

## Concept: Solving Multi-Step Equations

Name: \_\_\_\_\_

- You should have completed Equations – Section 4 Part A: Solving Multi-Step Equations before beginning this handout.

### Warm Up

Solve each multi-step equation below. *Show all your steps and make sure you check to see if your solution is correct.*

$$\begin{aligned}
 1. \qquad & 4(t - 2) - (t + 3) = t - 1 \\
 & 4t - 8 - t - 3 = t - 1 \\
 & 3t - 11 = t - 1 \\
 -t) & 3t - t - 11 = t - t - 1 \\
 & 2t - 11 = -1 \\
 +11) & 2t - 11 + 11 = -1 + 11 \\
 & 2t = 10 \\
 \div 2) & \frac{2t}{2} = \frac{10}{2} \\
 & t = 5
 \end{aligned}$$

**Check:**

$$\begin{array}{ll}
 \text{L.S.} & = 4(t - 2) - (t + 3) & \text{R.S.} & = t - 1 \\
 & = 4(5 - 2) - (5 + 3) & & = 5 - 1 \\
 & = 4(3) - (8) & & = 4 \\
 & = 12 - 8 \\
 & = 4 & & \text{L.S. equals R.S., the solution is } t = 5.
 \end{array}$$

$$\begin{aligned}
 2. \qquad & 5x + 5.4 = 2.9x - 0.9 \\
 -2.9x) & 5x - 2.9x + 5.4 = 2.9x - 2.9x - 0.9 \\
 & 2.1x + 5.4 = -0.9 \\
 -5.4) & 2.1x + 5.4 - 5.4 = -0.9 - 5.4 \\
 & 2.1x = -6.3 \\
 \div 2.1) & \frac{2.1x}{2.1} = \frac{-6.3}{2.1} \\
 & x = -3
 \end{aligned}$$

**Check:**

$$\begin{array}{ll}
 \text{L.S.} & = 5x + 5.4 & \text{R.S.} & = 2.9x - 0.9 \\
 & = 5(-3) + 5.4 & & = 2.9(-3) - 0.9 \\
 & = -15 + 5.4 & & = -8.7 - 0.9 \\
 & = -9.6 & & = -9.6
 \end{array}$$

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

## COMPUTER COMPONENT

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

**Equations > Solving Multi-Step Equations**

NOTE: Use the **Menu** button in order to get to the lesson where you left off.



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

- *Summary*
- *Literal Equations*



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

## NOTES:

Fill in the following:

- Two ways to solve an equation.
  - Solve and equation with algebra tiles.
  - Solve an equation algebraically.
- To keep a balance balanced, you must perform the same operation to both sides.
- You know when you have a solution when:
  - There is one variable tile on one side of the equation (tile solution).
  - There is one variable on one side of the equation (algebraic solution).
- Combine like terms if they are on the same side of the equation.
- Equations with fractions, require you to first multiply each side (three words) by a common denominator (two words).

This keeps the equation balanced.

6. Use the original equation to check your answer by substituting your solution for the variable. Check each side of the equation. Your solution is correct if you have the same value on each side.

### Literal Equations

7. Are the following perimeter equations the same? Why or why not.

$$\begin{array}{l}
 P = 2L + 2W \quad (1) \quad \text{and} \quad L = \frac{P - 2W}{2} \quad (2) \\
 \\
 \begin{array}{l}
 P = 2L + 2W \\
 -2W) \quad P - 2W = 2L + 2W - 2W \\
 \quad \quad P - 2W = 2L
 \end{array} \\
 \\
 \div 2) \quad \frac{P - 2W}{2} = \frac{2L}{2} \quad \text{SAME} \\
 \\
 \frac{P - 2W}{2} = L
 \end{array}$$

*The perimeter equations are the same but in different forms. The first (1) is useful for finding P when the length and width are known. The second (2) is useful for finding L when the Perimeter and width are known.*

**Solving Linear Equations:** (You use similar steps to solve literal equations as you do for equations with one variable)

Solve  $4x + 2y = 16$  for  $y$

- The equation has two different variables, x and y
- Determine the variable you have to solve for: y.
- You will need to isolate the variable to solve the literal equation.

