

Concept: Solving Multi-Step Equations

Name: _____

Warm Up

Recall: A two-step equation requires 2 operations in order to isolate and solve for the variable

Solve each two-step equation below. Show all your steps.

(a) $4x + 3 = 23 - 3$

(b) $12m - 4 = 104$

$-3) 4x + 3 - 3 = 23 - 3 - 3$

$+4) 12m - 4 + 4 = 104 + 4$

$4x = 17$

$12m = 108$

$\div 4) \frac{4x}{4} = \frac{17}{4}$

$\div 12) \frac{12m}{12} = \frac{108}{12}$

$x = \frac{17}{4}$

$m = 9$

Check:

Check:

$$\begin{aligned} L.S. &= 4x + 3 \\ &= 4\left(\frac{17}{4}\right) + 3 \\ &= 17 + 3 \\ &= 20 \end{aligned}$$

$$\begin{aligned} R.S. &= 23 - 3 \\ &= 20 \end{aligned}$$

$$\begin{aligned} L.S. &= 12m - 4 \\ &= 12(9) - 4 \\ &= 108 - 4 \\ &= 104 \end{aligned}$$

$$R.S. = 104$$

L.S. equals R.S.

L.S. equals R.S.

∴ *The solution is $x = \frac{17}{4}$.*

∴ *The solution is $m = 9$.*

$$(c) \quad 24 = 20 - \frac{t}{3}$$

$$-20) \quad 24 - 20 = 20 - 20 - \frac{t}{3}$$

$$4 = -\frac{t}{3}$$

$$\times -3) \quad -3 \times 4 = -\frac{t}{3} \times -3$$

$$-12 = t$$

Check:

$$\begin{aligned} L.S. = 24 \quad R.S. &= 20 - \frac{t}{3} \\ &= 20 - \frac{(-12)}{3} \\ &= 20 + 4 \\ &= 24 \end{aligned}$$

L.S. equals R.S.

∴ *The solution is $t = -12$.*

$$(d) \quad 1.5 + 3z = 8.1$$

$$-1.5) \quad 1.5 + 3z - 1.5 = 8.1 - 1.5$$

$$3z = 6.6$$

$$\div 3) \quad \frac{3z}{3} = \frac{6.6}{3}$$

$$z = 2.2$$

Check:

$$\begin{aligned} L.S. = 1.5 + 3z \quad R.S. &= 8.1 \\ &= 1.5 + 3(2.2) \\ &= 1.5 + 6.6 \\ &= 8.1 \end{aligned}$$

L.S. equals R.S.

∴ *The solution is $z = 2.2$.*

Try This One:

Equation	Corresponding Tile Representation
$3x - 2 = x + 4$	
$\begin{aligned} -1x) \quad 3x - 1x - 2 &= x - 1x + 4 \\ 2x - 2 &= 4 \end{aligned}$	
$\begin{aligned} +2) \quad 2x - 2 + 2 &= 4 + 2 \\ 2x &= 6 \end{aligned}$	
$\begin{aligned} \div 2) \quad \frac{2x}{2} &= \frac{6}{2} \\ x &= 3 \end{aligned}$	

(You can check your answer with the computer later)

COMPUTER COMPONENT

Instructions: In  follow the **Content Menu** path:

Equations > Solving Multi-Step Equations



Work through all Sub Lessons of the following Lessons **in order**:

- *Our Problem*
- *Examples With Tiles*
- *Examples Without Tiles*

Additional Required Materials: *Pencil Crayons (red and blue)*





NOTE: You will not be finishing the entire section before stopping to complete some **OFF COMPUTER EXERCISES**.



As you work through the computer exercises, you will be prompted to make notes in your notebook/math journal.

When you reach the end of the lesson *Concepts – Examples without Tiles* on the computer, move on to the **OFF COMPUTER EXERCISES** below.

