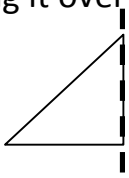
Solving Multistep Linear Inequalities

5.0 Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

Vocabulary: range, translation, scale change, reflection

Warm Up:

CST/CAHSEE: Algebra I 5.0	Review: 6 SDAP 1.1
What is the solution to the inequality $x-5>14$? **A** $x>9$ **B** $x>19$ **C** $x<9$ **D** $x<19$	Given: 5 5 4 8 2 6 Find the range.
Current: Algebra I 5.0	**Other: Reflections 6 MG 3.2**
Solve the equation $4+3x-6=19$ • Could your first step be to add 6 to each side?	Draw the other side of each figure by reflecting it over the dotted line. a)  b) 

Learning Objective:

Today we will be solving multistep linear inequalities and providing a justification for the direction of each inequality.

Prior Knowledge:

Teacher: Let's add, subtract, multiply, and divide an inequality and look for a pattern.

$-2 < 8$ $-2+3 < 8+3$ $1 < 11$	$-2 < 8$ $-2-6 < 8-6$ $-8 < 2$
$-2 < 8$ $-2(6) < 8(6)$ $-12 < 48$	$-2 < 8$ $\frac{-2}{2} < \frac{8}{2}$ $-1 < 4$
$-2 < 8$ $-2(-6) \ ? \ 8(-6)$ $12 > -48$ Multiplication with a negative number changes the direction of the inequality symbol.	$-2 < 8$ $\frac{-2}{-1} \ ? \ \frac{8}{-1}$ $2 > -8$ Division with a negative number changes the direction of the inequality symbol.

Alternative Chart:

	$5 < 15$	True/ False	Direction
Add 4	$5+4 < 15+4$ $9 < 19$	True	<
Subtract 10	$5-10 < 15-10$ $-5 < 5$	True	<
Multiply by 2	$5(2) < 15(2)$ $10 < 30$	True	<
Divide by 5	$5 \div 5 < 15 \div 5$ $1 < 3$	True	<
Multiply by -3	$5(-3) < 15(-3)$ $-15 < -45$	False	>
Divide by -1	$5 \div (-1) < 15 \div (-1)$ $-5 < -15$	False	>

Concept Development:

Let's measure this _____. (Use tape measure starting at the left and bending the metal at the end which is the right). I see this distance is _____ inches long.

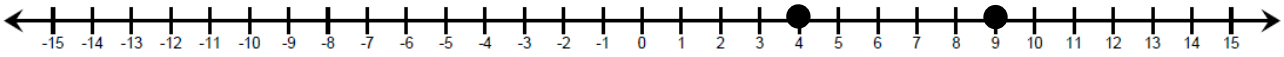
Did I start to measure from the left or the right? [You started from the left.]

How did I show the end of the measurement? [You bent the metal when you got to the end of the measurement.]

Today we will be finding the distance between two points. Instead of using a tape measure to determine distance, we will be calculating the range.

The range is the difference between the largest and the smallest number.

Plot the numbers 4 and 9 on the first number line on your white board. Write an inequality to show the relationship between 4 and 9. ☐



Just like moving your marker on a board game, let's count the number of steps from 4 to 9. (1, 2, 3, 4, 5) Now calculate the range on your white board.
[9 – 4 = 5]

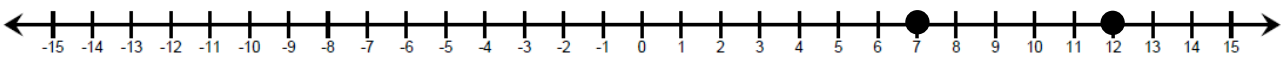
Calculating the range of two points gives the same result as counting the steps on the number line.

Using the range to find the distance between two points is faster than counting when points are far apart.

Let's go back to our inequality 4 < 9 and add 3 to each side. Write the steps on your white board.

$$4 < 9$$
$$4 + 3 < 9 + 3$$
$$7 < 12$$

Now plot 7 and 12 on the next number line.



Calculate the range of 7 and 12 on your white board.

The range of 7 and 12 is 5. Since the range of 4 and 9 is also 5, we can see the distance between the two points is the same for each set of points but the location of the points changes. The second set of points has slid or been translated to the right.

