

We already know how to solve many systems of linear equations. The system below cannot be solved quickly by any of the methods we have learned, but we can change it into a system that's easy to solve. All we have to do is use the Multiplication Principle to multiply both sides of the first equation by 2.

$$5x + 4y = 14$$

$$3x - 2y = 26$$

I can make this  $-4y$  if I multiply by 2.

$$5x + 4y = 14$$

$$6x - 4y = 52$$

$$11x + 0 = 66$$

$$11x = 66$$

$$x = 6$$

$$5 \cdot 6 + 4y = 14$$

$$30 + 4y = 14$$

$$4y = -16$$

$$y = -4$$

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

Replace each system of equations below with an equivalent system which you could solve by addition or subtraction. You don't need to solve the system.

$$7x + 6y = 2$$

$$7x + 6y = 2$$

$$2x - 3y = 10$$

$$4x - 6y = 20$$

$-3y$  times 2 equals  $-6y$ .

$$3x + 5y = 26$$

$$3x + 5y = 26$$

$$5(2x - y = 13)$$

$$10x - 5y = 65$$

$$3x + 4y = 11$$

$$3x + 4y = 11$$

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

$$-10x - 4y = 10$$

$$-3(x - 2y = -12)$$

$$-3x + 6y = 36$$

$$3x + 8y = 34$$

$$3x + 8y = 34$$

$$4x + 3y = 7$$

$$4x + 3y = 7$$

$$-2(2x - 9y = 35)$$

$$-4x + 18y = 70$$

$$-3(2x + 3y = 0)$$

$$-6x - 9y = 0$$

$$6x - 5y = -28$$

$$6x - 5y = -28$$

$$7x - 3y = 37$$

$$7x - 3y = 37$$

$$-3(2x - y = 12)$$

$$-6x + 3y = -36$$

$$5x - 4y = 10$$

$$5x - 4y = 10$$

$$-2(3x - 2y = 6)$$

$$-6x + 4y = -12$$

$$-28(x + y = 10)$$

$$-28x - 28y = 10$$

$$-9(x + 2y = 21)$$

$$-9x - 18y = -189$$

$$15x + 28y = 176$$

$$15x + 28y = 176$$

$$9x + 24y = 213$$

$$9x + 24y = 213$$

$$44(x - y = 2)$$

$$44x - 44y = 2$$

$$-60(x + y = 20)$$

$$-60x - 60y = -1200$$

$$31x + 44y = 812$$

$$31x + 44y = 812$$

$$60x + 75y = 1260$$

$$60x + 75y = 1260$$

Note: There is more than 1 right answer.

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Solving Systems of Equations by Elimination

Solve each system by elimination.

1)  $-4x - 2y = -12$   
 $4x + 8y = -24$

$(6, -6)$

$6y = -36$   
 $y = -6$

$4x + 8(-6) = -24$   $4x - 48 = -24$   $x = 6$

3)  $x - y = 11$   
 $2x + y = 19$

$(10, -1)$

$3x = 30$   
 $x = 10$

$10 - y = 11$   
 $-y = 1$   $y = -1$

5)  $-2x - 9y = -25$   
 $4x + 9y = +23$

$(-1, 3)$

$2x = -2$   
 $x = -1$

$-2(-1) - 9y = -25$

7)  $-6x + 6y = 6$   
 $+6x + 3y = +12$

$2 - 9y = -25$

$-9y = -27$

$y = 3$

$(5, 6)$

$-6x + 36 = 6$

$-6x = -30$

$x = 5$

$3y = 18$   
 $y = 6$

$-6(x) + 6(6) = 6$

9)  $5x + y = 9$   
 $10x - 7y = -18$   
 $35x + 7y = 63$

$(1, 4)$

$45x = 45$   
 $x = 1$

$5(1) + y = 9$

$y = 4$

11)  $(-3x + 7y = -16) - 3$   
 $-9x + 5y = 16$

$(-4, -4)$

$9x - 21y = 48$

$-9x + 5y = 16$

$-16y = 64$   
 $y = -4$

$3x + 7(-4) = -16$   
 $-3x - 28 = -16$

$-3x = 12$   
 $x = -4$

2)  $4x + 8y = 20$   
 $-4x + 2y = -30$

$(7, -1)$

$10y = -10$   
 $y = -1$

$4x + 8(-1) = 20$

$4x - 8 = 20$

$4x = 28$

$x = 7$

4)  $-6x + 5y = 1$   
 $6x + 4y = -10$

$(-1, -1)$

$9y = -9$   
 $y = -1$

$-6x + 5(-1) = 1$   $-6x = 6$

$-6x - 5 = 1$

$x = -1$

6)  $8x + y = -16$   
 $+3x + y = +5$

$(-1, -8)$

$11x = -11$   $x = -1$

$8(-1) + y = -16$

$y = -8$

$-8 + y = -16$

8)  $7x + 2y = 24$   
 $-8x + 2y = 30$

$(6, -9)$

$-x = -6$   
 $x = 6$

$48 + 2y = 30$

$2y = -18$

$y = -9$

$8(6) + 2y = 30$

10)  $-4x + 9y = 9$   
 $4(x - 3y = -6)$

$(9, 5)$

$-4x + 9y = 9$

$x - 15 = -6$

$4x - 12y = -24$

$x = 9$

$-3y = -15$   $y = 5$

12)  $(7x + y = -19) - 3$   
 $-2x + 3y = -19$

$(2, -5)$

$-21x - 3y = 57$

$-2x + 3y = -19$

$-19x = -38$

$39$

$x = 2$

$-7(2) + y = -19$

$-14 + y = -19$   
 $y = -5$

$$13) \begin{cases} 16x - 10y = 10 \\ -8x - 6y = 6 \end{cases}$$

$$(0, -1)$$

$$\begin{array}{r} 16x - 10y = 10 \\ -16x + 12y = -12 \\ \hline 2y = -2 \\ y = -1 \end{array}$$

