

Key

Unit 6

Multi-Step Equations

Notes

SOL 8.15abd

Students will

- Solve multi-step linear equations in one variable with the variable on one and two sides of the equation
- Identify properties of operations used to solve an equation.

6-1: Combining Like Terms

Like Terms

"Like terms" are terms whose variables and exponents are the same.

In other words, terms that are "like" each other.

Examples:

$7x$	x	$-2x$	Like terms	Unlike Terms
------	-----	-------	------------	--------------

$7y$	xy	$-2z$	Like terms	Unlike Terms
------	------	-------	------------	--------------

$\frac{1}{3}xy^2$	$-2xy^2$	$4y^2x$	Like terms	Unlike Terms
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$4x^2y^2$

$\frac{1}{3}x^2y^2$	$-xy^2$	$4x^2$	Like terms	Unlike Terms
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Directions: Place each term with in the column with the "like terms"

$-x$	$4x^2$	$6xy$	$2xy$	5	$7z$	$6x$	$-2x^2$
$15z$	11	$-8x$	$-yx$	$-9x^2$	10	$3z$	

constants

x	x^2	xy	z	12
$-x$	$4x^2$	$6xy$	$7z$	5
$6x$	$-7x^2$	$2x$	$3z$	10
$-8x$	$-9x^2$	yx	$15z$	7

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Combining Like Terms

Example 1:

Algebraic Expression	Picture	Combined
$7x + 2x + 4x$	$\times \times \times \times \times \times$ $\times \times$ $\times \times \times \times$	$13x$

Example 2:

Algebraic Expression	Picture	Combined
$-7x + 2x + 4x$	$\times \times \times \times \times \times$ $\times \times \times \times \times \times$ $\times \times$	$-1x$

Example 3:

Algebraic Expression	Picture	Combined
$7x + 4 - 2x$	$\times \times \times \times \times \times$ $\times \times$ $+ + + +$	$5x + 4$

Directions: Simplify each expression by combining like terms.

How to Combine Like Terms

- Step 1: Rewrite so that all like terms are together
- Step 2: Follow integer rules and combine like terms
- Step 3: Make sure the variable is first for final answer
 - If there is more than one variable follow ABC order

$$3 + 5y - 4y + 2y - 8x$$

$$\underline{5y - 4y + 2y} - 8x + 3$$

$$\underline{1y + 2y} - 8x + 3$$

$$3y - 8x + 3$$

ABC order
 $\underline{-8x + 3y + 3}$

1) $2x + 16 + x$

$$\underline{2x + x + 16}$$

$$(3x + 16)$$

2) $5x + 3 - 2x - 4$

$$\underline{-2x + 3 - 4}$$

$$(3x - 1)$$

3) $-7y + 5 - 16y$

$$\underline{-7y - 16y + 5}$$

$$(-23y + 5)$$

4) $7 - 3y - 9 + y - 2y$

$$\underline{-3y + y - 2y + 7 - 9}$$

$$-2y - 2y + 7 - 9$$

$$(-4y - 2)$$

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Directions: Simplify each expression by combining like terms.

5) $12 - 8n + 3n + 6$

$$-8n + 3n + 12 + 6$$

$$\underline{-5n + 18}$$

6) $-2t + 7 - t + 9t$

$$-2t - t + 9t$$

$$-3t + 9t + 7$$

$$\underline{6t + 7}$$

7) $-g + 6 - 4g - 2$

$$-1g - 4g + 6 - 2$$

$$\underline{-5g + 4}$$

8) $5.5 - 5p - 1.2 + 3p + 1$

$$-5p + 3p + 5.5 - 1.2 + 1$$

$$\underline{-2p + 5.3}$$

9) $5xy - 9x - 5y + 4x - xy + x - 13y$

$$- \underline{9x + 4x + x} + 5xy - 1xy - 5y - 13y$$

$$\underline{-4x + 4xy - 18y}$$

10) $-7x - 3y + 15 - 2x + 3y$

$$-7x - 2x - 3y + 3y + 15$$

$$\underline{-9x + 15}$$

11) $6 - 7y + 9 - 4y$

$$-7y - 4y + 6 + 9$$

$$\underline{-11y + 15}$$

12) $-9.5 + 7h + 3.2h + 15 - h$

$$7h + 3.2h - 1h - 9.5 + 15$$

$$\underline{9.2h + 5.5}$$

13) $-6x + 5y - 10 + 6x - 5y$

$$-6x + 6x + 5y - 5y - 10$$

$$\underline{-10}$$

14) $8a + b - 3a + 4b - 6$

$$8a - 3a + 1b + 4b - 6$$

$$\underline{+ 5b - 6}$$

15) $1 + 5x - 9y - 10x + 10y - 2$

$$5x - 10x - 9y + 10y + 1 - 2$$

$$\underline{-5x + 1y - 1}$$

16) $-x + 4x - 8x - 9 + 2x + 1$

$$-1x \dots -8x + 2x - 9 + 1$$

$$\underline{1x - 8}$$

Distributive Property

Distributive Property: The distributive property helps you simplify what is in parenthesis when the terms cannot be combined.

Example 1: $4(-x + y) = x$ and y are NOT like terms. They cannot be added to each other. To eliminate the parenthesis, you must distribute the number touching the parenthesis to each term inside of the parenthesis.

$$4(-x + y) = 4(-x) + 4(y)$$

$$-4x + 4y$$

NO DOUBLE SIGNS!