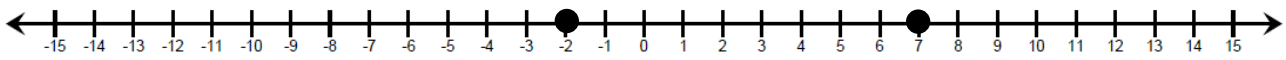
A translation slides our values to the left or the right.

A translation occurs when we add or subtract the same non-zero number to both sides of an inequality.

Note: Pass out worksheet. Teacher models all examples as students fill in their worksheet.

Example #1

When you receive your worksheet, fill in the vocabulary word that goes with the first definition on your paper. Plot the points −2 and 7, write an inequality, and find the range in the space provided.



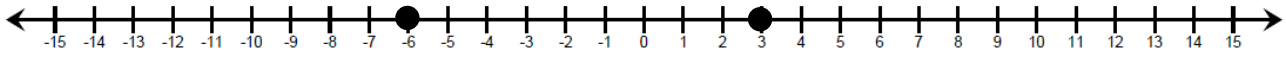
Who can tell me the inequality for our two points? ☐

What is the range? [The range is 9.]

Now we will subtract 4 from each side of our inequality. Copy the steps onto the lower part of your worksheet.

$$-2 < 7$$
$$-2-4 < 7-4$$
$$-6 < 3$$

Plot −6 and 3 on the next number line and find the range. [9]

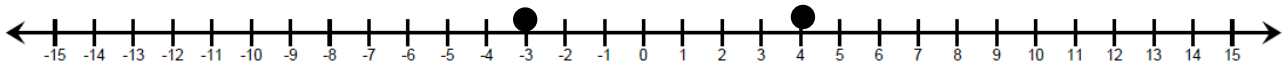


A translation occurs when we add or subtract the same non-zero number to both sides of an inequality. A translation slides our values to the left or the right. (show sliding with your hands) Write the word **translation** in the box next to this definition.

A translation happens when we add or subtract the same non-zero number to both sides of an inequality. A translation slides our values to the left or the right.

Example #2

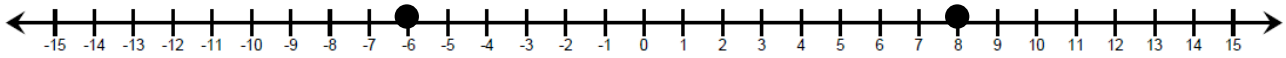
Plot −3 and 4 on the next number line, write the inequality, and calculate the range. [−3 < 4, 7]



Multiply both sides of the inequality by 2. Copy the steps onto your worksheet.

$$-3 < 4$$
$$-3(2) < 4(2)$$
$$-6 < 8$$

Plot −6 and 8 on the next number line and calculate the range. [14]



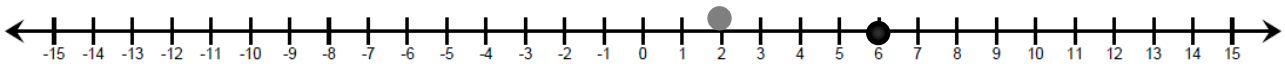
Demonstrate stretching and shrinking with your hands. If getting bigger is stretching and getting smaller is shrinking, show me with your hands how the range of −6 and 8 is different from the range of −3 and 4. Yes, the range stretches. Stretching or shrinking the range is called a scale change. If we multiply both sides of our inequality $-6 < 8$ by $\frac{1}{2}$, show me with your hands how the range will change. Yes, the range will shrink.

A scale change stretches or shrinks the range.

A scale change happens when we multiply or divide each side of an inequality by the same number. Now write the words **scale change** in the box next to this definition. (Note: A scale change does not occur when we multiply by 1.)

Example #3

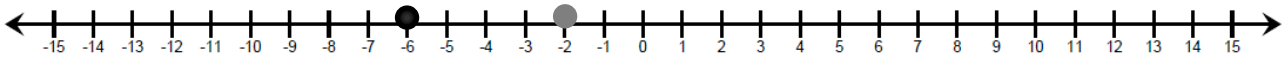
Now move to the next number line on your paper. Plot 2 with light shading, plot 6 with dark shading, write the inequality, and calculate the range. ☐



Multiply both sides of the inequality by −1. Copy the steps onto the lower part of your worksheet.

$$2 < 6$$
$$2(-1) > 6(-1)$$
$$-2 > -6$$

Plot −2 with light shading and −6 with dark shading on the next number line.



Tell your partner which direction you moved to find −6. [left]. The change in direction is caused by a reflection.

