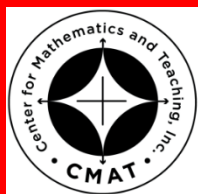


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**Mathlinks**

**8-6**

**STUDENT PACKET**

**MATHLINKS GRADE 8  
STUDENT PACKET 6  
SOLVING EQUATIONS**

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<b>6.1</b>	<b>Cups and Counters Equations 2</b>	<b>1</b>
	<ul style="list-style-type: none"><li>• Use a model to solve multistep algebraic equations.</li><li>• Solve equations with integer coefficients.</li><li>• Recognize that linear equations may have no solution, one solution, or infinitely many solutions.</li><li>• Use substitution to check solutions.</li></ul>	
<hr/>		
<b>6.2</b>	<b>Solving Equations with Integer Coefficients</b>	<b>7</b>
	<ul style="list-style-type: none"><li>• Solve multistep algebraic equations.</li><li>• Solve equations with integer coefficients.</li><li>• Justify the steps in equation solving.</li><li>• Recognize that linear equations may have no solution, one solution, or infinitely many solutions.</li><li>• Use substitution to check solutions.</li></ul>	
<hr/>		
<b>6.3</b>	<b>Solving Equations With Rational Coefficients</b>	<b>13</b>
	<ul style="list-style-type: none"><li>• Solve multistep equations with rational coefficients.</li><li>• Justify the steps in equation solving.</li><li>• Solve equations for one variable in terms of the others.</li></ul>	
<hr/>		
<b>6.4</b>	<b>Skill Builders, Vocabulary, and Review</b>	<b>21</b>

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# WORD BANK

Word or Phrase	Definition or Explanation	Example or Picture
equation		
integers		
numerical coefficient		
rational numbers		
solution to an equation		
variable		

## CUPS AND COUNTERS EQUATIONS 2

### Summary (Ready)

We will solve more complex linear equations using a model and record the steps with pictures and algebraic symbols

### Goals (Set)

- Use a model to solve multistep algebraic equations.
- Solve equations with integer coefficients.
- Recognize that linear equations may have no solution, one solution, or infinitely many solutions.
- Use substitution to check solutions.

### Warmup (Go)

Fill in the missing numbers and name the property of arithmetic illustrated by each equation.

Equation	Property
1. $(3)(4) = (\underline{\quad})(3) = 12$	
2. $2(5 + 10) = 2(5) + (\underline{\quad})(10) = 30$	
3. $\left(\frac{3}{3}\right)(6) = (\underline{\quad})(6) = 6$	
4. $3 \cdot 7 - 5 \cdot 7 = (3 - \underline{\quad}) \cdot 7 = -14$	

## ANOTHER LOOK AT CUPS AND COUNTERS

Follow your teacher's instructions to build and record equations. Use a mental strategy to solve and/or to check your answers.

1.	Picture	Equation
		$-x = 3$ $x = \underline{\quad}$

2.	Picture	Equation
		$-2x + 2 = -6$





3.	Picture	Equation
		$-(x + 1) = 5$

4.	Picture	Equation
		$-2(x + 1) = 4$





## MORE EQUATIONS WITH CUPS AND COUNTERS

Build, draw, record, solve, and check each equation.

1.

Picture	Equation/Steps	What did you do?
	$-x + 4 = 2x + 1$	
		
		
		
Check your solution using substitution:		





2.

Picture	Equation/Steps	What did you do?
	$-2(x + 1) = -4x - 6$	
		
		
		
Check your solution using substitution:		





## MORE EQUATIONS WITH CUPS AND COUNTERS (Continued)

Build, draw, record, solve, and check each equation.

3.

Picture	Equation/Steps	What did you do?
	$2x = -2x - 4$	
		
		
		
Check your solution using substitution:		





4.

Picture	Equation/Steps	What did you do?
	$-x + 10 = 3x + 2$	
		
		
		
Check your solution using substitution:		





## MORE EQUATIONS WITH CUPS AND COUNTERS (Continued)

Build, draw, record, solve, and check each equation.

5.