NOTES:
Remember:

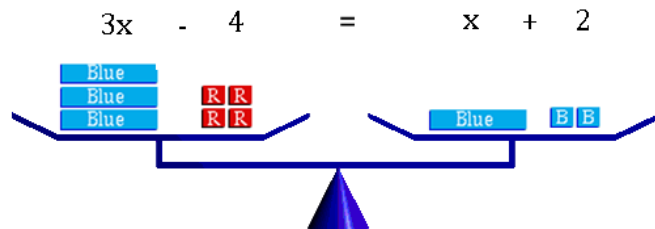
Tile	Represents
	$1x$
	$-1x$
 	$1x - 1x$ <i>or</i> 0

Solve the following examples with tiles as you fill in the blanks and keep the balance balanced:

1. Solve $3x - 4 = x + 2$

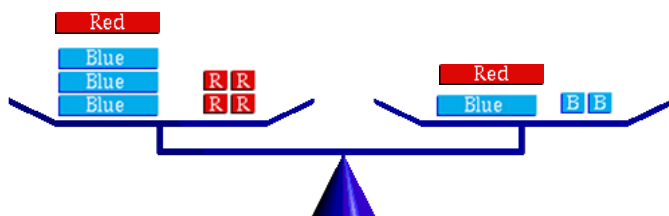
Step 1 (Draw the tiles)

$$3x - 4 = x + 2$$



Step 2 (Add negatives)

$$3x - 1x - 4 = x - 1x + 2$$

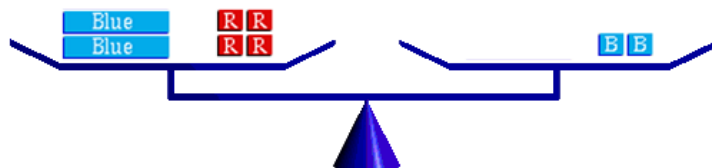


Group all x tile on 1 side of the balance
Hint: Draw the appropriate number of *red* tiles over the *blue* tiles.

Remember to keep the balance balanced.

Step 3 Simplify

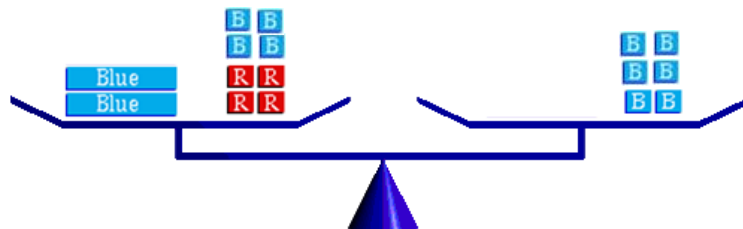
$$2x - 4 = 2$$



Simplify
Remember to keep the balance balanced.

Step 4 (Add positives)

$$2x - 4 + 4 = 2 + 4$$

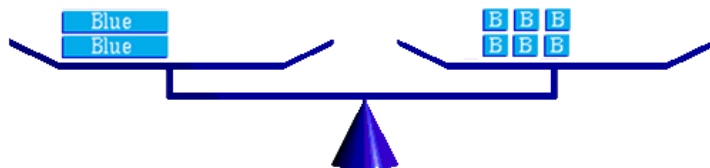


Isolate the x tiles
Hint: Draw the appropriate number of *blue* tiles (+1) over the *red* tiles (-1).

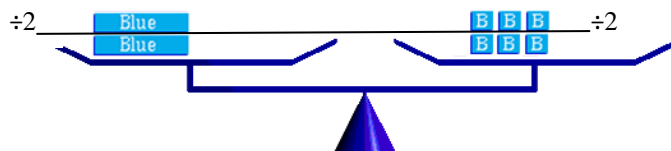
Remember to keep the balance balanced.

Step 5 Simplify

$$2x = 6$$


Step 6 (Divided by 2)

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

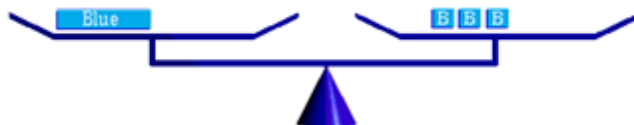


Rearrange each side into 2 equal groups.

divide each side by 2

Step 7 Simplify

$$x = 3$$


Step 8 Check

$$\begin{aligned} \text{Left Side} &= 3x - 4 \\ &= 3(\mathbf{3}) - 4 \\ &= \mathbf{9} - 4 \\ &= \mathbf{5} \end{aligned}$$

$$\begin{aligned} \text{Right Side} &= x + 2 \\ &= \mathbf{3} + 2 \\ &= \mathbf{5} \end{aligned}$$

L.S. = R.S., the solution $x = \mathbf{3}$ is correct.

Review

A multi-step equation is an equation that requires multiple steps in order to solve it.