A reflection flips numbers to the opposite side of zero and changes the order of an inequality. (Show on your hand how the order of your fingers changes when you flip your hand over.)

A reflection happens when we multiply or divide each side of an inequality by −1. A reflection changes the order of the numbers and changes the direction of the inequality symbol. Now write the word **reflection** in the box next to this definition.

Guided Practice:

I will solve the inequality $3 - 6y > 23$ on the board and justify each inequality symbol. Please copy each step in your notebook.

$3 - 6y > 23$	Given
$3 - 3 - 6y > 23 - 3$	Translation
$-6y > 20$	Simplify
$\frac{-6}{-6}y < \frac{20}{-6}$	Reflection and scale change
$y < \frac{-20}{6}$	Simplify
$y < \frac{-10}{3}$	Simplify

Solve the inequality $8 - 2x > 14$ on your white board. Justify each inequality symbol and share your solution with your partner.

$8 - 2x > 14$	Given
$8 - 8 - 2x > 14 - 8$	Translation
$-2x > 6$	Simplify
$\frac{-2}{-2}x < \frac{6}{-2}$	Reflection and scale change
$x < -3$	Simplify

Please do the next problem in your notebook. Solve the inequality $5 - 7y < 40$ and justify each inequality symbol. Check your solution with your partner.

Ask for a volunteer to share their answer at the board or under a document reader.

$5 - 7y < 40$	Given
$5 - 5 - 7y < 40 - 5$	Translation
$-7y < 35$	Simplify
$\frac{-7}{-7}y > \frac{35}{-7}$	Reflection and scale change
$y > -5$	Simplify

Independent Practice:

In you notebook and on your own, please solve the inequality $8x + 7 - 7x > -3$ and justify each inequality symbol.

Ask for a volunteer to share their answer at the board or under a document reader.

$8x + 7 - 7x > -3$	Given
$x + 7 > -3$	Combining like terms
$x + 7 - 7 > -3 - 7$	Translation
$x > -10$	Simplify

In your notebook and on your own, please solve the inequality $18 - 6x \geq 9x - 6$ and justify each inequality symbol.

Select a student to solve the inequality.

$18 - 6x \geq 9x - 6$	Given
$18 - 18 - 6x \geq 9x - 6 - 18$	Translation
$-6x \geq 9x - 24$	Simplify
$-6x - 9x \geq 9x - 9x - 24$	Translation
$-15x \geq -24$	Simplify
$\frac{-15}{-15}x \leq \frac{-24}{-15}$	Reflection and scale change
$x \leq \frac{-24}{-15}$	Simplify
$x \leq \frac{8}{5}$	Simplify

Additional Practice:

1. $7 - 4x < 8$
2. $5x - 7 \geq 14$
3. $13x + 5 \leq 12x + 4$
4. $4x - 4 > 8 + 2x$
5. $24 - 7y < 11y - 14$

Solutions to Additional Practice

1.	$7 - 4x < 8$	Given
	$7 - 7 - 4x < 8 - 7$	Translation
	$-4x < 1$	Simplify
	$\frac{-4}{-4}x > \frac{1}{-4}$	Reflection with scale change
	$x > \frac{-1}{4}$	Simplify
2.	$5x - 7 \geq 14$	Given
	$5x - 7 + 7 \geq 14 + 7$	Translation
	$5x \geq 21$	Simplify
	$\frac{5}{5}x \geq \frac{21}{5}$	Scale change
	$x \geq \frac{21}{5}$	Simplify
3.	$13x + 5 \leq 12x + 4$	Given
	$13x + 5 - 12x \leq 12x + 4 - 12x$	Translation
	$x + 5 \leq 4$	Simplify
	$x + 5 - 5 \leq 4 - 5$	Translation
	$x \leq -1$	Simplify
4.	$4x - 4 > 8 + 2x$	Given
	$4x - 2x - 4 > 8 + 2x - 2x$	Translation
	$2x - 4 > 8$	Simplify
	$2x - 4 + 4 > 8 + 4$	Translation
	$2x > 12$	Simplify
	$\frac{2}{2}x > \frac{12}{2}$	Scale change
	$x > 6$	Simplify
5.		Given
	$24 - 7y < 11y - 14$	Translation
	$24 - 7y - 11y < 11y - 14 - 11y$	Simplify
	$24 - 18y < -14$	Translation
	$24 - 18y - 24 < -14 - 24$	Simplify
	$-18y < -38$	Reflection and scale change
	$\frac{-18}{-18}y > \frac{-38}{-18}$	Simplify
	$y > \frac{19}{9}$	