Picture	Equation/Steps	What did you do?
	$-4x - 5 = -(x - 4)$	
		
		
		
Check your solution using substitution:		

6.

Picture	Equation/Steps	What did you do?
	$-2(x + 2) = 2(-x - 1)$	
		
		
		
Check your solution using substitution:		

## MORE EQUATIONS WITH CUPS AND COUNTERS (Continued)

Build, draw, record, solve, and check each equation.

7.	Picture	Equation/Steps	What did you do?
		$4x - 4 - x = -7 + 3x + 3$	
		=	
		=	
		=	
Check your solution using substitution:			

8.	Picture	Equation/Steps	What did you do?
		$-x + 4 - 2x = -(2 + x)$	
		=	
		=	
		=	
Check your solution using substitution:			



# SOLVING EQUATIONS WITH INTEGER COEFFICIENTS

## Summary (Ready)

We will begin to transition from solving equations with a model to using only algebraic notation.

## Goals (Set)

- Solve multistep algebraic equations.
- Solve equations with integer coefficients.
- Justify the steps in equation solving.
- Recognize that linear equations may have no solution, one solution, or infinitely many solutions.
- Use substitution to check solutions.

## Warmup (Go)

Solve the equation. Fill in the table completely.

Picture	Equation/Steps	What did you do?
=	$-3(x - 1) = x - 5$	

Check your solution using substitution:

## PROPERTIES OF ARITHMETIC AND EQUALITY

### Properties of Arithmetic

Property	Symbols (Variables)	Example with numbers	Abbreviation
Associative property of addition	$a + (b + c) = (a + b) + c$		
Commutative property of addition	$a + b = b + a$		
Identity property of addition	$0 + a = a + 0 = a$		
Inverse property of addition	$a + (-a) = (-a) + a = 0$		
Associative property of multiplication	$a \cdot (b \cdot c) = (a \cdot b) \cdot c$		
Commutative property of multiplication	$a \cdot b = b \cdot a$		
Identity property of multiplication	$1 \cdot a = a \cdot 1 = a$		
Inverse property of multiplication	$\frac{1}{a} \cdot a = a \cdot \frac{1}{a} = 1$ when $a \neq 0$		
Distributive property	$a(b + c) = ab + ac$		

### Properties of Equality

Property	Description	Example with numbers	Abbreviation
Addition property of equality	If $a = b$ and $c = d$ , then $a + c = b + d$ .		
Multiplication property of equality	If $a = b$ and $c = d$ , then $ac = bd$ .		

## GIVE THE REASONS

Write what was done for each step. Use pictures if needed. Check each solution.

1.	Equation/Steps	State what was done.
	$16x - 9 = 20x + 19$	given equation
	$16x - 9 = 20x + 19$ $-16x \quad -16x$	subtract $16x$ from both sides; addition (subtraction) property of equality
	$-9 = 4x + 19$ $-19 \quad -19$	
	$\frac{-28}{4} = \frac{4x}{4}$	
	$-7 = x$	
	Check your solution using substitution:	

2.	Equation/Steps	State what was done.
	$-2x - 1 = -(x - 1) - x$	given equation
	$-2x - 1 = -x + 1 - x$	
	$-2x - 1 = -2x + 1$	
	$-2x - 1 = -2x + 1$ $+2x \quad +2x$	
	$-1 = 1$	
	Check your solution using substitution:	

## FIND THE MISTAKE

Find the mistake in each problem, circle it, and rework the problem from that point on. Use pictures if needed. Check each solution.

1.	Equation/Steps	Circle the error and rework the problem.
	$-x + 7 = -3(x - 5)$	given equation
	$-x + 7 = 3x - 15$	
	$-x + 7 = -3x - 15$ $+3x + 0 = +3x$	
	$x + 7 = -15$ $-7 = -7$	
	$\frac{2x}{2} = \frac{-22}{2}$ $x = -11$	
	Check your solution using substitution:	

2.	Equation/Steps	Circle the error and rework the problem.
	$-2(x + 3) = 12$	given equation
	$-2x - 6 = 12$	
	$-2x - 6 = 12$ $+6 +6$	
	$\frac{-2x}{2} = \frac{18}{2}$	
	$x = 9$	
	Check your solution using substitution:	

## SOLVING MORE EQUATIONS

Write all the steps used to solve the equations. Provide justifications/explanations for each step. Use pictures as needed.