Fill in the steps to the examples and complete the step instructions by filling in the blanks:

(a) Solve the following equation $3x - 4 = 6x + 5$.

$$3x - 4 = 6x + 5$$

Step 1

Rewrite the equation.

$$3x - 3x - 4 = 6x - 3x + 5$$

Step 2

Group all x variables together

(Keep the balance balanced)

Perform the same operations; add,

or subtract the same quantity from

both sides.

$$-4 = 3x + 5$$

Step 3

Simplify

$$-4 - 5 = 3x + 5 - 5$$

Step 4

Isolate the term containing x.

Add or subtract the same

number from both sides.

$$-9 = 3x$$

Step 5

Simplify

$$\frac{-9}{3} = \frac{3x}{3}$$

Step 6

Isolate the x variable.

(Keep the balance balanced)

Perform the same operations; **multiply**,

or divide both sides by

the same number.

$$-3 = x$$

Step 7

Simplify

$$\begin{aligned} \text{Left Side} &= 3x - 4 \\ &= 3(-3) - 4 \\ &= -9 - 4 \\ &= -13 \end{aligned}$$

Step 8

Check

$$\begin{aligned} \text{Right Side} &= 6x + 5 \\ &= 6(-3) + 5 \\ &= -18 + 5 \\ &= -13 \end{aligned}$$

Substitute the *value of x into both the left side and right side to see if both sides are equal.*

L.S. = R.S., the solution $x = -3$ is correct.

(b) Solve the following equation $2(x + 6) = 4x$.

$$2(x + 6) = 4x$$

Step 1

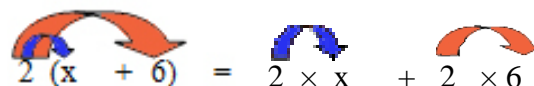
Rewrite the equation.

Step 2

Expand the *brackets*.

$$2x + 12 = 4x$$

Remember:



$$2(x + 6) = 2 \times x + 2 \times 6$$

$$2x - 2x + 12 = 4x - 2x$$

$$12 = 2x$$

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

$$6 = x$$

$$\begin{aligned} \text{Left Side} &= 2(x + 6) \\ &= 2(6 + 6) \\ &= 2(12) \\ &= 24 \end{aligned}$$

$$\begin{aligned} \text{Right Side} &= 4x \\ &= 4(6) \\ &= 24 \end{aligned}$$

L.S. = R.S., the solution $x = 6$ is correct.

Step 3

Group all x variables together

(Keep the balance balanced)

Perform the same operations; **add**
or **subtract** the same quantity from
both sides.

Step 4

Simplify

Step 5

Isolate the term containing x .

Divide or **multiply** the
same number from **both** sides.

Step 6

Simplify

Step 7

Check

Substitute the **value of x into both the**
left side and right side to see if both
sides are **equal**.

(c) Solve the following equation

$$\frac{8x + 3}{9} = \frac{3x - 1}{3}$$

$$\frac{8x + 3}{9} = \frac{3x - 1}{3}$$

Step 1

Rewrite the equation.

Step 2

Clear the fraction

$$9 \left(\frac{8x + 3}{9} \right) = 9 \left(\frac{3x - 1}{3} \right)$$

Multiply each side by the

Lowest Common Denominator

Need help with LCD – see: Fractions: Section 8 - Adding Fractions Lesson: The Lowest Common Denominator.

Step 3

$$1(8x + 3) = 3(3x - 1)$$

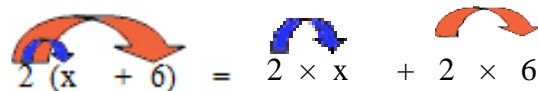
Simplify

Step 4

Expand

$$8x + 3 = 9x - 3$$

Remember:



$$2(x + 6) = 2 \times x + 2 \times 6$$

Step 5

Group like terms.

$$8x - 9x + 3 = 9x - 9x - 3$$

Add or subtract the

same number or term from

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

both sides, then simplify.

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

$$-1x = -6$$

$$(-1)[-1x] = -6(-1)$$

$$x = 6$$

$$\begin{aligned} \text{Left Side} &= \frac{8(6) + 3}{9} \\ &= \frac{48 + 3}{9} \\ &= \frac{51}{9} \\ &= 5.67 \end{aligned}$$

Step 6

Isolate the term containing x.

Add or subtract the same number from both sides

Step 7

Isolate the x variable.

(Keep the balance balanced)

Perform the same operations; multiply or divide for both sides.

Hint: Try multiplying

Then **simplify**.

