



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.

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

$$(b) \quad 12m - 4 = 104$$

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

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

$$4x = 17$$

$$12m = 108$$

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

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

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

$$m = 9$$

Check:

Check:

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

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

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

$$\text{R.S.} = 104$$

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:

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

L.S. equals R.S.

∴ The solution is $t = -12$.

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

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

$$3z = 6.6$$

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

$$z = 2.2$$

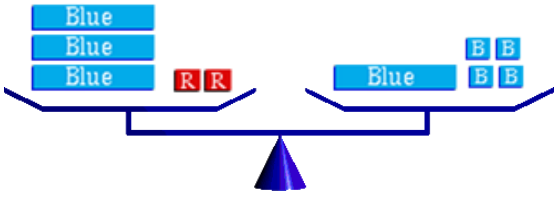
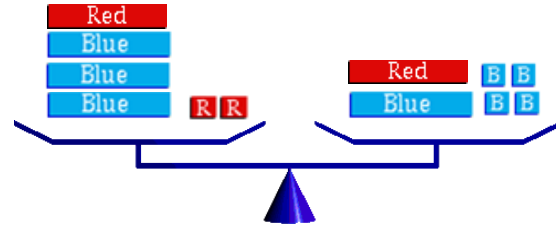
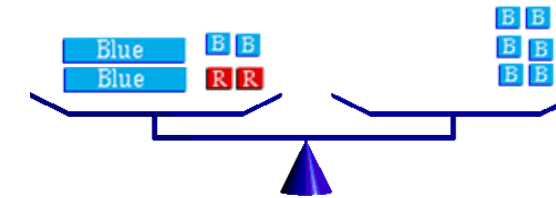
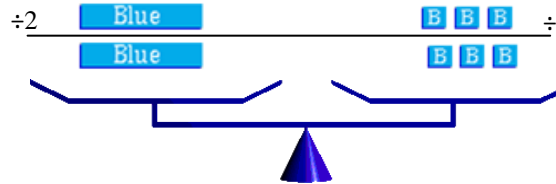
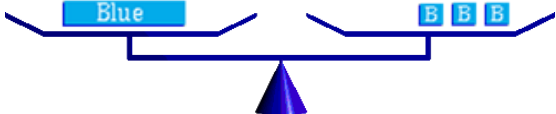
Check:

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

L.S. equals R.S.

∴ The solution is $z = 2.2$.

Try This One:

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

(You can check your answer with the computer later)

COMPUTER COMPONENT

Instructions: Select the computer program *Understanding Equations* (Neufeld)
Follow the instructions to the Main Menu.
Select *Solving Multi-Step Equations* from the Main Menu.



Work through all sections of this topic **in order**:

- *Our Problem*
- *Concepts – Examples with Tiles*
- *Concepts – Examples without Tiles*

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





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



As you work through the computer exercises, make your notes in the
NOTES section of this page.

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

NOTES:**Remember:**

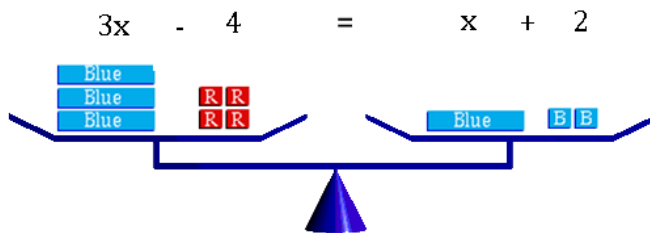
Tile	Represents
	1x
	-1x
 	1x – 1x or 0

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

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

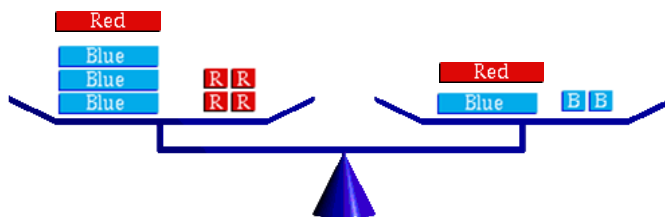
Step 1 (Draw the tiles)

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



Step 2 (Add negatives)

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

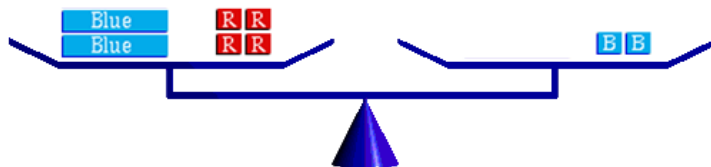


Group all x tile on 1 side of the balance
Hint: Draw the appropriate number of *red* tiles over the *blue* tiles.

Remember to keep the balance balanced.