1.

Equation/Steps	Why can you do that?
$-3x + 7 = 3x + 19$	given equation
$-3x + 7 = 3x + 19$ $\quad -7 \quad \quad -7$	addition (subtraction) property of equality
Check your solution using substitution:	

2.

Equation/Steps	Why can you do that?
$-4x - 20 = 6x$	
Check your solution using substitution:	

## SOLVING MORE EQUATIONS (Continued)

Write all the steps used to solve the equations. Provide justifications/explanations for each step. Use pictures as needed.

3.

Equation/Steps	Why can you do that?
$-x - 7 = -5x + 5$	
Check solution by substitution:	

4.

Equation/Steps	Why can you do that?
$3(x + 1) - 2(x - 1) = x + 5$	given equation
Check your solution using substitution:	

# SOLVING EQUATIONS WITH RATIONAL COEFFICIENTS

### Summary (Ready)

We will solve more algebraic equations using algebraic notation. We will justify the steps used to solve equations. Some equations will involve non-integer values.

### Goals (Set)

- Solve multistep equations with rational coefficients.
- Justify the steps in equation solving.
- Solve equations for one variable in terms of the others.

### Warmup (Go)

Compute.

1. $7.8 + 9.6$	2. $7.8 - 9.6$
3. $(-8.6) \cdot (4.3)$	4. $(-8.6) \div (4.3)$
5. $\frac{2}{3} + \frac{3}{5}$	6. $\frac{2}{3} - \frac{3}{5}$
7. $\left(-\frac{3}{4}\right) \cdot \left(-\frac{1}{2}\right)$	8. $\frac{-\frac{3}{4}}{-\frac{1}{2}}$

**SOLVING EQUATIONS MENTALLY**

Solve each equation. Use mental strategies if possible.

1.  $5.6 = x + 2.3$

2.  $x - 1.5 = 1.5$

3.  $5.5 = 3x + 2.5$

4.  $-0.2x = -0.04$

5.  $x + \frac{1}{2} = 4\frac{1}{2}$

6.  $x - \frac{3}{4} = 2$

7.  $\frac{1}{2}x = 8$

8.  $-\frac{1}{2}x = 8$



## SOLVING EQUATIONS ALGEBRAICALLY

Solve each equation. Justify each step.

Equation	What did you do?
1. $\frac{1}{2}x + 2 = \frac{1}{4}x - 6$	
2. $1.6x + 9.8 = 3x + 5.4 + 0.8x$	
3. $2x + \frac{1}{2} = \frac{1}{2} + \frac{1}{3}$	

## SOLVING EQUATIONS ALGEBRAICALLY (Continued)

Solve each equation. Justify each step.

Equation	What did you do?
4. $-2.6 = 3x + 2.5$	
5. $\frac{3}{4}x + 3 - \frac{1}{4}x = 5$	
6. $3x - \frac{4}{5} = 2\left(x + \frac{1}{5}\right)$	

**SOLVING EQUATIONS: PROPORTIONS**

Solve each equation. Justify each step.

Equation	What did you do?
1. $\frac{4}{x} = \frac{1}{8}$	
2. $\frac{x}{6} = \frac{9}{8}$	
3. $\frac{5}{3} = \frac{2x}{7}$	

**PRACTICE**

Solve each equation.

1.  $3x + \frac{2}{5} = \frac{4}{5}$

2.  $x + 2.5 = 4.6$

3.  $\frac{3}{2}(x + 4) = 2(x - 1)$

4.  $2x + 3.6 = 3(x + 2.5)$

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

6.  $1.5x + 3 = 2(x - 2.5)$

7.  $\frac{1}{2}x + 4 = 3x - 2x$

8.  $-2.5x + 3 = x - 4$

9.  $\frac{x}{10} = \frac{11}{15}$

10.  $\frac{9}{5} = \frac{3x}{2}$

**SOLVING PROBLEMS USING ALGEBRA**

For each problem, first translate it into an equation, and then solve the equation using any method.