Step 8

Check

Substitute the value of x into both the left side and right side to see if both sides are equal.

$$\begin{aligned}
 \text{Right Side} &= \frac{3(6) - 1}{3} \\
 &= \frac{18 - 1}{3} \\
 &= \frac{17}{3} \\
 &= \mathbf{5.67}
 \end{aligned}$$

L.S. = R.S., the solution $x = 6$ is correct.

Of the three examples, *pick the one that you felt was the most difficult and tell why.*

(Answers may vary)

OFF COMPUTER EXERCISES

1. Solve each equation. *Be sure to write out all of your steps and to check each answer.*

$$\begin{aligned}
 \text{(a)} \quad & 6x + 14 = -5x - 8 \\
 +5x) \quad & +5x + 6x + 14 = -5x + 5x - 8 \\
 & \quad \quad \quad 11x + 14 = -8 \\
 -14) \quad & 11x + 14 - 14 = -8 - 14 \\
 & \quad \quad \quad 11x = -22 \\
 \div 11) \quad & \frac{11x}{11} = \frac{-22}{11} \\
 & \quad \quad \quad x = -2
 \end{aligned}$$

Check:

$$\begin{array}{ll}
 \text{L.S.} &= 6x + 14 & \text{R.S.} &= -5x - 8 \\
 &= 6(-2) + 14 & &= 5(-2) - 8 \\
 &= -12 + 14 & &= 10 - 8 \\
 &= 2 & &= 2
 \end{array}$$

L.S. = R.S., the solution is $x = -2$.

$$\begin{array}{rcl}
 \text{(b)} & -2x + 1 = x - 2 \\
 & -x) & -2x - x + 1 = x - x - 2 \\
 & -1) & \quad -3x + 1 = -2 \\
 & & \quad -3x + 1 - 1 = -2 - 1 \\
 & & \quad \quad -3x = -3 \\
 \div -3) & & \quad \quad \underline{-x} = \underline{-3} \\
 & & \quad \quad \quad -3 \quad -3 \\
 & & \quad \quad \quad x = 1
 \end{array}$$

Check:

$$\begin{array}{rcl}
 L.S. & = & -2x + 1 \\
 & = & -2(1) + 1 \\
 & = & -2 + 1 \\
 & = & -1 \\
 R.S. & = & x - 2 \\
 & = & (1) - 2 \\
 & = & -1
 \end{array}$$

L.S. = R.S., the solution is $x = 1$.

$$\text{(c)} \quad 2(x - 3) + (x + 3) = 6x$$

$$\begin{array}{rcl}
 \text{Expand:} & 2x - 6 + x + 3 & = 6x \\
 \text{Simplify:} & \quad 3x - 3 & = 6x \\
 -3x) & \quad 3x - 3x - 3 & = 6x - 3x \\
 & \quad \quad -3 & = 3x \\
 \div 3) & \quad \quad \underline{-3} & = \underline{3x} \\
 & \quad \quad \quad 3 & \quad 3 \\
 & \quad \quad \quad -1 & = x
 \end{array}$$

Check:

$$\begin{array}{rcl}
 L.S. & = & 2(x - 3) + (x + 3) \\
 & = & 2(-1 - 3) + (-1 + 3) \\
 & = & 2(-4) + 2 \\
 & = & -6 \\
 R.S. & = & 6x \\
 & = & 6(-1) \\
 & = & -6
 \end{array}$$

L.S. = R.S., the solution is $x = -1$.

$$\text{(d)} \quad 3(x - 10) = 5(4 - 3x) - 14$$

$$\begin{array}{rcl}
 \text{Expand:} & 3x - 30 & = 20 - 15x - 14 \\
 \text{Simplify:} & 3x - 30 & = 6 - 15x \\
 +15x) & 3x - 30 + 15x & = 6 - 15x + 15x \\
 & \quad 18x - 30 & = 6 \\
 +30) & \quad 18x - 30 + 30 & = 6 + 30 \\
 & \quad \quad 18x & = 36 \\
 \div 18) & \quad \quad \underline{18x} & = \underline{36} \\
 & \quad \quad \quad 18 & \quad 18 \\
 & \quad \quad \quad x & = 2
 \end{array}$$

Check:

$$\begin{array}{lcl}
 L.S. & = & 3(x - 10) \\
 & = & 3(2 - 10) \\
 & = & 3(-8) \\
 & = & -24 \\
 R.S. & = & 5(4 - 3x) - 14 \\
 & = & 5(4 - 3(2)) - 14 \\
 & = & 5(4 - 6) - 14 \\
 & = & 5(-2) - 14 \\
 & = & -10 - 14 \\
 & = & -24
 \end{array}$$

L.S. = R.S., the solution is $x = 2$.