Practice distributing

1) $4(-3x - 8)$

$$4(-3x) - 4(8)$$

$$\underline{-12x - 32}$$

2) $5(-3z + 4)$

$$5(-3z) + 5(4)$$

$$\underline{-15z + 20}$$

3) $-4(y - 3)$

$$-4(y) - -4(3)$$

$$\text{OR } \begin{array}{r} -4(y) -4(3) \\ \hline 4y + 12 \end{array}$$

$$\underline{-4y + 12}$$

4) $-8(2y + 10)$

$$\begin{array}{r} -8(2y) -8(10) \\ \hline -16y - 80 \end{array}$$

5) $-(4x + 3)$

$$\begin{array}{r} -1(4x + 3) \\ -1(4x) -1(3) \\ \hline -4x - 3 \end{array}$$

$$\frac{1}{2}(-4h + 8) \quad \frac{1}{2}\text{ of } -4 \quad \frac{1}{2}\text{ of } 8$$

$$\underline{-2h + 4}$$

7) $-5(x + 6)$

$$\begin{array}{r} -5(x) -5(6) \\ \hline -5x - 30 \end{array}$$

8) $(-y + 8)10$

$$\begin{array}{r} -y(10) 8(10) \\ \hline -10y + 80 \end{array}$$

9) $5(-x + 4)$

$$\boxed{-5x + 20}$$

10) $-2(-9g + 4)$

$$\boxed{18g - 8}$$

11) $-4(-3x - 1)$

$$\boxed{12x + 4}$$

12) $5(-2 + y)$

$$\begin{aligned} &-10 + 5y \\ &\boxed{5y - 10} \end{aligned}$$

13) $3(3 + -y)$

$$9 + -3y$$

$$\boxed{-3y + 9}$$

14) $-7(2y + 3)$

$$\boxed{-14y - 21}$$

15) $5(-2x + 4)$

$$\boxed{-10x + 20}$$

16) $\frac{1}{2}(2h - 10)$

$$\boxed{1h - 5 \text{ or } h - 5}$$

17) $-5(2x + y)$

$$\boxed{-10x - 5y}$$

18) $4(y - 3x)$

$$\begin{aligned} &y - 12x \\ &\boxed{-12x + 4y} \end{aligned}$$

19) $-(-x + 4)$

$$\boxed{x - 4}$$

20) $5(-g + 8)$

$$\boxed{-5g + 40}$$

Distribute & CLT

In order to simplify an expression with variables you MUST

- 1) Distribute FIRST
- 2) Then combine like terms

Example: $2(r+4)+6r$

$$\begin{aligned} & 2r + 8 + 6r \\ & 2r + 6r + 8 \\ & \textcircled{8r + 8} \end{aligned}$$

Directions: Use the distributive property. Then simplify the expressions by combining like terms.

1) $2(x+5)+9x$

$$\begin{aligned} & 2x + 10 + 9x \\ & 2x + 9x + 10 \\ & \textcircled{11x + 10} \end{aligned}$$

2) $-2(x-3)+17x$

$$\begin{aligned} & -2x + 6 + 17x \\ & -2x + 17x + 6 \\ & \textcircled{15x + 6} \end{aligned}$$

3) $-2+-4(p+7)+8p$

$$\begin{aligned} & -2 - 4p - 28 + 8p \\ & -4p + 8p - 2 - 28 \\ & \textcircled{4p - 30} \end{aligned}$$

4) $-3(2-n)+n$

$$\begin{aligned} & -6 + 3n + n \\ & \textcircled{4n - 6} \end{aligned}$$

5) $8\left(\frac{1}{4}x+4\right)-5x$

$$\textcircled{-3x + 32}$$

6) $-(7-4x)+8-3x$

$$\begin{aligned} & -7 + 4x + 8 - 3x \\ & \textcircled{1x + 1} \quad \text{or} \quad x + 1 \end{aligned}$$

7) $9(2w-3)-w$

$$\begin{aligned} & 18w - 27 - w \\ & \textcircled{17w - 27} \end{aligned}$$

8) $2(5x+3)-8+6x$

$$\begin{aligned} & 10x + 6 - 8 + 6x \\ & \textcircled{16x - 2} \end{aligned}$$

9) $-5(5k-6)+11-4k$

$$\begin{aligned} & -25k + 30 + 11 - 4k \\ & \textcircled{-29k + 41} \end{aligned}$$

10) $-4(2x-6)+8x$

$$\begin{aligned} & -8x + 24 + 8x \\ & \textcircled{24} \end{aligned}$$

6-2: Distribute/CLT and Solve

The **distributive property** is necessary to solve equations when the variable is inside of the parenthesis. Distributing allows us to remove the parenthesis by multiplying each term inside the parenthesis by the term located on the outside of the parenthesis.

Step 1: Distribute

Step 2: Solve for the variable using inverse operations.

$$\text{Example: } 9(2w - 3) = 81$$

$$18w - 27 = 81$$

$$+27 \quad +27$$

$$w = 6$$

$$\frac{18w}{18} = \frac{108}{18}$$

Solve.

1) $-3(3x - 1) = 30$

$$\begin{array}{rcl} -9x + 3 & = & 30 \\ -3 & & -3 \\ -9x & = & 27 \\ \hline -9 & & -9 \end{array}$$

$$x = -3$$

2) $2(-3z + 4) = -16$

$$\begin{array}{rcl} -6z + 8 & = & -16 \\ -8 & & -8 \\ -6z & = & -24 \\ \hline -6 & & -6 \end{array}$$

$$z = 4$$

3) $10(-y + 8) = 20$

$$\begin{array}{rcl} -10y + 80 & = & 20 \\ -80 & & -80 \\ -10y & = & -60 \\ \hline -10 & & -10 \end{array}$$

$$y = 6$$

4) $-8(2y + 10) = -16$

$$\begin{array}{rcl} -16y - 80 & = & -16 \\ +80 & & +80 \\ -16y & = & 64 \\ \hline -16 & & -16 \end{array}$$

$$y = -4$$

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

$$\begin{array}{rcl} -4x - 3 & = & 5 \\ +3 & & +3 \\ -4x & = & 8 \\ \hline -4 & & -4 \end{array}$$