1. The perimeter of a rectangle is 94 cm. Its length is 23 cm. What is its width?

let  $P$  = perimeter,  $\ell$  = length,  $w$  = width

Equation:  $P = \underline{\hspace{2cm}}$

Solution:

2. The perimeter of an isosceles triangle is 75 mm. The two congruent sides are each 6 mm longer than the third side. How long is the third side?

let  $x$  = the length of the third side

Equation:

Solution:

3. A number added to twice this number is 78. What is the number?

let  $n$  = the original number

Equation:

Solution:

4. 5 times the sum of a number and 10 is -50. What is the number?

let  $m$  = the number

Equation:

Solution:

**SOLVING FOR ONE VARIABLE IN TERMS OF ANOTHER**

You have learned to use properties of arithmetic and equality to solve equations. We will use the same properties to solve for one variable in terms of another.

1a. Solve for $x$ : $-3x = y$	1b. Solve for $h$ : $bh = A$
2a. Solve for $x$ : $-14 + 5 + x = 20$	2a. Solve for $c$ : $a + b + c = 2b$
3a. Solve for $z$ : $8 + 2z = -28$	3b. Solve for $W$ : $2L + 2W = 40$
4a. Solve for $y$ : $12 + 2y = 30$	4b. Solve for $y$ : $x + 2y = -30$

# SKILL BUILDERS, VOCABULARY, AND REVIEW

## SKILL BUILDER 1

Compute.

1. $(-11) + (7)$	2. $(14) + (-7)$	3. $(-73) + (73)$
4. $(8) - (-6)$	5. $(-8) - (6)$	6. $(-8) - (-6)$
7. $(-7)(-8)$	8. $\frac{49}{-7}$	9. $-4 \cdot 3 \cdot -2$
10. $\frac{-8+4}{-2}$	11. $\frac{-8}{-2} + 4$	12. $\frac{-8}{-2+4}$

13. Perform the number trick below.

Step	Words	Numbers	Pictures	Algebraic Process
1	Choose a number.		<b>V</b>	$n$
2	Multiply by 4.			
3	Subtract 4.			
4	Find half of it.			
5	What is the result?			

14. What is the number trick? \_\_\_\_\_

15. Does this always work? Explain.

## SKILL BUILDER 2

Build, draw, record, solve, and check each equation.

1.	Picture	Equation/Steps	What did you do?
	=	$3(x + 1) = 3x + 1$	
	=	=	
	=	=	
	=	=	
Check your solution using substitution:			

2.	Picture	Equation/Steps	What did you do?
	=	$2(x + 2) - 5 = x + 3 + x - 4$	
	=	=	
	=	=	
	=	=	
Check your solution using substitution:			



