23}}$$

$$m = 1$$

$2m - 5n = 7$ The 2nd equation

$$2(\mathbf{1}) - 5n = 7$$

$$2 - 5n - \mathbf{2} = 7 - \mathbf{2}$$

$$-5n = 5$$

$$\frac{-5n}{-5} = \frac{5}{-5}$$

$$n = -1$$

The solution is (1, -1).

$$86. \begin{cases} \frac{x}{2} - \frac{y}{3} = -2 \\ \frac{x}{3} + \frac{2}{3}y = \frac{4}{3} \end{cases}$$

Clear both equations of fractions.

$$\begin{cases} 6\left(\frac{x}{2}\right) - 6\left(\frac{y}{3}\right) = 6(-2) \\ 3\left(\frac{x}{3}\right) + 3\left(\frac{2}{3}y\right) = 3\left(\frac{4}{3}\right) \end{cases}$$

$$\begin{cases} 3x - 2y = -12 \\ x + 2y = 4 \end{cases}$$

Eliminate y .

$$\begin{array}{r} 3x - 2y = -12 \\ x + 2y = 4 \\ \hline 4x \quad = -8 \\ \frac{4x}{4} = \frac{-8}{4} \\ x = -2 \end{array}$$

$$x + 2y = 4 \quad \text{The 2}^{\text{nd}} \text{ equation}$$

$$-2 + 2y = 4$$

$$-2 + 2y + 2 = 4 + 2$$

$$2y = 6$$

$$\frac{2y}{2} = \frac{6}{2}$$

$$y = 3$$

The solution is $(-2, 3)$.

$$87. \begin{cases} 3x + 12y = -12 \\ x = 3y + 10 \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} 3x + 12y = -12 \\ x - 3y = 10 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 4.

$$\begin{array}{r} 3x + 12y = -12 \\ 4x - 12y = 40 \\ \hline 7x \quad = 28 \\ \frac{7x}{7} = \frac{28}{7} \\ x = 4 \end{array}$$

$$x - 3y = 10 \quad \text{The 2}^{\text{nd}} \text{ equation.}$$

$$4 - 3y = 10$$

$$4 - 3y - 4 = 10 - 4$$

$$-3y = 6$$

$$\frac{-3y}{-3} = \frac{6}{-3}$$

$$y = -2$$

The solution is $(4, -2)$.

$$88. \begin{cases} 3x + 2y = 3 \\ y = 2x - 16 \end{cases}$$

Write the 2nd equation in standard form.

$$\begin{cases} 3x + 2y = 3 \\ -2x + y = -16 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by -2 .

$$\begin{array}{r} 3x + 2y = 3 \\ 4x - 2y = 32 \\ \hline 7x \quad = 35 \\ \frac{7x}{7} = \frac{35}{7} \\ x = 5 \end{array}$$

$$-2x + y = -16 \quad \text{The 2}^{\text{nd}} \text{ equation.}$$

$$-2(5) + y = -16$$

$$-10 + y + 10 = -16 + 10$$

$$y = -6$$

The solution is $(5, -6)$.

APPLICATIONS

89. EDUCATION

Let x = the number of years since 1980

$$\begin{cases} 9x + 11y = 352 \\ 5x - 11y = -198 \end{cases}$$

Eliminate y .

$$9x + 11y = 352$$

$$\underline{5x - 11y = -198}$$

$$14x = 154$$

$$\frac{14x}{14} = \frac{154}{14}$$

$$x = 11$$

$x = 0$ implies 1980

$x = 11$ implies 1980 + 11

The year when the percents are equal is 1991.

90. NEWSPAPERS

Let x = the number of years since 1990

$$\begin{cases} 37x - 2y = -1,128 \\ 31x + y = 1,059 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by 2.

$$37x - 2y = -1,128$$

$$\underline{62x + 2y = 2,118}$$

$$99x = 990$$

$$\frac{99x}{99} = \frac{990}{99}$$

$$x = 10$$

$x = 0$ implies 1990

$x = 10$ implies 1990 + 10

The year 2000 is when the number of paper will be equal.

WRITING

91. Answers will vary.

92. Answers will vary.

93. Answers will vary.

94. Answers will vary.

REVIEW

95. Find an equation of the line with slope $-\frac{11}{6}$ that passes through $(2, -6)$. Write the answer in slope-intercept form.