Fill in the blanks.

Literal Equation	Similar Equation
$4x + 2y = 16$	$35 + 8y = 11$

➤ You will need to isolate the variable to solve the literal equation.

$4x \quad \underline{-4x} \quad + 2y = 16 \quad \underline{-4x}$	$35 \quad \underline{-35} \quad + 8y = 11 \quad \underline{-35}$
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➤ Simplify

$2y = 16 \quad \underline{-4x}$	$8y = \underline{-24}$
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➤ Isolate y

$\frac{2y}{2} = \frac{16 - 4x}{2}$ $= \frac{16}{2} - \frac{4x}{2}$	$\frac{8y}{8} = \frac{-24}{8}$
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➤ Simplify

$y = 8 - 2x$	$y = -3$
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**Literal Equations:**

Use the Frayer Diagram to demonstrate your understanding of the meaning of the word “Literal Equations”. First fill in examples and then the non- examples. Using these, determine the characteristics of “Literal Equations”. With the information in the chart, write your definition of “Literal Equations”.

(Answers will vary) Example:

**Frayer Diagram**
**Definition**

*An equation that is expressed by means of at least 2 different variables.*

**Characteristics**

- *At least two variables*
- *equation*

Literal  
Equations

**Examples**

$$P = 2L + 2W$$

$$V = \frac{BH}{3}$$

$$A = l \times w$$

$$d = 2r$$

**Non-Examples**

$$2x + 3 = 1$$

$$5y$$

$$4(t - 2) - (t + 3) = t - 1$$

**OFF COMPUTER EXERCISES**

1. Solve the following equations. (*Remember to show your work and check your answers.*)

(a)  $9 + 3(m - 4) = 5m + 1$

$$\begin{array}{l}
 \text{Expand:} \quad 9 + 3m - 12 = 5m + 1 \\
 \text{Simplify:} \quad 3m - 3 = 5m + 1 \\
 \text{-3m)} \quad 3m - 3m - 3 = 5m - 3m + 1 \\
 \quad \quad \quad -3 = 2m + 1 \\
 \text{-1)} \quad -3 - 1 = 2m + 1 - 1 \\
 \quad \quad \quad -4 = 2m \\
 \text{\div 2)} \quad \underline{-4} = \underline{2m} \\
 \quad \quad \quad 2 \quad 2 \\
 \quad \quad \quad -2 = m
 \end{array}$$

**Check:**

$$\begin{array}{l}
 \text{L.S.} = 9 + 3(m - 4) \\
 = 9 + 3(-2 - 4) \\
 = 9 + 3(-6) \\
 = 9 - 18 \\
 = -9 \\
 \\
 \text{R.S.} = 5m + 1 \\
 = 5(-2) + 1 \\
 = -10 + 1 \\
 = -9
 \end{array}$$

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

(b)  $3m - 4(m + 6) = 2(m + 2) - 13$

$$\begin{array}{l}
 \text{Expand:} \quad 3m - 4m - 24 = 2m + 4 - 13 \\
 \quad \quad \quad -1m - 24 = 2m - 9 \\
 \text{-2m)} \quad -1m - 2m - 24 = 2m - 2m - 9 \\
 \quad \quad \quad -3m - 24 = -9 \\
 \text{+24)} \quad -3m + 24 - 24 = -9 + 24 \\
 \quad \quad \quad -3m = 15 \\
 \text{\div -3)} \quad \underline{-3m} = \underline{15} \\
 \quad \quad \quad -3 \quad -3 \\
 \quad \quad \quad m = -5
 \end{array}$$