$$x = -2$$

6) $\frac{1}{2}(-4h + 8) = 16$

$$\begin{array}{rcl} 2h + 4 & = & 16 \\ -4 & & -4 \\ -2h & = & 12 \\ \hline -2 & & -2 \end{array}$$

$$h = -6$$

7) $-5(x + 6) = -25$

$$\begin{array}{rcl} -5x - 30 & = & -25 \\ +30 & & +30 \\ -5x & = & 5 \\ \hline -5 & & -5 \end{array}$$

$$x = -1$$

8) $-4(y - 3) = -4$

$$\begin{array}{rcl} -4y + 12 & = & -4 \\ -12 & & -12 \\ -4y & = & -16 \\ \hline -4 & & -4 \end{array}$$

$$y = 4$$

Combining Like terms in Equations

Example: $8x - 4x + 15 = -5$

$$\begin{array}{r} 4x + 15 \\ \hline -15 \end{array}$$

$$\frac{4x}{4} = \frac{-20}{4}$$

$$x = -5$$

1) $6x - 2x - 13 = 3$

$$\begin{array}{r} 4x - 13 = 3 \\ +13 +13 \end{array}$$

$$\frac{4x}{4} = \frac{16}{4}$$

$$x = 4$$

2) $4a + 2 - 12a = 18$

$$\underline{4a - 12a} + 2 = 18$$

$$\begin{array}{r} -8a + 2 = 18 \\ -2 -2 \end{array}$$

$$\frac{-8a}{-8} = \frac{16}{-8}$$

$$a = -2$$

3) $5x - 4x + 16 = -1$

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

$$1x = -17$$

$$x = -17$$

4) $-10c + 5 - 8c = 59$

$$\underline{-10c - 8c} + 5 = 59$$

$$\begin{array}{r} -18c + 5 = 59 \\ -5 -5 \end{array}$$

$$\frac{-18c}{-18} = \frac{54}{-18}$$

$$c = -3$$

5) $6z - 4 - z + 10 = -9$

$$\underline{6z - 1z - 4 + 10} = -9$$

$$\begin{array}{r} 5z + 6 = -9 \\ -6 -6 \end{array}$$

$$\frac{5z}{5} = \frac{-15}{5}$$

$$z = -3$$

6) $-10 - 14y + 21 = 53$

$$\underline{-14y - 10 + 21} = 53$$

$$\begin{array}{r} -14y + 11 = 53 \\ -11 -11 \end{array}$$

$$\frac{-14y}{-14} = \frac{42}{-14}$$

$$y = -3$$

7) $6c - 5 - 2c = 15$

$$\underline{6c - 2c - 5} = 15$$

$$\begin{array}{r} 4c - 5 = 15 \\ +5 +5 \end{array}$$

$$\frac{4c}{4} = \frac{20}{4}$$

$$c = 5$$

8) $12 + 6p + 3 = 63$

$$\underline{6p + 12 + 3} =$$

$$\begin{array}{r} 6p + 15 = 63 \\ -15 -15 \end{array}$$

$$\frac{6p}{6} = \frac{48}{6}$$

$$p = 8$$

9) $3 - 7a + 6a - 4 = 8$

$$\underline{-7a + 6a} + 3 - 4 = 8$$

$$\begin{array}{r} -1a - 1 = 8 \\ +1 +1 \end{array}$$

$$\frac{-1a}{-1} = \frac{9}{-1}$$

$$a = -9$$

10) $6x + 4 - 2x - 13 = 7$

$$\underline{6x - 2x + 4 - 13} = 7$$

$$\begin{array}{r} 4x - 9 = 7 \\ +9 +9 \end{array}$$

$$\frac{4x}{4} = \frac{16}{4}$$

$$x = 4$$

Solving Equations with Distributive Property AND Combining Like Terms

Step 1: Apply the Distributive Property

Step 2: Combine Like Terms

Step 3: Solve for the variable by applying inverse operations

EXAMPLE: $2(2a-2)+a=6$

$$\begin{aligned} 4a - 4 + a &= 6 \\ 4a + a - 4 &= 6 \end{aligned}$$

$$\begin{array}{rcl} 5a - 4 & = & 6 \\ +4 & & +4 \end{array}$$

$$\frac{5a}{5} = \frac{10}{5}$$

$$a = 2$$

1) $2(r+4)+6r=72$

$$2r + 8 + 6r = 72$$

$$2r + 6r + 8 = 72$$

$$\begin{array}{rcl} 8r + 8 & = & 72 \\ -8 & & -8 \end{array}$$

$$\begin{array}{rcl} 8r & = & 64 \\ 8 & & 8 \end{array}$$

$$r = 8$$

2) $-2(x-3)+17x=36$

$$-2x + 6 + 17x = 36$$

$$-2x + 17x + 6 = 36 \quad \frac{15x}{15} = \frac{30}{15}$$

$$\begin{array}{rcl} 15x + 6 & = & 36 \\ -6 & & -6 \end{array}$$

$$x = 2$$

3) $-4(p+7)+8p=4$

$$-4p - 28 + 8p = 4$$

$$-4p + 8p - 28 = 4$$

$$\begin{array}{rcl} 4p - 28 & = & 4 \\ +28 & & +28 \end{array}$$

$$\begin{array}{rcl} 4p & = & 32 \\ 4 & & 4 \end{array}$$

$$p = 8$$

4) $-3(-n+2)+n=10$

$$3n - 6 + n = 10$$

$$3n + n - 6 = 10$$

$$\begin{array}{rcl} 4n - 6 & = & 10 \\ +6 & & +6 \end{array}$$

$$\frac{4n}{4} = \frac{16}{4}$$

$$n = 4$$

5) $8\left(\frac{1}{4}x+4\right)-5x=-1$

$$2x + 32 - 5x = -1$$

$$2x - 5x + 32 = -1$$

$$\begin{array}{rcl} -3x + 32 & = & -1 \\ -32 & & -32 \end{array}$$