$$\begin{array}{r} -8x + 6 = 6 \\ x = 0 \end{array}$$

$$15) \begin{cases} -4x - 15y = -17 \\ -4(-x + 5y) = -13 \end{cases}$$

$$(8, -1)$$

$$\begin{array}{r} -4x - 15y = -17 \\ 4x - 20y = +52 \\ \hline -35y = 35 \\ y = -1 \end{array}$$

$$\begin{array}{r} -4x + 15 = -17 \\ -4x = -32 \\ x = 8 \end{array}$$

$$17) \begin{cases} 7x - 8y = 9 \\ 4x + 9y = -22 \end{cases}$$

$$(1, -2)$$

$$\begin{array}{r} -28x - 32y = 36 \\ 28x - 63y = 154 \\ \hline -95y = 190 \\ y = -2 \end{array}$$

$$\begin{array}{r} -7x + 16 = 9 \\ -7x = -7 \\ x = 1 \end{array}$$

$$19) \begin{cases} -4x - 2y = 14 \\ -10x + 7y = -25 \end{cases}$$

$$(-1, -5)$$

$$\begin{array}{r} -28x + 14y = 98 \\ -20x + 44y = -56 \\ \hline -48x + 48y = -1 \end{array}$$

$$\begin{array}{r} 4 - 2y = 14 \\ -2y = 10 \\ y = -5 \end{array}$$

$$21) \begin{cases} 5x + 4y = -14 \\ 3x + 6y = 6 \end{cases}$$

$$(-6, 4)$$

$$\begin{array}{r} 15x + 12y = -42 \\ -15x - 30y = -30 \\ \hline -18y = -72 \\ y = 4 \end{array}$$

$$\begin{array}{r} 5x + 16 = -14 \\ 5x = -30 \\ x = -6 \end{array}$$

$$23) \begin{cases} -14 = -20y - 7x \\ 10y + 4 = 2x \end{cases}$$

$$(2, 0)$$

$$\begin{array}{r} -14 = -20y - 7x \\ [1 = -10y + 2x] \times 2 \\ \hline -14 = -20y - 7x \\ -8 = 20y - 4x \\ \hline -22 = -11x \\ x = 2 \end{array}$$

$$\begin{array}{r} 10y = 0 \\ y = 0 \end{array}$$

$$14) \begin{cases} 8x + 14y = 4 \\ -6x - 7y = -10 \end{cases}$$

$$(4, -2)$$

$$\begin{array}{r} 8x + 14y = 4 \\ -12x - 14y = -20 \\ \hline -4x = -16 \\ x = 4 \end{array}$$

$$\begin{array}{r} 8(4) + 14y = 4 \\ 32 + 14y = 4 \\ 14y = -28 \\ y = -2 \end{array}$$

$$16) \begin{cases} -x - 7y = 14 \\ -4x - 14y = 28 \end{cases}$$

$$(0, -2)$$

$$\begin{array}{r} 2x + 14y = -28 \\ -4x - 14y = 28 \\ \hline -2x = 0 \\ x = 0 \end{array}$$

$$\begin{array}{r} 0 - 7y = 14 \\ y = -2 \end{array}$$

$$18) \begin{cases} 5x + 4y = -30 \\ 3x - 9y = -18 \end{cases}$$

$$(-6, 0)$$

$$\begin{array}{r} 45x + 36y = -270 \\ 12x - 36y = -72 \\ \hline 57x = -342 \\ x = -6 \end{array}$$

$$\begin{array}{r} -30 + 4y = -30 \\ y = 0 \end{array}$$

$$20) \begin{cases} 3x - 2y = 2 \\ 5x - 5y = 10 \end{cases}$$

$$(-2, -4)$$

$$\begin{array}{r} -15x + 10y = -10 \\ 15x - 15y = 30 \\ \hline -5y = 20 \\ y = -4 \end{array}$$

$$\begin{array}{r} 3x + 8 = 2 \\ 3x = -6 \\ x = -2 \end{array}$$

$$22) \begin{cases} 2x + 8y = 6 \\ 5x - 20y = -15 \end{cases}$$

$$\begin{array}{r} 10x + 40y = 30 \\ -10x - 40y = -30 \\ \hline 0 = 0 \end{array}$$

these are the same line

infinite solutions

$$24) \begin{cases} 3 + 2x - y = 0 \\ -3 - 7y = 10x \end{cases}$$

$$(-1, 1)$$

$$\begin{array}{r} -5[2x - y = -3] \\ 10x + 7y = -3 \\ -10x + 5y = 15 \\ \hline 12y = 12 \\ y = 1 \end{array}$$

$$x = -1$$