**Check:**

$$\begin{array}{l}
 \text{L.S.} = 3m - 4(m + 6) \\
 = 3m - 4(-5 + 6) \\
 = 15 - 4(1) \\
 = -15 - 4 \\
 = -19 \\
 \\
 \text{R.S.} = 2(m + 2) - 13 \\
 = 2(-5 + 2) - 13 \\
 = 2(-3) - 13 \\
 = -6 - 13 \\
 = -19
 \end{array}$$

*L.S. equals R.S., the solution is  $m = -5$ .*

$$(c) \quad 3 - 2(x + 4) = -3(1 - 2x) + 14$$

$$\begin{array}{rcl}
 \text{Expand:} & 3 - 2x - 8 & = 3 + 6x + 14 \\
 & -2x - 5 & = 6x + 11 \\
 +2x) & -2x + 2x - 5 & = 6x + 2x + 11 \\
 & -5 & = 8x + 11 \\
 -11) & -5 - 11 & = 8x + 11 - 11 \\
 & -16 & = 8x \\
 \div 8) & \underline{-16} & = \underline{\frac{8x}{8}} \\
 & 8 & \\
 & & -2 = x
 \end{array}$$

**Check:**

$$\begin{array}{rcl}
 \text{L.S.} & = 3 - 2(x + 4) & \text{R.S.} = -3(1 - 2x) + 14 \\
 & = 3 - 2(-2 + 4) & = -3(1 - 2(-2)) + 14 \\
 & = 3 - 2(2) & = -3(1 + 4) + 14 \\
 & = 3 - 4 & = -3(5) + 14 \\
 & = -1 & = -15 + 14 \\
 & & = -1
 \end{array}$$

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

$$(d) \quad 6 + 3(m - 4) = 6m - 3$$

$$\begin{array}{rcl}
 \text{Expand:} & 6 + 3m - 12 & = 6m - 3 \\
 & 3m - 6 & = 6m - 3 \\
 -3m) & 3m - 3m - 6 & = 6m - 3m - 3 \\
 & -6 & = 3m - 3 \\
 +3) & -6 + 3 & = 3m - 3 + 3 \\
 & -3 & = 3m \\
 \div 3) & \underline{-3} & = \underline{\frac{3m}{3}} \\
 & 3 & \\
 & & -1 = m
 \end{array}$$

**Check:**

$$\begin{array}{rcl}
 \text{L.S.} & = 6 + 3(m - 4) & \text{R.S.} = 6m - 3 \\
 & = 6 + 3(-1 - 4) & = 6(-1) - 3 \\
 & = 6 + 3(-5) & = -6 - 3 \\
 & = 6 - 15 & = -9 \\
 & = -9 &
 \end{array}$$

*L.S. equals R.S., the solution is  $m = -1$ .*

$$(e) \quad \frac{2n - 3}{2} = \frac{-n - 1}{4}$$

*Clear Fraction:*

$$\times 4) \quad \overset{2}{\cancel{4}} \left( \frac{2n - 3}{\cancel{2}_1} \right) = \overset{1}{\cancel{4}} \left( \frac{-n - 1}{\cancel{4}_1} \right)$$

$$2(2n - 3) = -n - 1$$

*Expand:*

$$4n - 6 = -n - 1$$

*+n)*

$$4n + n - 6 = -n + n - 1$$

$$5n - 6 = -1$$

*+6)*

$$5n - 6 + 6 = -1 + 6$$

$$5n = 5$$

*÷5)*

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

$$n = 1$$

*Check:*

$$\begin{aligned} L.S. &= \frac{2n - 3}{2} \\ &= \frac{2(1) - 3}{2} \\ &= \frac{2 - 3}{2} \\ &= \frac{-1}{2} \end{aligned}$$

$$\begin{aligned} R.S. &= \frac{-n - 1}{4} \\ &= \frac{-(1) - 1}{4} \\ &= \frac{-2}{4} \\ &= \frac{-1}{2} \end{aligned}$$