$$\begin{array}{rcl} -3x & = & -33 \\ -3 & & -3 \end{array}$$

$$x = 11$$

6) $-(-4x+7)+8-3x=9$

$$4x - 7 + 8 - 3x = 9$$

$$4x - 3x - 7 + 8 = 9$$

$$\begin{array}{rcl} 1x - 1 & = & 9 \\ +1 & & +1 \end{array}$$

$$\begin{array}{rcl} 1x & = & 10 \\ x & = & 10 \end{array}$$

7) $3(-5y+3)=-36$

$$\begin{array}{rcl} -15y + 9 & = & -36 \\ -9 & & -9 \end{array}$$

$$\begin{array}{rcl} -15y & = & -45 \\ -15 & & -15 \end{array}$$

$$y = 3$$

8) $2(3x+9)-2x=34$

$$6x + 18 - 2x = 34$$

$$\underline{6x - 2x + 18 = 34}$$

$$\frac{4x}{4} = \frac{16}{4}$$

$$\begin{array}{rcl} 4x + 18 & = & 34 \\ -18 & & -18 \end{array}$$

$$x = 4$$

Practice

1) $108 = -6(5c + 2)$

$$\begin{array}{rcl} 108 & = & -30c - 12 \\ +12 & & +12 \end{array}$$

$$\begin{array}{rcl} 120 & = & -30c \\ -30 & & -30 \end{array}$$

$$(c = -4)$$

2) $5m - 18 - 3m = 4$

$$5m - 3m - 18 = 4$$

$$\begin{array}{rcl} 2m - 18 & = & 4 \\ +18 & & +18 \end{array}$$

$$\begin{array}{rcl} 2m & = & 22 \\ 2 & & 2 \end{array}$$

$$(m = 11)$$

3) $7(3 - u) + u - 2u = 5$

$$21 - [7u + u - 2u] = 5$$

$$-6u - 2u$$

$$\begin{array}{rcl} -8u + 21 & = & 5 \\ -21 & & -21 \end{array}$$

$$\begin{array}{rcl} -8u & = & -16 \\ -8 & & -8 \end{array}$$

$$(u = 2)$$

4) $7a + 3a + 2 - a = 20$

$$\begin{array}{rcl} 7a + 3a - a & = & 20 \\ 10a - a & & \end{array}$$

$$\begin{array}{rcl} 9a & = & 20 \\ 2 & & 2 \end{array}$$

$$\frac{9a}{9} = \frac{20}{2}$$

$$(a = 2)$$

5) $-5y - 3y + 4 = -4$

$$\begin{array}{rcl} -8y + 4 & = & -4 \\ -4 & & -4 \end{array}$$

$$\begin{array}{rcl} -8y & = & -8 \\ -8 & & -8 \end{array}$$

$$(y = 1)$$

6) $5m - 18 - 6m = 4$

$$5m - 6m - 18 = 4$$

$$\begin{array}{rcl} -1m - 18 & = & 4 \\ +18 & & +18 \end{array}$$

$$\begin{array}{rcl} -1m & = & 22 \\ -1 & & -1 \end{array}$$

$$(m = -22)$$

7) $-5(x + 2) = -20$

$$\begin{array}{rcl} -5x - 10 & = & -20 \\ +10 & & +10 \end{array}$$

$$\begin{array}{rcl} -5x & = & -10 \\ -5 & & -5 \end{array}$$

$$(x = 2)$$

8) $22 = -4(6 - b) + 10$

$$22 = -24 + 4b + 10$$

$$\begin{array}{rcl} 22 & = & -14 + 4b \\ +14 & & +14 \end{array}$$

$$\begin{array}{rcl} 36 & = & 4b \\ 4 & & 4 \end{array}$$

$$(b = 9)$$

6-3: VBS

Hannah needs to solve the following problem: $4a - 6 = -2a + 18$. How is the problem different from any other equation you have solved before? What would be the first step to solving this problem? Can we combine like terms?

Example

Step 1: Move the variable to the left

Step 2: Take care of any constants to get the answer

$$\begin{array}{r}
 4a - 6 = -2a + 18 \\
 +2a \quad \quad \quad +2a \\
 \hline
 6a - 6 = 18 \\
 +6 \quad \quad \quad +6 \\
 \hline
 6a = 24 \\
 \hline
 6 \quad \quad \quad 6
 \end{array}$$

$$a = 4$$

Solve.

1) $7a = 3a + 20$

$$\begin{array}{r}
 -3a \quad \quad \quad -3a \\
 \hline
 4a = 20 \\
 \hline
 4 \quad \quad \quad 4
 \end{array}$$

$$a = 5$$

3) $5m - 18 = 6m + 4$

$$\begin{array}{r}
 -6m \quad \quad \quad -6m \\
 \hline
 -1m - 18 = 4 \\
 +18 \quad \quad \quad +18 \\
 \hline
 -1m = 22 \\
 \hline
 -1 \quad \quad \quad -1
 \end{array}$$

$$m = -22$$

5) $6m - 14 = 2m + 6$

$$\begin{array}{r}
 -2m \quad \quad \quad -2m \\
 \hline
 4m - 14 = 6 \\
 +14 \quad \quad \quad +14 \\
 \hline
 4m = 20 \\
 \hline
 4 \quad \quad \quad 4
 \end{array}$$

$$m = 5$$

7) $7b - 3 = 6b - 3$

$$\begin{array}{r}
 -6b \quad \quad \quad -6b \\
 \hline
 1b - 3 = -3 \\
 +3 \quad \quad \quad +3 \\
 \hline
 1b = 0 \\
 \hline
 b = 0
 \end{array}$$