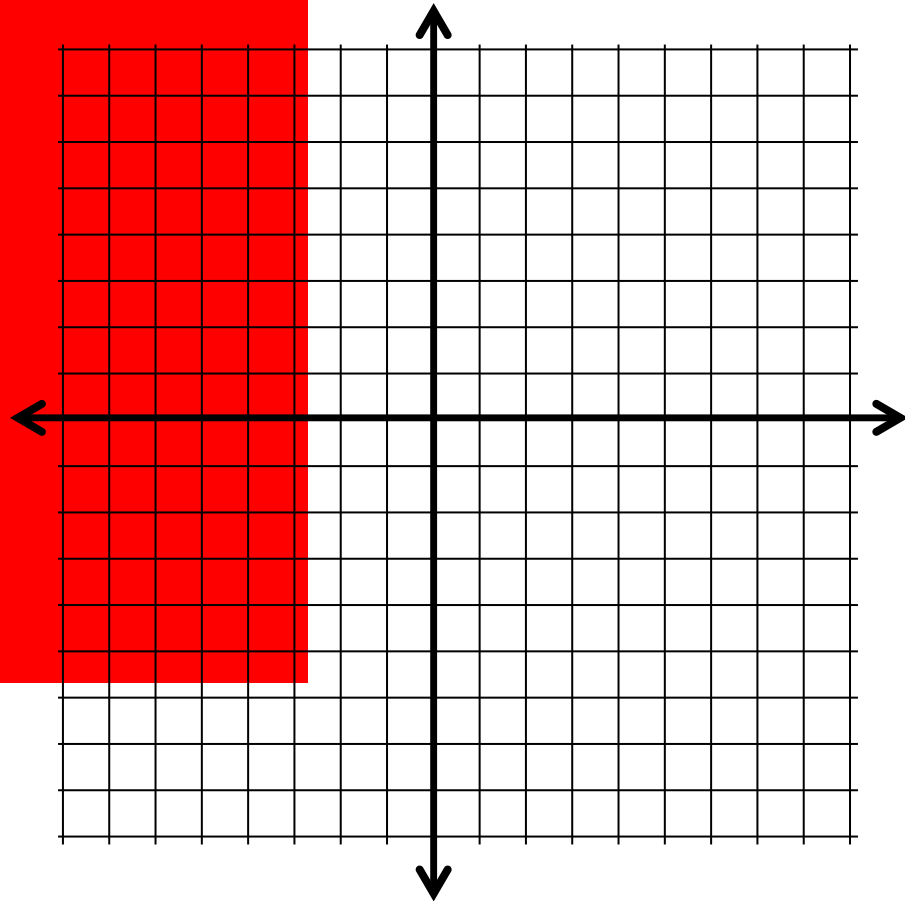
## SKILL BUILDER 3

For each equation, find the output values ( $y$ ) for the given input values ( $x$ ). Graph the ordered pairs for each equation using a different color pencil. Connect the points for each equation.

1. $y = x - 1$	
$x$	$y$
0	
8	
-4	

2. $y = 3x - 1$	
$x$	$y$
0	
2	
-1	

3. $y = \frac{1}{3}x - 1$	
$x$	$y$
0	
6	
-3	




4. How are the graphs of the equations the same?

5. How are the graphs of the equations different?

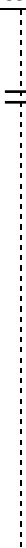
### SKILL BUILDER 4

Draw, record, solve, and check each equation.

1.

Picture	Equation/Steps	What did you do?
	$-x + 2 - x = -(x + 2) - 2x$ $=$ $=$ $=$	
<p>Check your solution using substitution:</p>		

2.

Picture	Equation/Steps	What did you do?
	$-(1 + 2x) = -4(x - 2) + 1$ $=$ $=$ $=$	
<p>Check your solution using substitution:</p>		

### SKILL BUILDER 5

Write what was done for each step. Use pictures if needed. Check each solution.

1.	Equation/Steps	State what was done.
	$-6 = 6x + 12$	given equation
	$-6 = 6x + 12$ $-12 \quad -12$	subtract 12 from both sides; addition (subtraction) property of equality
	$\frac{-18}{6} = \frac{6x}{6}$	
	$-3 = x$	
Check your solution using substitution:		

Find the mistake in each problem, circle it, and rework the problem from that point on. Use pictures if needed. Check each solution.

2.	Equation/Steps	Circle the error and rework the problem.
	$2(x - 4) = x + 1$	given equation (nothing done)
	$2x - 4 = x + 1$	
	$2x - 4 = x + 1$ $-x \quad -x$	
	$x - 4 = 1$ $+4 \quad +4$	
	$x = 5$	
Check your solution using substitution:		

## SKILL BUILDER 6

Write all the steps used to solve the equations. Provide justifications/explanations for each step. Use pictures as needed.

1.

Equation/Steps	Why can you do that? (include the property used)
$2(x+3) - 4 = 10$	Given equation
Check your solution using substitution:	

2.