*L.S. equals R.S., the solution is  $n = 1$ .*



(f)

$$\frac{3}{5} - \frac{x}{3} = \frac{x}{2}$$

$$\times 30) \quad 30 \times \left( \frac{3}{5} - \frac{x}{3} \right) = \frac{x}{2} \times 30$$

$$\overset{6}{\cancel{30}} \times \frac{\overset{10}{\cancel{3}}}{\cancel{5}} - \overset{10}{\cancel{30}} \times \frac{\overset{15}{\cancel{x}}}{\cancel{3}} = \frac{\overset{15}{\cancel{x}}}{\cancel{2}} \times \overset{15}{\cancel{30}}$$

$$\frac{18}{1} - \frac{10x}{1} = \frac{15x}{1}$$

$$18 - 10x = 15x$$

$$+10x) \quad 18 - 10x + 10x = 15x + 10x$$

$$18 = 25x$$

$$\div 25) \quad \frac{18}{25} = \frac{25x}{25}$$

$$\frac{18}{25} = x$$

**Check:**

$$LS = \frac{3}{5} - \frac{1}{3} \times \frac{18}{25}$$

$$RS = \frac{18}{25} \times \frac{1}{2}$$

$$= \frac{3 \times 5}{5 \times 5} - \frac{6}{25}$$

$$= \frac{9}{25}$$

$$= \frac{15}{25} - \frac{6}{25}$$

$$= \frac{9}{25}$$

*L.S. equals R.S., the solution is  $x = 18$ .*

g)

$$\frac{3}{4} (2x - 1) = \frac{5}{6} (2 - 4x)$$

$$\times 12) \quad \frac{\cancel{12}^3}{\cancel{4}_1} \times \frac{3}{1} (2x - 1) = \frac{\cancel{12}^2}{\cancel{6}_1} \times \frac{5}{1} (2 - 4x)$$

$$9(2x - 1) = 10(2 - 4x)$$

*Expand:*  $18x - 9 = 20 - 40x$

$$\begin{aligned} +9) \quad 18x - 9 + 9 &= 20 - 40x + 9 \\ 18x &= 29 - 40x \end{aligned}$$

$$\begin{aligned} +40x) \quad 18x + 40x &= 29 - 40x + 40x \\ 58x &= 29 \end{aligned}$$

$$\div 58) \quad \frac{58x}{58} = \frac{29}{58}$$

$$x = \frac{1}{2}$$

*Check*

$$\begin{aligned} L.S. &= \frac{3}{4} (2x - 1) & R.S. &= \frac{5}{6} (2 - 4x) \\ &= \frac{3}{4} (\cancel{2}(\frac{1}{2}) - 1) & &= \frac{5}{6} (2 - \cancel{4}(\frac{1}{2})) \\ &= \frac{3(0)}{4} & &= \frac{5(0)}{6} \\ &= 0 & &= 0 \end{aligned}$$

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

$$\begin{aligned}
 \text{h)} \quad & \frac{6a - 5}{3} - 2 = \frac{5a - 1}{4} + \frac{1}{3} \\
 \times 12) \quad & 12 \times \left( \frac{6a - 5}{3} - 2 \right) = 12 \times \left( \frac{5a - 1}{4} + \frac{1}{3} \right) \\
 & \overset{4}{\cancel{12}} \times \frac{\overset{3}{\cancel{6a - 5}}}{1} - 12 \times 2 = \overset{3}{\cancel{12}} \times \frac{\overset{4}{\cancel{5a - 1}}}{1} + \overset{4}{\cancel{12}} \times \frac{\overset{3}{\cancel{1}}}{1} \\
 & 24a - 20 - 24 = 15a - 3 + 4 \\
 & 24a - 44 = 15a + 1 \\
 +44) \quad & 24a - 44 + 44 = 15a + 1 + 44 \\
 & 24a = 15a + 45 \\
 -15a) \quad & 24a - 15a = 15a - 15a + 45 \\
 & 9a = 45 \\
 \div 9) \quad & \frac{9a}{9} = \frac{45}{9} \\
 & a = 5
 \end{aligned}$$