2) $-5y = 3y - 4$

$$\begin{array}{r}
 -3y \quad \quad \quad -3y \\
 \hline
 -8y = -4 \\
 \hline
 -8 \quad \quad \quad -8
 \end{array}$$

$$y = \frac{-4}{-8} = \frac{1}{2}$$

4) $7x - 4 = 3x - 16$

$$\begin{array}{r}
 -3x \quad \quad \quad -3x \\
 \hline
 4x - 4 = -16 \\
 +4 \quad \quad \quad +4 \\
 \hline
 4x = -12 \\
 \hline
 4 \quad \quad \quad 4
 \end{array}$$

$$x = -3$$

6) $6w + 1 = 9w + 4$

$$\begin{array}{r}
 -9w \quad \quad \quad -9w \\
 \hline
 -3w + 1 = 4 \\
 -1 \quad \quad \quad -1 \\
 \hline
 -3w = 3 \\
 \hline
 -3 \quad \quad \quad -3
 \end{array}$$

$$w = -1$$

8) $3u - 8 = 10u + 13$

$$\begin{array}{r}
 -10u \quad \quad \quad -10u \\
 \hline
 -7u - 8 = 13 \\
 +8 \quad \quad \quad +8 \\
 \hline
 -7u = 21 \\
 \hline
 -7 \quad \quad \quad -7
 \end{array}$$

$$u = -3$$

Solve.

9) $18n + 12 = 27n + 3$

$-27n \quad | -27n$

$-9n + 12 = 3$
 $-12 \quad | -12$

$\frac{-9n}{-9} = \frac{-9}{-9}$

$n = 1$

11) $12x - 4 = 23 + 9x$

$-9x \quad | -9x$

$3x - 4 = 23$
 $+4 \quad | +4$
 $\frac{3x}{3} = \frac{27}{3}$

$x = 9$

13) $-5x - 10 = -4x - 20$

$+4x \quad | +4x$

$-1x - 10 = -20$
 $+10 \quad | +10$

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

$x = 10$

15) $7u - 14 = 22 - 2u$

$+2u \quad | +2u$

$9u - 14 = 22$
 $+14 \quad | +14$

$\frac{9u}{9} = \frac{36}{9}$

$u = 4$

17) $2a + 4 = 10a$

$-10a \quad | -10a$

$-8a + 4 = 0$
 $-4 \quad | -4$

$\frac{-8a}{-8} = \frac{-4}{-8}$

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

19) $18w - 9 = w - 26$

$-1w \quad | -1w$

$17w - 9 = -26$
 $+9 \quad | +9$

$\frac{17w}{17} = \frac{-17}{17}$

$w = -1$

10) $-8n + 6 = 7n - 9$

$-7n \quad | -7n$

$-15n + 6 = -9$
 $-6 \quad | -6$

$\frac{-15n}{-15} = \frac{-15}{-15}$

$n = 1$

12) $3p - 9 = 4p + 3$

$-4p \quad | -4p$

$-1p - 9 = 3$
 $+9 \quad | +9$

$\frac{-1p}{-1} = \frac{12}{-1}$

$p = -12$

14) $7y + 28 = 7 + 8y$

$-8y \quad | -8y$

$-1y + 28 = 7$
 $-28 \quad | -28$

$\frac{-1y}{-1} = \frac{-21}{-1}$

$y = 21$

16) $-6b + 22 = 24 - 4b$

$+4b \quad | +4b$

$-2b + 22 = 24$
 $-22 \quad | -22$

$\frac{-2b}{-2} = \frac{2}{-2}$

$b = -1$

18) $21x + 6 = 20x - 5$

$-20x \quad | -20x$

$x + 6 = -5$
 $-6 \quad | -6$

$x = -11$

20) $10x - 2 = 46 + 2x$

$-2x \quad | -2x$

$8x - 2 = 46$
 $+2 \quad | +2$

$\frac{8x}{8} = \frac{48}{8}$

$x = 6$

VBS with CLT

Equations with more than one variable and/or one constant on either side of the equal sign must be "cleaned up" first before you solve. Combining like terms first simplifies the equation.

Step 1: Combine like terms on the left

Step 2: Combine like terms on the right

Step 3: Move variables to the left

Step 4: Solve

Example: $8x - 35 = 5 + 18x + 10$

$$\begin{aligned} 8x - 35 &= 5 + 10 + 18x \\ 8x - 35 &= 15 + 18x \\ -18x &\quad -18x \\ -10x - 35 &= 15 \\ +35 \quad +35 &\quad \frac{-10x = 50}{-10 \quad -10} \\ &\quad x = -5 \end{aligned}$$

Solve.

1) $7a - 5 = 3a + 10 + 5$

$$\begin{aligned} 7a - 5 &= 3a + 15 \\ -3a &\quad -3a \\ 4a - 5 &= 15 \\ +5 \quad +5 &\quad a = 5 \\ 4a &= 20 \\ \frac{4a}{4} &= \frac{20}{4} \end{aligned}$$

3) $5m - 18 = 4m + 2m + 2$

$$\begin{aligned} 5m - 18 &= 6m + 2 \\ -6m &\quad -6m \\ -1m - 18 &= 2 \\ +18 \quad +18 &\quad m = -20 \\ -1m &= 20 \\ \frac{-1m}{-1} &= \frac{20}{-1} \end{aligned}$$

5) $9m - 14 - 3m = 2m + 6$

$$\begin{aligned} 9m - 3m - 14 &= 2m + 6 \\ -2m &\quad -2m \\ 4m - 14 &= 6 \\ +14 \quad +14 &\quad m = 5 \\ 4m &= 20 \\ \frac{4m}{4} &= \frac{20}{4} \end{aligned}$$