Date _____

Warm-Up

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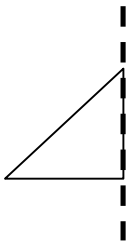
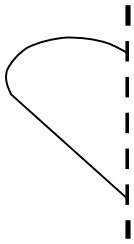
Solve the equation $4+3x-6=19$ • Could your first step be to add 6 to each side?	Draw the other side of each figure by reflecting it over the dotted line. a)  b) 

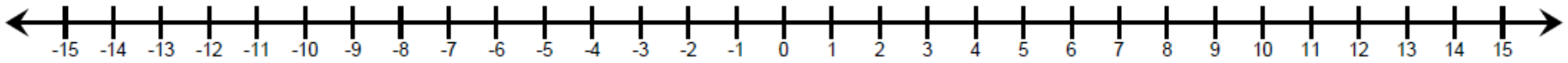
Today's Objective/Standards: Students solve multistep linear inequalities in one variable and provide justification for the direction of each inequality. (5.0)

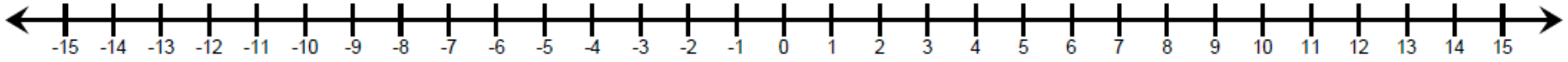
Name: _____

Worksheet for Inequalities with Translation, Scale Change, and Reflection

The [ ] is the difference between the largest number and the smallest number.

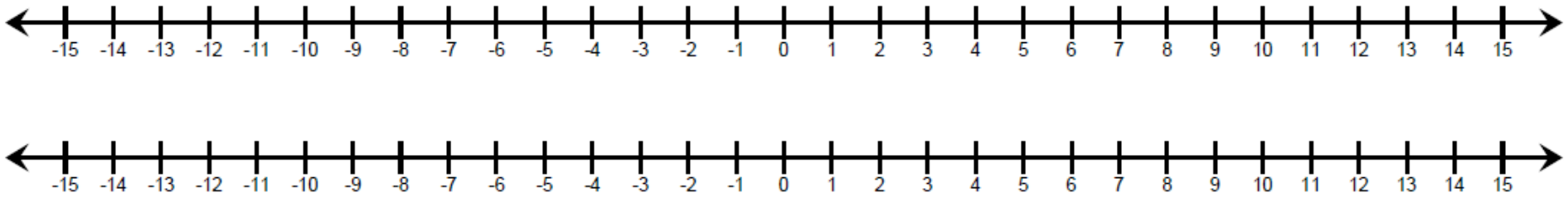
Inequality: [ ] Range: [ ]





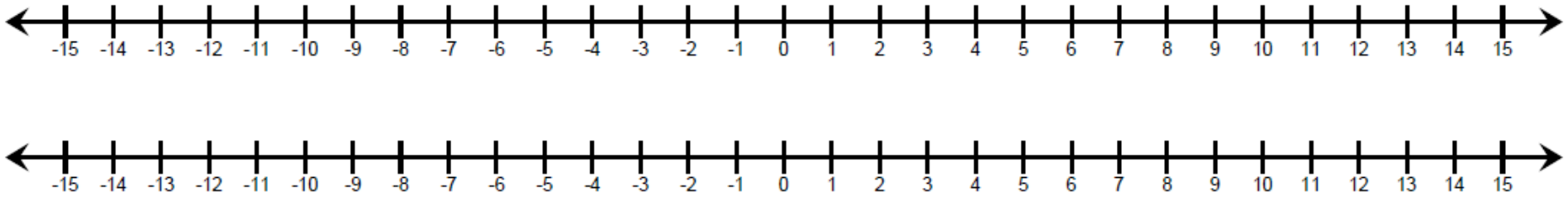
A [ ] slides our values to the left or the right and happens when we add or subtract the same number to both sides of an inequality

Inequality: Range:



A stretches or shrinks the distance between values and happens when we multiply or divide both sides of an inequality the same number.

Inequality: Range:



A changes the order of the numbers and changes the direction of the inequality symbol. This happens when we multiply or divi both sides of an inequality by−1.