Step 3 Simplify

$$2x - 4 = 2$$

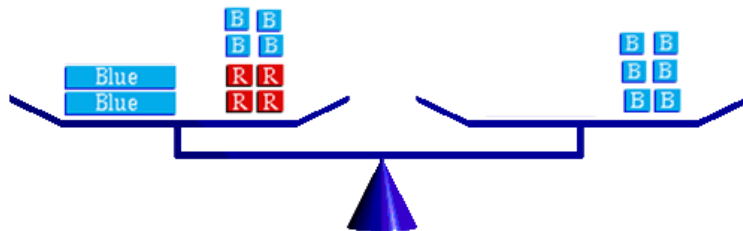


Simplify

Remember to keep the balance balanced.

Step 4 (*Add positives*)

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



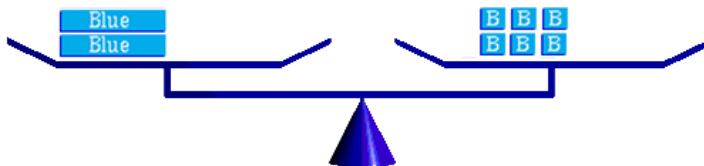
Isolate the x tiles

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

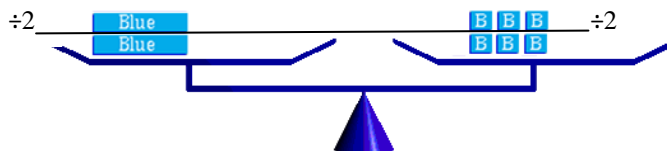
Remember to keep the balance balanced.

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

Left Side	= $3x - 4$
	= $3(\mathbf{3}) - 4$
	= $\mathbf{9} - 4$
	= $\mathbf{5}$
Right Side	= $x + 2$
	= $\mathbf{3} + 2$
	= $\mathbf{5}$
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.

$$3x - \mathbf{3x} - 4 = 6x - \mathbf{3x} + 5$$

Step 2

Group all **x** variables together

(Keep the balance balanced)

Perform the same operations; **add**,

or **subtract** the same quantity from

both sides.

$$-4 = 3x + 5$$

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

$$-9 = 3x$$

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

$$-3 = x$$

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

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

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

Step 3
Simplify

Step 4

Isolate the term containing **x**.

Add or **subtract** the **same**
number from **both** sides.

Step 5
Simplify

Step 6

Isolate the **x** variable.

(Keep the balance balanced)

Perform the same operations; **multiply**,
or **divide** **both** sides by
the same number.

Step 7

Simplify

Step 8

Check

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

(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:

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

Step 3

Group all x variables together

(Keep the balance balanced)

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

Perform the same operations; **add**

or **subtract** the same quantity from

both sides.

Step 4

Simplify

$$12 = 2x$$

Step 5

Isolate the term containing x .

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

Divide or **multiply** the

same number from **both** sides.

$$6 = x$$

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

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

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

(c) Solve the following equation

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

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

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

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.**

Step 1

Rewrite the equation.

Step 2

Clear the fraction

Multiply **each side** by the

Lowest Common Denominator

*Need help with LCD – see: **Understanding Fractions, Section 8 - Adding Fractions**
Topic: **The Lowest Common Denominator.***

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

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

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

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

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

$$-1x = -6$$

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

$$x = 6$$

Step 3**Simplify****Step 4****Expand**

Remember:

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

Step 5**Group** like terms.

Add or **subtract** the **same** number or term from **both** sides, then **simplify**.

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**.

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

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

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)

Step 8

Check

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

OFF COMPUTER EXERCISES

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

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

Check:

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

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

$$\text{(b)} \quad -2x + 1 = x - 2$$

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

Check:

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

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

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

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

Check:

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

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

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

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

Check:

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

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

$$(e) \quad 3x - 0.5 = 0.7$$

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

Check:

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

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

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

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

Check:

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

$$\begin{array}{rcl} & = & 2(2 + 5) + 1 \\ & = & 2(7) + 1 \\ & = & 15 \end{array}$$

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

g)

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

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

Expand:

$$\begin{aligned} 2(5x + 6) &= 3(3x + 4) \\ 10x + 12 &= 9x + 12 \\ -9x) \quad 10x + 12 - 9x &= 9x + 12 - 9x \\ \quad x + 12 &= 12 \\ -12) \quad x + 12 - 12 &= 12 - 12 \\ \quad \quad x &= 0 \end{aligned}$$

Check:

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

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

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

(h)

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

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

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

$$\times 12) \quad \begin{array}{c} 4 \\ \cancel{12} \times \frac{4}{\cancel{3}}n = \frac{3}{\cancel{4}}n \\ 1 \qquad \qquad \qquad 1 \end{array}$$

$$\begin{array}{r} 16n \\ -9n \\ \hline 7n \end{array} = \begin{array}{r} 9n \\ 9n - 9n \\ \hline 0 \end{array}$$

$$\div 7) \quad \frac{7n}{7} = \frac{0}{7}$$

$$n = 0$$

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 $n = 0$.