7) $7b - 3 = 6b - 3 - 3b$

$$\begin{aligned} 7b - 3 &= [6b - 3b] - 3 \\ -3b &\quad -3b \\ 4b - 3 &= -3 \\ +3 \quad +3 &\quad b = 0 \\ 4b &= 0 \end{aligned}$$

2) $-5y + 6 = 5y - 10 - 2y$

$$\begin{aligned} -5y + 6 &= [5y - 2y] - 10 \\ -5y + 6 &= 3y - 10 \\ -3y &\quad -3y \\ -8y + 6 &= -10 \\ -6 \quad -6 &\quad y = 2 \\ -8y &= -16 \\ \frac{-8y}{-8} &= \frac{-16}{-8} \end{aligned}$$

4) $-4x + 1 = 12x - 20 + 5$

$$\begin{aligned} -4x + 1 &= 12x - 15 \\ -12x &\quad -12x \\ -16x + 1 &= -15 \\ -1 \quad -1 &\quad x = 1 \\ -16x &= -16 \\ \frac{-16x}{-16} &= \frac{-16}{-16} \end{aligned}$$

6) $6w + 1 = 5w + 4 + 4w$

$$\begin{aligned} 6w + 1 &= [5w + 4w] + 4 \\ -9w &\quad -9w \quad -3w = \frac{3}{-3} \\ -3w + 1 &= 4 \\ -1 \quad -1 &\quad w = -1 \\ -3w &= 3 \end{aligned}$$

8) $3u - 21 = 2u + 18 - 12u$

$$\begin{aligned} 3u - 21 &= [2u - 12u] + 18 \\ +10u \quad +10u &\quad 13u = \frac{39}{13} \\ 13u - 21 &= 18 \\ +21 \quad +21 &\quad u = 3 \\ 13u &= 39 \\ \frac{13u}{13} &= \frac{39}{13} \end{aligned}$$

Solve. Show ALL work.

9) $18n + 12 = 14 + 27n + 16$

$18n + 12 = \boxed{14 + 16} + 27n$

$$\begin{aligned} 18n + 12 &= 30 + 27n & -9n &= 18 \\ -27n & & -\frac{9n}{-9} &= \frac{18}{-9} \\ -9n + 12 &= 30 & n &= -2 \end{aligned}$$

10) $-n + 36 - 7n = 7n - 9$

$-\boxed{n - 7n} + 36 = 7n - 9$

$$\begin{aligned} -8n + 36 &= 7n - 9 \\ -7n & & -7n &= -9 \\ -15n + 36 &= -9 & -\frac{15n}{-15} &= \frac{-9}{-15} \\ -36 & & n &= 3 \end{aligned}$$

11) $12x - 4 = 26 + 9x - 3$

$12x - 4 = \boxed{26 - 3} + 9x$

$$\begin{aligned} 12x - 4 &= 23 + 9x & \frac{3x}{3} &= \frac{27}{3} \\ -9x & & x &= 9 \\ 3x - 4 &= 23 & 3x &= 27 \\ +4 & & +4 & \\ x & & x &= 9 \end{aligned}$$

12) $5p - 9 = 6p + 3 - 2p$

$5p - 9 = \boxed{6p - 2p} + 3$

$5p - 9 = 4p + 3$

$-4p$

$1p - 9 = \frac{3}{9} + 9$

$1p = 12$

$p = 12$

13) $-5x - \boxed{15 + 5} = -4x - 20$

$-5x - 10 = -4x - 20$

$+4x$

$-1x - 10 = -20$

$+10$

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

$x = 10$

14) $10 + 9y + 18 = 7 + 8y$

$\boxed{10 + 18} + 9y = 7 + 8y$

$28 + 9y = 7 + 8y$

$-8y$

$1y = -21$

$\frac{28 + 1y}{-28} = \frac{7}{-28}$

$y = -21$

15) $-3 + 7u - 18 = 33 - 2u$

$\boxed{-3 - 18} + 7u = 33 - 2u$

$-21 + 7u = 33 - 2u$

$+2u$

$-21 + 9u = 33$

$+21$

$9u = \frac{45}{9}$

$u = 5$

16) $-b + 22 - 4b = 47 - 4b$

$\boxed{-b - 4b} + 22 = 47 - 4b$

$-5b + 22 = \frac{47}{-22}$

$\frac{-5b}{-5} = \frac{25}{-5}$

$b = -5$

17) $-5 + 2a + 9 = 10a$

$\boxed{-5 + 9} + 2a = 10a$

$4 + 2a = 10a$

$-10a$

$4 - 8a = 0$

-4

$\frac{-8a}{-8} = \frac{-4}{-8}$

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

18) $10x - 5 = 14x + 6 + 7x$

$10x - 5 = \boxed{14x + 7x} + 6$

$10x - 5 = 21x + 6$

$-21x$

$-11x - 5 = \frac{6}{+5}$

$\frac{-11x}{-11} = \frac{11}{-11}$

$x = -1$

6-4: Multi-Step Equations

Here's How	Example
1) Simplify each side of the equation a. Can you distribute? b. Can you combine like terms? c. Move all variables to the left side 2) Solve for x	$2(4x + 7) + 4 = 32 + x$ $8x + \boxed{14 + 4} = 32 + x$ $8x + 18 = 32 + x$ $\cancel{-1x} \quad \cancel{-x}$ $7x + 18 = 32$ $\quad \quad \quad -18 \quad -18$ $\frac{7x}{7} = \frac{14}{7}$ $x = 2$

Questions 1-4: State the first step to solve for the variable.