(e) $3x - 0.5 = 0.7$

$$\begin{array}{lcl}
 +0.5) & 3x - 0.5 + 0.5 & = 0.7 + 0.5 \\
 & 3x & = 1.2 \\
 \div 3) & \frac{3x}{3} & = \frac{1.2}{3} \\
 & x & = 0.4
 \end{array}$$

Check:

$$\begin{array}{lcl}
 L.S. & = & 3x - 0.5 \\
 & = & 3(0.4) - 0.5 \\
 & = & 1.2 - 0.5 \\
 & = & 0.7 \\
 R.S. & = & 0.7
 \end{array}$$

L.S. = R.S., the solution is $x = 0.4$.

(f) $7(m - 1) - 2(m - 6) = 2(m + 5) + 1$

$$\begin{array}{lcl}
 \text{Expand:} & 7m - 7 - 2m + 12 & = 2m + 10 + 1 \\
 \text{Simplify:} & 5m + 5 & = 2m + 11 \\
 -2m) & 5m + 5 - 2m & = 2m + 11 - 2m \\
 & 3m + 5 & = 11 \\
 -5) & 3m + 5 - 5 & = 11 - 5 \\
 & 3m & = 6 \\
 \div 3) & \frac{3m}{3} & = \frac{6}{3} \\
 & m & = 2
 \end{array}$$

Check:

$$\begin{array}{lcl}
 L.S. & = & 7(m - 1) - 2(m - 6) \\
 & = & 7(2 - 1) - 2(2 - 6) \\
 & = & 7(1) - 2(-4) \\
 & = & 7 - (-8) \\
 & = & 15 \\
 R.S. & = & 2(m + 5) + 1 \\
 & = & 2(2 + 5) + 1 \\
 & = & 2(7) + 1 \\
 & = & 15
 \end{array}$$

L.S. = R.S., the solution is $m = 2$.

(g)

$$\frac{5x + 6}{3} = \frac{3x + 4}{2}$$

Clear the Fraction: $\cancel{6} \left(\frac{\cancel{3} \frac{5x + 6}{\cancel{3}}}{1} \right) = \cancel{6} \left(\frac{\cancel{2} \frac{3x + 4}{\cancel{2}}}{1} \right)$

$$2(5x + 6) = 3(3x + 4)$$

Expand:

-9x)

$$\begin{aligned} 10x + 12 &= 9x + 12 \\ 10x + 12 - 9x &= 9x + 12 - 9x \end{aligned}$$

-12)

$$\begin{aligned} x + 12 &= 12 \\ x + 12 - 12 &= 12 - 12 \\ x &= 0 \end{aligned}$$

Check:

$$\begin{aligned} L.S. &= \frac{5x + 6}{3} \\ &= \frac{5(0) + 6}{3} \\ &= \frac{6}{3} \\ &= 2 \end{aligned}$$

$$\begin{aligned} R.S. &= \frac{3x + 4}{2} \\ &= \frac{3(0) + 4}{2} \\ &= \frac{4}{2} \\ &= 2 \end{aligned}$$

L.S. = R.S., the solution is $x = 0$.

(h)

$$5 - \frac{4}{3}n = \frac{3}{4}n + 5$$

$$-5) \quad 5 - \frac{4}{3}n - 5 = \frac{3}{4}n + 5 - 5$$

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

$$\times 12) \quad \cancel{12} \times \frac{\cancel{3} \frac{4}{3}n}{1} = \cancel{12} \times \frac{\cancel{4} \frac{3}{4}n}{1}$$

$$\begin{aligned} 16n &= 9n \\ -9n) \quad 16n - 9n &= 9n - 9n \end{aligned}$$

$$7n = 0$$

÷7)

$$\frac{7n}{7} = \frac{0}{7}$$

$$n = 0$$

Check

$$\begin{aligned} \text{L.S.} &= 5 - \frac{4}{3}n \\ &= 5 - \frac{4}{3}(0) \\ &= 5 - 0 \\ &= 5 \end{aligned}$$

$$\begin{aligned} \text{R.S.} &= \frac{3}{4}n + 5 \\ &= \frac{3}{4}(0) + 5 \\ &= 0 + 5 \\ &= 5 \end{aligned}$$

L.S. = R.S., The solution is $n = 0$.