Concept: Solving Multi-Step Equations

Name:

- **You should have completed Equations Outline A for Topic 4: 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.*

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

$4t - 8 - t - 3 = t - 1$

$3t - 11 = t - 1$

-t) $3t - t - 11 = t - t - 1$

$2t - 11 = -1$

+11) $2t - 11 + 11 = -1 + 11$

$2t = 10$

÷2) $\frac{2t}{2} = \frac{10}{2}$

$t = 5$

Check:

L.S. $= 4(t - 2) - (t + 3)$
$= 4(5 - 2) - (5 + 3)$
$= 4(3) - (8)$
$= 12 - 8$
$= 4$

R.S. $= t - 1$
$= 5 - 1$
$= 4$

L.S. equals R.S., the solution is t = 5.

2. $5x + 5.4 = 2.9x - 0.9$

	$5x + 5.4 = 2.9x - 0.9$
-2.9x)	$5x - 2.9x + 5.4 = 2.9x - 2.9x - 0.9$
	$2.1x + 5.4 = -0.9$
-5.4)	$2.1x + 5.4 - 5.4 = -0.9 - 5.4$
	$2.1x = -6.3$
÷2.1)	$\frac{2.1x}{2.1} = \frac{-6.3}{2.1}$
	$x = -3$

Check:

L.S.			R.S.		
L.S.	=	$5x + 5.4$	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

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

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.

Notice: You will need to use the ***Jump To*** *feature of the program (found on the top left of your screen) in order to get to the section where you left off.*

Work through all sections of the following topics **in order**:

- *Summary*
- *Literal Equations*
- *Practice Questions*

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 *Practice Questions* on the computer, move on to the **OFF COMPUTER EXERCISES** below**.**

NOTES:

Fill in the following:

1. **Two ways to solve an equation.**

   (a) Solve and equation with algebra tiles.

   (b) Solve an equation algebraically.

2. To keep a balance balanced, you must perform the **same operation** to **both sides.**

3. You know when you have a solution when:

   (a) There is one variable tile on one side of the equation (tile solution).

   (b) There is one variable on one side of the equation (algebraic solution).

4. Combine like **terms** if they are on the **same** side of the **equation.**

5. 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.

(1) $P = 2L + 2W$ + and (2) $L = \frac{P - 2w}{2}$

$$P = 2L + 2W$$

-2W) $P - 2W = 2L + 2W - 2W$

$P - 2W = 2L$

÷2) $\frac{P - 2W}{2} = \frac{{}^{1}\not{2}L}{\not{2}_{1}}$ SAME

$$\frac{P - 2W}{2} = L$$

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 dofor 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.

$4x$ **-4x** $+ 2y = 16$ **- 4x**	35 **- 35** $+ 8y = 11$ **- 35**

➢ Simplify

$2y = 16 -$ **4x**	$8y =$ **- 24**

➢ Isolate y

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

➢ Simplify

$y =$ **8 - 2x**	$y =$ **-3**

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

$$\mathbf{P = 2L + 2W}$$

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

$$\mathbf{A = l \times w}$$

$$\mathbf{d = 2r}$$

Non-Examples

$$\mathbf{2x + 3 = 1}$$

$$\mathbf{5y}$$

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

OFF COMPUTER EXERCISES

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

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

Expand:	$9 + 3m - 12$	$=$	$5m + 1$
Simplify:	$3m - 3$	$=$	$5m + 1$
-3m)	$3m - 3m - 3$	$=$	$5m - 3m + 1$
	-3	$=$	$2m + 1$
-1)	$-3 - 1$	$=$	$2m + 1 - 1$
	-4	$=$	$2m$
÷2)	$\frac{-4}{2}$	$=$	$\frac{2m}{2}$
	-2	$=$	m

Check:

L.S.	$=$	$9 + 3(m - 4)$	**R.S.**	$=$	$5m + 1$
	$=$	$9 + 3(-2 - 4)$		$=$	$5(-2) + 1$
	$=$	$9 + 3(-6)$		$=$	$-10 + 1$
	$=$	$9 - 18$		$=$	-9
	$=$	-9			

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

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

Expand:	$3m - 4m - 24$	$=$	$2m + 4 - 13$
	$-1m - 24$	$=$	$2m - 9$
-2m)	$-1m - 2m - 24$	$=$	$2m - 2m - 9$
	$-3m - 24$	$=$	-9
+24)	$-3m + 24 - 24$	$=$	$-9 + 24$
	$-3m$	$=$	15
÷-3)	$\frac{-3m}{-3}$	$=$	$\frac{15}{-3}$
	m	$=$	-5

Check:

L.S.	$=$	$3m - 4(m + 6)$	**R.S.**	$=$	$2(m + 2) - 13$
	$=$	$3m - 4(-5 + 6)$		$=$	$2(-5 + 2) - 13$
	$=$	$15 - 4(1)$		$=$	$2(-3) - 13$
	$=$	$-15 - 4$		$=$	$-6 - 13$
	$=$	-19		$=$	-19

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

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

Expand:

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	=	$8x$
÷8)	$\frac{-16}{8}$	=	$\frac{8x}{8}$
	-2	=	x

Check:

L.S.	=	$3 - 2(x + 4)$	**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

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

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

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	=	$3m$
÷3)	$\frac{-3}{3}$	=	$\frac{3m}{3}$
	-1	=	m

Check:

L.S.	=	$6 + 3(m - 4)$	**R.S.**	=	$6m - 3$
	=	$6 + 3(-1 - 4)$		=	$6(-1) - 3$
	=	$6 + 3(-5)$		=	$-6 - 3$
	=	$6 - 15$		=	-9
	=	-9			

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

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

Clear Fraction:

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

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

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:

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

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

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

(f)

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

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

$$\overset{6}{\cancel{30}} \times \frac{3}{\underset{1}{\cancel{5}}} - \overset{10}{\cancel{30}} \times \frac{x}{\underset{1}{\cancel{3}}} = \frac{x}{\underset{1}{\cancel{2}}} \times \overset{15}{\cancel{30}}$$

$$18 - 10x = 15x$$

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

$$18 = 25x$$

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

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

Check:

LS $= \frac{3}{5} - \frac{1}{\cancel{3}_1} \times \frac{\cancel{18}^{6}}{25}$

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

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

$= \frac{9}{25}$

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

$= \frac{9}{25}$

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

g)

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

×12) $$\overset{3}{\cancel{12}} \times \frac{3}{\underset{1}{\cancel{4}}}(2x - 1) = \overset{2}{\cancel{12}} \times \frac{5}{\underset{1}{\cancel{6}}}(2 - 4x)$$

$$\mathbf{9(2x - 1) = 10(2 - 4x)}$$

Expand: $$\mathbf{18x - 9 = 20 - 40x}$$

+9) $$\mathbf{18x - 9 + 9 = 20 - 40x + 9}$$
$$\mathbf{18x = 29 - 40x}$$

+40x) $$\mathbf{18x + 40x = 29 - 40x + 40x}$$
$$\mathbf{58x = 29}$$

÷58) $$\mathbf{\frac{58x}{58} = \frac{29}{58}}$$

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

Check

L.S. $= \frac{3}{4}(2x - 1)$ **R.S.** $= \frac{5}{6}(2 - 4x)$

$= \frac{3}{4}\left(\overset{1}{\cancel{2}}\left(\frac{1}{\underset{1}{\cancel{2}}}\right) - 1\right)$ $= \frac{5}{6}\left(2 - \overset{2}{\cancel{4}}\left(\frac{1}{\underset{1}{\cancel{2}}}\right)\right)$

$= \frac{3(0)}{4}$ $= \frac{5}{6}(0)$

$= 0$ $= 0$

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

h) $\frac{6a - 5}{3} - 2 = \frac{5a - 1}{4} + \frac{1}{3}$

$$\times 12) \quad 12 \times \left(\frac{6a - 5}{3} - 2\right) = 12 \times \left(\frac{5a - 1}{4} + \frac{1}{3}\right)$$

$$\overset{4}{\cancel{12}} \times \frac{(6a - 5)}{\underset{1}{\cancel{3}}} - 12 \times 2 = \overset{3}{\cancel{12}} \times \frac{(5a - 1)}{\underset{1}{\cancel{4}}} + \overset{4}{\cancel{12}} \times \frac{1}{\underset{1}{\cancel{3}}}$$

$$\begin{aligned}
& 24a - 20 - 24 &=& \ 15a - 3 + 4 \\
& 24a - 44 &=& \ 15a + 1 \\
+44) \quad & 24a - 44 + 44 &=& \ 15a + 1 + 44 \\
& 24a &=& \ 15a + 45 \\
-15a) \quad & 24a - 15a &=& \ 15a - 15a + 45 \\
& 9a &=& \ 45 \\
\div 9) \quad & \frac{9a}{9} &=& \ \frac{45}{9} \\
& a &=& \ 5
\end{aligned}$$

Check:

L.S.

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

R.S.

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

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

1. Solve each literal question.

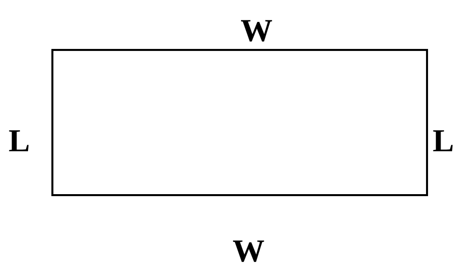
a) Solve: $y = mx + b$ for x

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

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

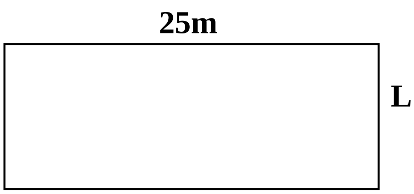
$$\begin{aligned} & & C &= 2pr + w \\ -w) & & C - w &= 2pr + w - w \\ & & C - w &= 2pr \\ \div 2r) & & \frac{C - w}{2r} &= \frac{2pr}{2r} \\ & & \frac{C - w}{2r} &= p \end{aligned}$$

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



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

d) As you know, P = 2 L + 2 W 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.)*



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

$$\frac{P - 2W}{2} = L$$

$$\frac{206 - 2(25)}{2} = L$$

$$\frac{206 - 50}{2} = L$$

$$\frac{156}{2} = L$$

$$78 = L$$

Therefore the length of the field is 78m.