1) $16x + 43 - 13x = 24$ combine $16x - 13x$ $3x$	2) $19m - 22 = 30 - 7m$ $\text{add } 7m \text{ to both sides}$
3) $198 = -6(5c + 2)$ $\text{distribute } -6$ $-30c - 12$	4) $4(4m+2) - 8 = 30 + m$ $\text{distribute } 4$ $16m + 8$

Directions: solve each multi-step equation

5) $7d - 2(3 + 4d) = 19$ $7d - 6 - 8d = 19$ $-1d - 6 = 19$ $\cdot +6 \quad +6$ $\underline{-1d = 25}$ $\underline{\quad \quad \quad -1}$ $d = -25$	6) $124 = 28 - 6(2x + 4)$ $124 = \underline{28} - 12x - \underline{24}$ $124 = 4 - 12x$ $\quad \quad \quad -4 \quad -4$ $\underline{120 = -12x}$ $\quad \quad \quad \underline{-12 \quad -12}$ $x = -10$
7) $15 - (2y + 7) = 14$ $15 - 2y - 7 = 14$ $8 - 2y = 14$ $\quad \quad \quad -8$ $\underline{-2y = 6}$ $\quad \quad \quad \underline{-2}$ $y = -3$	8) $4n + 5(6 - n) = 30$ $4n + 30 - 5n = 30$ $-1n + 30 = 30$ $\quad \quad \quad -30$ $\underline{-1n = 0}$ $\quad \quad \quad \underline{-1}$ $n = 0$

Carefully solve each multi-step equation.

9) $-(5x + 8) + 12 + 4x = 4$

$$\begin{aligned} -5x - 8 + 12 + 4x &= 4 \\ -1x + 4 &= 4 \\ -4 &\quad -4 \\ -1x &= 0 \\ \hline -1 &\quad -1 \\ x &= 0 \end{aligned}$$

10) $-15 = 12y - 3(2y + 3)$

$$\begin{aligned} -15 &= 12y - 6y - 9 \\ -15 &= 6y - 9 \\ +9 &\quad +9 \\ \hline -6 &= 6y \\ \hline 6 &\quad 6 \\ y &= -1 \end{aligned}$$

11) $12 = 4m - 3(2m - 6) + 4m$

$$12 = -6m + 18 + 4m$$

$$12 = -2m + 18$$

$$\begin{array}{r} -18 \\ \hline -2m \end{array}$$

$$\begin{array}{r} -6 \\ \hline -2 \\ \hline -2 \end{array}$$

$m = 3$

12) $7d - 2(3 + 4d) = 19$

$$-2(3 + 4d) + 7d = 19$$

$$\begin{array}{r} -6 \\ -8d + 7d \end{array} = 19$$

$$\begin{array}{r} -6 \\ -1d \end{array} = 19$$

$$\begin{array}{r} +6 \\ +6 \end{array}$$

$$\begin{array}{r} -1d \\ \hline -1 \\ \hline -25 \end{array}$$

$d = -25$

13) $124 = 28 - 6(2x + 4)$

$$124 = -6(2x + 4) + 28$$

$$124 = -12x - 24 + 28$$

$$124 = -12x + 4$$

$$\begin{array}{r} -4 \\ -4 \end{array}$$

$$\begin{array}{r} 120 \\ -12 \\ \hline -12 \end{array}$$

$x = -10$

14) $15 - (2y + 7) = 14$

$$-1(2y + 7) + 15 = 14$$

$$\begin{array}{r} -2y \\ -7 + 15 \end{array} = 14$$

$$\begin{array}{r} -2y \\ -8 \\ -8 \end{array} = 14$$

$$\begin{array}{r} -2y \\ \hline -2 \\ \hline 6 \end{array}$$

$y = -3$

15) $4(4m + 2) - 8 = 30 + m$

$$16m + 8 - 8 = 30 + m$$

$$16m = 30 + m$$

$$\begin{array}{r} -1m \\ -1m \end{array}$$

$$\begin{array}{r} 15m \\ \hline 15 \\ \hline 15 \end{array}$$

$m = 2$

16) $5(x + 1) + 2(11 - x) = -6$

$$5x + 5 + 22 - 2x = -6$$

$$\begin{array}{r} 3x + 27 \\ -27 \\ -27 \end{array} = -6$$

$$\begin{array}{r} 3x \\ \hline 3 \\ \hline -33 \end{array}$$

$x = -11$

Carefully solve each multi-step equation.

17) $3x - 2(2x + 3) = 23$

$$3x - 4x - 6 = 23$$

$$\begin{array}{r} -1x - 6 = 23 \\ \quad + 6 \quad + 6 \\ \hline -1x = 29 \end{array}$$

$$\begin{array}{r} -1 \\ \hline -1 \end{array}$$

$$x = -29$$

19) $-2(3 - u) + u = 4 - 2u$

$$-6 + 2u + u = 4 - 2u$$

$$\begin{array}{r} -6 + 3u = 4 - 2u \\ \quad + 2u \quad + 2u \\ \hline -6 + 5u = 4 \end{array}$$