Equation/Steps	Why can you do that?
$2x - 3 = -6 - x$	
Check your solution using substitution:	

**SKILL BUILDER 7**Solve for  $x$ .

1.  $-5(x + 1) = 25$

2.  $3(x + 2) = 36$

3.  $3x = -3x - 6$

4.  $2(x - 6) = x - 3$

5.  $-3x - 15 = 2x$

6.  $-x + 5 = -2(x - 6)$

7.  $-3(2x + 1) = -5x - 4$

8.  $-20x - 8 = -12x + 24$

**SKILL BUILDER 8**Solve for  $x$ .

1.  $1.25 + x = 2.25 + 1.50$

2.  $4x - x = 3.75$

3.  $\frac{1}{6} = 10x - \frac{1}{5}$

4.  $2(x - 4.5) = -2.5 + x$

5.  $\frac{2}{3}x - 4 = \frac{1}{6}x + 8$

6.  $10.4 - 1.5x = 3.6x - 40.4 + 10$

7.  $\frac{15}{6} = \frac{5x}{8}$

8.  $6\left(\frac{1}{3}x - 1\right) + x = 3$

**SKILL BUILDER 9**

Solve for the variable indicated.

1. Solve for  $t$ :  $6t = D$

2. Solve for  $t$ :  $rt = D$

3. Solve for  $x$ :  $x - 2y = 7$

4. Solve for  $y$ :  $x - 2y = 7$

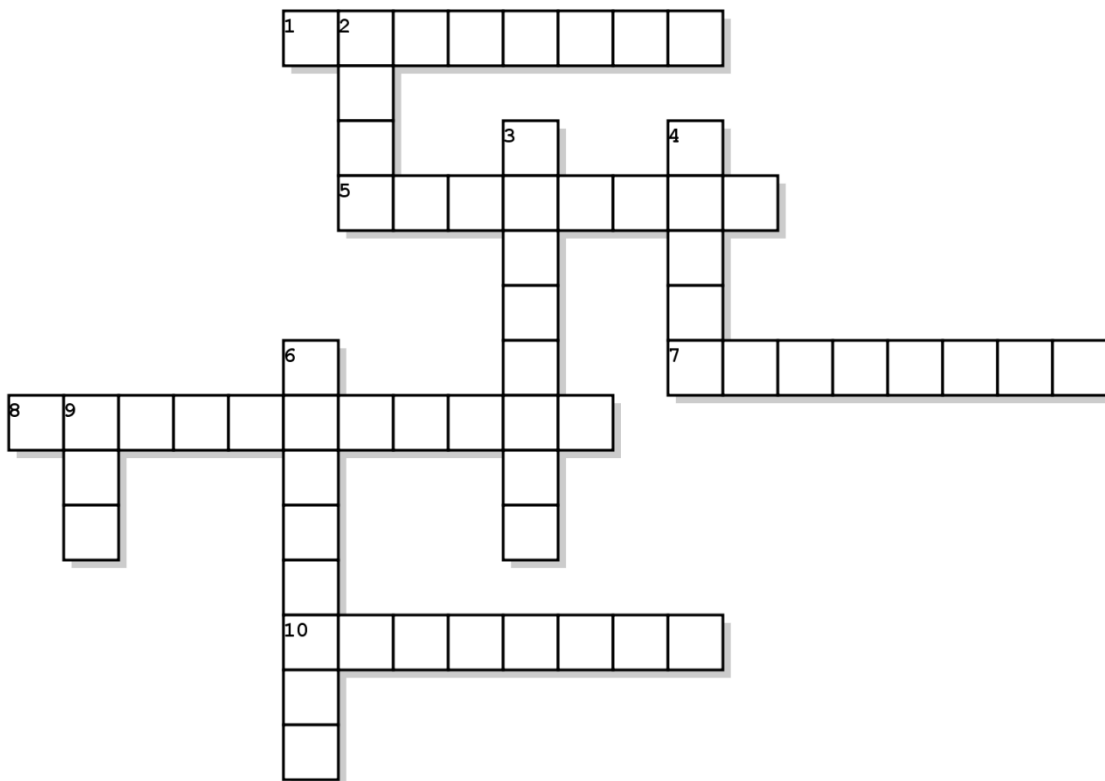
5. Solve for  $H$ :  $LWH = V$

6. Solve for  $B$ :  $A = \frac{1}{2}Bh$

7. Solve for  $x$ :  $3x + y = 12$

8. Solve for  $y$ :  $3x + y = 12$

## FOCUS ON VOCABULARY



### Across

- 1 the number of solutions of the equation  $x + x + 6 = 2x + 6$
- 5 mathematical statement that asserts that two expressions are equal
- 7 compute the value of an expression
- 8 the “-5” in  $-5x$
- 10 whole numbers and their opposites

### Down

- 2 the number of solutions of the equation  $2x + x = 3x + 4$
- 3 quotients of integers are \_\_\_\_ numbers
- 4 find the unknown in an equation
- 6 to combine like terms, for example
- 9 the number of solutions of the equation  $3x - 2 = x + 4$



## SELECTED RESPONSE

Show your work on a separate sheet of paper and choose the best answer(s).