Check:

$$\begin{aligned}
 \text{L.S.} &= \frac{6a - 5}{3} - 2 \\
 &= \frac{6(5) - 5}{3} - 2 \\
 &= \frac{30 - 5}{3} - 2 \\
 &= \frac{25}{3} - 2 \\
 &= \frac{25}{3} - \frac{2 \times 3}{1 \times 3} \\
 &= \frac{25 - 6}{3} \\
 &= \frac{19}{3} \\
 &= \frac{19}{3} \\
 \text{R.S.} &= \frac{5a - 1}{4} + \frac{1}{3} \\
 &= \frac{5(5) - 1}{4} + \frac{1}{3} \\
 &= \frac{25 - 1}{4} + \frac{1}{3} \\
 &= \frac{24}{4} + \frac{1}{3} \\
 &= \frac{6}{1} + \frac{1}{3} \\
 &= \frac{6 \times 3}{1 \times 3} + \frac{1}{3} \\
 &= \frac{18 + 1}{3} \\
 &= \frac{19}{3}
 \end{aligned}$$

*L.S. equals R.S., the solution is  $a = 5$ .*

2. Solve each literal question.

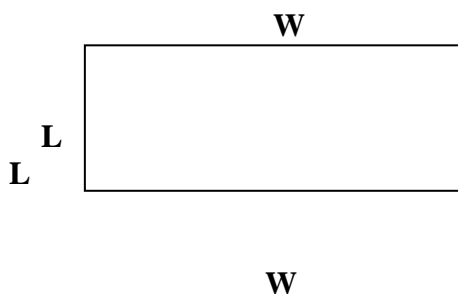
a) Solve:  $y = mx + b$  for  $x$

$$\begin{aligned}
 & y = mx + b \\
 -b) & \quad y - b = mx + b - b \\
 \div m) & \quad \frac{y - b}{m} = \frac{mx}{m} \\
 & \quad \frac{y - b}{m} = x
 \end{aligned}$$

b) Solve:  $C = 2pr + w$  for  $p$

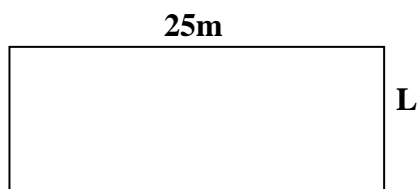
$$\begin{aligned}
 & C = 2pr + w \\
 -w) & \quad C - w = 2pr + w - w \\
 & \quad C - w = 2pr \\
 \div 2r) & \quad \frac{C - w}{2r} = \frac{2pr}{2r} \\
 & \quad \frac{C - w}{2r} = p
 \end{aligned}$$

c) Solve:  $P = 2L + 2W$  for  $L$  (Hint: use a diagram.)



$$\begin{aligned}
 & P = 2L + 2W \\
 -2W) & \quad P - 2W = 2L + 2W - 2W \\
 & \quad P - 2W = 2L \\
 \div 2) & \quad \frac{P - 2W}{2} = \frac{2L}{2} \\
 & \quad \frac{P - 2W}{2} = L
 \end{aligned}$$

d) As you know,  $P = 2L + 2W$  is the formula for perimeter. If a field has a width of 25m and a perimeter of 206 m, *find the length by using your answer in (c).* (Hint: use a diagram.)



$$\begin{aligned}
 P &= 2L + 2W \\
 &= 206 \text{ m}
 \end{aligned}$$

$$\begin{aligned}\frac{P - 2W}{2} &= L \\ \frac{206 - 2(25)}{2} &= L \\ \frac{206 - 50}{2} &= L \\ \frac{156}{2} &= L \\ 78 &= L\end{aligned}$$

*Therefore the length of the field is 78m.*