$$\begin{array}{r} + 6 \quad + 6 \\ \hline 5u = 10 \end{array}$$

$$\begin{array}{r} 5 \\ \hline 5 \end{array}$$

$$u = 2$$

23) $-5(x + 2) = 3(x + 2) - 20$

$$-5x - 10 = 3x + 6 - 20$$

$$\begin{array}{r} -5x - 10 = 3x - 14 \\ \quad -3x \quad -3x \end{array}$$

$$\begin{array}{r} -8x - 10 = -14 \\ \quad + 10 \quad + 10 \end{array}$$

$$\begin{array}{r} -8x = -4 \\ \quad -8 \quad -8 \end{array}$$

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

25) $7(3 - u) + u = 5 - 2u$

$$21 - 7u + u = 5 - 2u$$

$$21 - 6u = 5 - 2u$$

$$\begin{array}{r} + 2u \quad + 2u \end{array}$$

$$21 - 4u = 5$$

$$\begin{array}{r} - 21 \quad - 21 \\ \hline -4u = -16 \end{array}$$

$$\begin{array}{r} -4 \\ \hline -4 \end{array}$$

$$u = 4$$

18) $14 + 2(4a - 3) = 40$

$$14 + 8a - 6 = 40$$

$$\begin{array}{r} 8a + 8 = 40 \\ \quad - 8 \quad - 8 \end{array}$$

$$\begin{array}{r} 8a = \underline{32} \\ \quad 8 \quad 8 \end{array}$$

$$a = 4$$

20) $42 - 13x = -4(4x + 6)$

$$\begin{array}{r} 42 - 13x = -16x - 24 \\ \quad + 16x \quad + 16x \end{array}$$

$$\begin{array}{r} 42 - 3x = -24 \\ \quad - 42 \quad - 42 \end{array}$$

$$\begin{array}{r} -3x = -\underline{66} \\ \quad -3 \quad -3 \end{array}$$

$$x = 22$$

24) $7(y + 1) - 5y = 4(y + 3) + 1$

$$7y + 7 - 5y = 4y + 12 + 1$$

$$\begin{array}{r} 2y + 7 = 4y + 13 \\ \quad - 4y \quad - 4y \end{array}$$

$$\begin{array}{r} -2y + 7 = 13 \\ \quad - 7 \quad - 7 \end{array}$$

$$\begin{array}{r} -2y = 6 \\ \quad -2 \quad -2 \end{array}$$

$$y = -3$$

26) $22 + 2b = -4(6 - b) + 10$

$$22 + 2b = 24 + 4b + 10$$

$$\begin{array}{r} 22 + 2b = -14 + 4b \\ \quad - 4b \quad - 4b \end{array}$$

$$\begin{array}{r} 22 - 2b = -14 \\ \quad - 22 \quad - 22 \end{array}$$

$$\begin{array}{r} -2b = -\underline{36} \\ \quad -2 \quad -2 \end{array}$$

$$b = 18$$

Solving Equations with FRACTIONS

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

$$\quad \quad +5 \quad +5$$

$$\left(\frac{2}{1}\right)\frac{1}{2}x = -1\left(\frac{2}{1}\right)$$

$$x = -2$$

$$2) \frac{2}{3}x - 9 = 15$$

$$\quad \quad +9 \quad +9$$

$$\left(\frac{3}{2}\right)\frac{2}{3}x = 24\left(\frac{3}{2}\right)$$

$$x = \frac{72}{2}$$

$$x = 36$$

$$3) \left(\frac{x}{1}\right) \frac{30}{x} = -3 \left(\frac{x}{1}\right)$$

$$\frac{30}{-3} = -\frac{3x}{-3}$$

$$x = -10$$

$$4) \left(\frac{3}{1}\right) \frac{(x-5)}{3} = 16 \left(\frac{3}{1}\right)$$

$$x-5 = 48$$

$$+5 \quad +5$$

$$x = 53$$

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

$$3x-3 = -24$$

$$+3 \quad +3$$

$$\frac{3x}{3} = -\frac{21}{3}$$

$$x = -7$$

$$6) \left(\frac{12}{1}\right) \frac{5x-2}{12} = -1 \left(\frac{12}{1}\right)$$

$$5x-2 = -12$$

$$+2 \quad +2$$

$$\frac{5x}{5} = \frac{-10}{5}$$

$$x = -2$$

$$7) \frac{(x-3)}{4} + 10 = 6$$

$$\quad \quad -10 \quad -10$$

$$\left(\frac{4}{1}\right) \frac{(x-3)}{4} = -4 \left(\frac{4}{1}\right)$$

$$x-3 = -16$$

$$+3 \quad +3$$

$$x = -13$$

$$8) \frac{(x+5)}{6} - 5 = 15$$

$$\quad \quad +5 \quad +5$$

$$\left(\frac{6}{1}\right) \frac{(x+5)}{6} = 20 \left(\frac{6}{1}\right)$$

$$x+5 = 120$$

$$-5 \quad -5$$

$$x = 115$$

$$9) \left(\frac{x}{1}\right) \frac{104}{x} = -13 \left(\frac{x}{1}\right)$$

$$\frac{104}{-13} = -13x$$

$$x = -8$$

$$10) \left(\frac{3}{1}\right) \frac{x}{3} = 16 \left(\frac{3}{1}\right)$$

$$x = 48$$

PRACTICE

Directions: State what the first step is to solve each equation.

11) $5a - 4 + a = 8$

CLT

$5a + a = 6a$

12) $5(b - 2) + 6 = -12$

distribute the 5

$5(b) - 5(2)$

13) $8r + 6 = 72$

$-6 - 6$

14) $-2(x - 3) = 36 - 17x$

distribute the -2

$-2(x) + 2(3)$

15) $-4p + 7 + 8p = 4$

CLT

$-4p + 8p = 4p$

16) $\frac{1}{2}x = 10$

multiply by $\frac{2}{1}$

17) $8 - 5x = -1$

$-8 - 8$

18) $-4x + 7 - 3x - 8 = 9$

CLT

$-4x - 3x = -7x$

19) $\frac{x+1}{3} = -12$

multiply by 3

20) $6x + 18 - 2x = 4 + 5x$

CLT

$6x - 2x = 4x$

Directions: For Question 21-24, identify if the statement is true or false.

21) $\frac{x+1}{3} = -12$

true

The first step is to clear the denominator by multiplying by

3, because $\frac{x+1}{3}$ is one giant fraction that really means

$\frac{x}{3} + \frac{1}{3}$.

22) $6x + 18 - 2x = 4$

The best first step is to move the 18 over to the left by adding it to both sides.

False

23) $-3(-n+2) + n = 10$

The first step is to distribute the -3 to all terms on the left.

False

24) $\frac{1}{3}y - 5 = 10$

False

The first step is to multiply both sides by 3.