---

1. Choose ALL of the following that can be the first step in solving the following equation **when using cups and counters**:  $-5x = -7x - 10$

- A. Take away 5 cups from both sides      B. Add 5 cups to both sides  
 C. Take away 5 upside down cups from both sides      D. Take away 7 upside down cups from both sides
- 

2. Solve for x:  $9 - x = -3(x + 1)$

- A.  $x = -6$       B.  $x = -4$       C.  $x = -2$       D.  $x = 6$
- 

3. Solve:  $-3(x + 5) = 2x + 35$

- Step 1:  $-3x - 15 = 2x + 35$   
 Step 2:  $-3x = 2x + 50$   
 Step 3:  $x = 50$

Which is the first incorrect step in the solution shown above?

- A. Step 1      B. Step 2      C. Step 3      D. There are no mistakes
- 

4. What is the solution to the equation  $\frac{1}{2}(x-1) = \frac{1}{2}$  ?

- A. -1      B. 0      C. 1      D. 2
- 

5. Solve for x:  $2.5x + 5 = 2(x - 3.5)$

- A. -24      B. -8      C. 8      D. 24
-

## KNOWLEDGE CHECK

Show your work on a separate sheet of paper and write your answers on this page.

### 6.1 Cups and Counters Equations 2

Solve each equation. Show all steps and check your solution using substitution. Draw pictures if needed.

1.  $4x = -4x - 8$

2.  $-6(x + 1) = -12$

### 6.2 Solving Equations with Integer Coefficients

Write all steps in solving the equations. Provide justification/explanations for each step. Use pictures as needed.

3.  $-5x + 10 = 7x - 6$

4.  $2(x - 2) - 3(x + 1) = 0$

### 6.3 Solving Equations with Rational Coefficients

Solve each equation and justify each step.

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

6.  $\frac{12}{9} = \frac{5}{x}$

7.  $2.5x + 7.5 = 0.5x + 16.5$

**HOME-SCHOOL CONNECTION**

Here are some questions to review with your young mathematician.

1. Solve  $-4x - 6 = 2x$  for  $x$  and check your solution using substitution.  
Use pictures if necessary.

2. Solve  $2(x + 2) = -2(4x + 2)$  for  $x$ .  
Provide justifications for each step.  
Use pictures if necessary.

3. Solve the equation  $\frac{5}{2}x + \frac{1}{2}x + 11 = -1$ .

Parent (or Guardian) Signature \_\_\_\_\_

# COMMON CORE STATE STANDARDS – MATHEMATICS

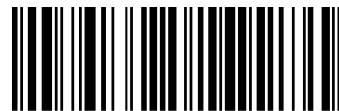
## SELECTED COMMON CORE STATE STANDARDS FOR MATHEMATICS

- 7.EE.1\* Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.
- 7.EE.4a\* Solve word problems leading to equations of the form  $px + q = r$  and  $p(x + q) = r$ , where  $p$ ,  $q$ , and  $r$  are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. *For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?*
- 8.EE.7a Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form  $x = a$ ,  $a = a$ , or  $a = b$  results (where  $a$  and  $b$  are different numbers).
- 8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

\*Review of content essential for success in 8<sup>th</sup> grade.

## STANDARDS FOR MATHEMATICAL PRACTICE

- MP1 Make sense of problems and persevere in solving them.
- MP2 Reason abstractly and quantitatively.
- MP3 Construct viable arguments and critique the reasoning of others.
- MP5 Use appropriate tools strategically.
- MP7 Look for and make use of structure.



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