$$y - y_1 = m(x - x_1)$$

$$y - (-6) = -\frac{11}{6}(x - 2)$$

$$y + 6 = -\frac{11}{6}x + \frac{22}{6}$$

$$y + 6 - 6 = -\frac{11}{6}x + \frac{22}{6} - \frac{36}{6}$$

$$y = -\frac{11}{6}x - \frac{14}{6}$$

$$y = -\frac{11}{6}x - \frac{7}{3}$$

96. Solve: $S = 2\pi rh + 2\pi r^2$ for h .

$$S = 2\pi rh + 2\pi r^2$$

$$S - 2\pi r^2 = 2\pi rh + 2\pi r^2 - 2\pi r^2$$

$$S - 2\pi r^2 = 2\pi rh$$

$$\frac{S - 2\pi r^2}{2\pi r} = \frac{2\pi rh}{2\pi r}$$

$$\frac{S - 2\pi r^2}{2\pi r} = h$$

$$h = \frac{S - 2\pi r^2}{2\pi r}$$

97. Evaluate:

$$-10(18 - 4^2)^3 = -10(18 - 16)^3$$

$$= -10(2)^3$$

$$= -10(8)$$

$$= -80$$

98. Evaluate:

$$\begin{aligned} -5^2 &= -(5 \cdot 5) \\ &= -25 \end{aligned}$$

CHALLENGE PROBLEMS

$$99. \begin{cases} \frac{x-3}{2} = \frac{11}{6} - \frac{y+5}{3} \\ \frac{x+3}{3} - \frac{5}{12} = \frac{y+3}{4} \end{cases}$$

Clear both equations of fractions

$$\begin{cases} 6\left(\frac{x-3}{2}\right) = 6\left(\frac{11}{6}\right) - 6\left(\frac{y+5}{3}\right) \\ 12\left(\frac{x+3}{3}\right) - 12\left(\frac{5}{12}\right) = 12\left(\frac{y+3}{4}\right) \end{cases}$$

$$\begin{cases} 3(x-3) = 11 - 2(y+5) \\ 4(x+3) - 5 = 3(y+3) \end{cases}$$

Distribute twice in both equations.

$$\begin{cases} 3x - 9 = 11 - 2y - 10 \\ 4x + 12 - 5 = 3y + 9 \end{cases}$$

Write both equations in standard form.

$$\begin{cases} 3x - 9 + 2y = 1 - 2y + 2y \\ 4x + 7 - 3y = 3y + 9 - 3y \end{cases}$$

$$\begin{cases} 3x + 2y - 9 = 1 \\ 4x - 3y + 7 = 9 \end{cases}$$

$$\begin{cases} 3x + 2y - 9 + 9 = 1 + 9 \\ 4x - 3y + 7 - 7 = 9 - 7 \end{cases}$$

$$\begin{cases} 3x + 2y = 10 \\ 4x - 3y = 2 \end{cases}$$

Eliminate y .

Multiply both sides of the 1st equation by 3.

Multiply both sides of the 2nd equation by 2.

$$\begin{array}{r} 9x + 6y = 30 \\ 8x - 6y = 4 \\ \hline 17x = 34 \\ \frac{17x}{17} = \frac{34}{17} \\ x = 2 \end{array}$$

$$3x + 2y = 10 \quad \text{The 1st equation}$$

$$3(2) + 2y = 10$$

$$6 + 2y - 6 = 10 - 6$$

$$2y = 4$$

$$\frac{2y}{2} = \frac{4}{2}$$

$$y = 2$$

The solution is (2, 2).

$$100. \begin{cases} 4(x+1) = 17 - 3(y-1) \\ 2(x+2) + 3(y-1) = 9 \end{cases}$$

Distribute both sides of each equation.

$$\begin{cases} 4x + 4 = 17 - 3y + 3 \\ 2x + 4 + 3y - 3 = 9 \end{cases}$$

$$\begin{cases} 4x + 4 = 20 - 3y \\ 2x + 3y + 1 = 9 \end{cases}$$

$$\begin{cases} 4x + 4 = 20 - 3y \\ 2x + 3y + 1 = 9 \end{cases}$$

$$\begin{cases} 4x + 4 = 20 - 3y \\ 2x + 3y + 1 = 9 \end{cases}$$

Write both equations in standard form

$$\begin{cases} 4x + 4 + 3y = 20 - 3y + 3y \\ 2x + 3y + 1 - 1 = 9 - 1 \end{cases}$$

$$\begin{cases} 4x + 4 + 3y = 20 - 3y + 3y \\ 2x + 3y + 1 - 1 = 9 - 1 \end{cases}$$

$$\begin{cases} 4x + 4 + 3y - 4 = 20 - 4 \\ 2x + 3y = 8 \end{cases}$$

$$\begin{cases} 4x + 3y = 16 \\ 2x + 3y = 8 \end{cases}$$

$$\begin{cases} 4x + 3y = 16 \\ 2x + 3y = 8 \end{cases}$$

$$\begin{cases} 4x + 3y = 16 \\ 2x + 3y = 8 \end{cases}$$

Eliminate y .

Multiply both sides of the 2nd equation by -1 .

$$4x + 3y = 16$$

$$\frac{-2x - 3y = -8}{\hline}$$

$$2x = 8$$

$$\frac{2x}{2} = \frac{8}{2}$$

$$x = 4$$

$$2x + 3y = 8 \quad \text{2nd equation}$$

$$2(4) + 3y = 8$$

$$8 + 3y - 8 = 8 - 8$$

$$3y = 0$$

$$\frac{3y}{3} = \frac{0}{3}$$

$$y = 0$$

The solution is (4, 0)