Grade Level/Course: Grade 7, Grade 8, and Algebra 1

Lesson/Unit Plan Name: Introduction to Solving Linear Inequalities in One Variable

Rationale/Lesson Abstract:

This lesson is designed to introduce graphing inequalities on a number line as well as solving one-step linear inequalities in one variable.

<	**"less than"**	**≤**	**"less than or equal to"**
>	**"greater than"**	**≥**	**"greater than or equal to"**

While these translations are technically correct, it is more important to think of the inequality symbol as a comparison of two values rather than a simple translation from left to right. Therefore this lesson also focuses on how to read inequalities from right to left as well as from left to right (i.e. the symbol **<** can be translated as "greater than" if the inequality is being read from right to left).

Timeframe: 60 minutes

Common Core Standard(s):

A.REI.3.1 Solve one-variable equations and inequalities involving absolute value, graphing the solutions and interpreting them in context.

Instructional Resources/Materials:

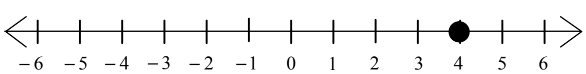
Warm up (pg. 10), student note-taking guide (pg. 11,12).

Please note that you try problems on the student note-taking guide are missing to prevent students from working ahead

Answers to Warm Up:

Solve the equation and then graph your solution on the number line below.

$$-2+3x=10$$
$$-2+3x+2=10+2$$
$$3x=12$$
$$\frac{3x}{3}=\frac{12}{3}$$
$$x=4$$



Write $<$ or $\geq$ in the box to make the sentence true.

$a)\ 10\ \boxed{\geq}\ 6$

$b)\ -7\ \boxed{<}\ -4$

$c)\ 2\ \boxed{\geq}\ 2$

Solve two ways.

$$4=-\frac{2}{5}x$$

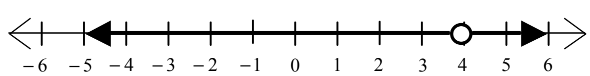
$$4=-\frac{2}{5}x$$
$$-\frac{5}{2}(4)=-\frac{5}{2}\left(-\frac{2}{5}x\right)$$
$$-10=x$$

$$4=-\frac{2}{5}x$$
$$-1(4)=-1\left(-\frac{2}{5}x\right)$$
$$-4=\frac{2}{5}x$$
$$5(-4)=5\left(\frac{2}{5}x\right)$$
$$-20=2x$$
$$\frac{-20}{2}=\frac{2x}{2}$$
$$-10=x$$

List 5 possible solutions to the inequality below. Then graph all possible solutions.

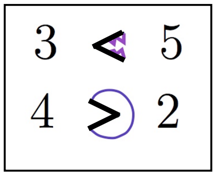
$x \neq 4$ (x doesn't equal 4)

$$x=3,-5,6,10,0,L$$



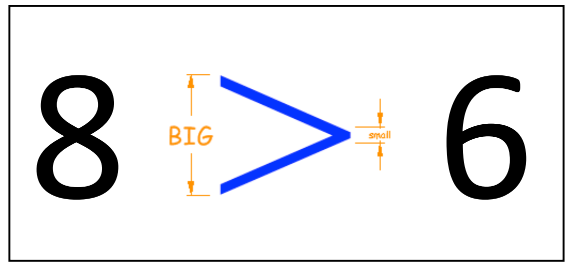
Prior Knowledge

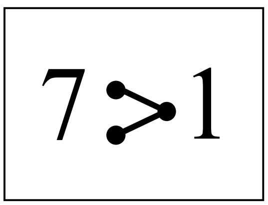
Students vary with how they were introduced to inequalities in previous grades. Here are some examples to help your awareness as you work with your students:



Pacman, Alligator, or anything else eats the bigger number

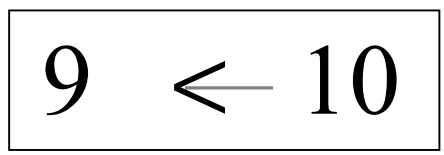
The bigger opening is on the side of the bigger number and the smaller opening is on the side of the smaller number





After drawing in endpoints, the side with two points is on the side of the bigger number and the side with one point is on the side of the smaller number

The arrow points to the smaller number



Activity/Lesson:

Graphing Inequalities

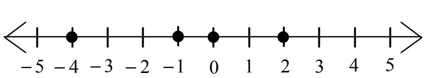
Example 1: Graph

a) $3 \geq x$

When reading this from left to right we can say "3 is greater than or equal to *x*".
When reading this from right to left we can say "*x* is less than or equal to 3".

If *x* is less than or equal to 3, what are some possible values for *x* that make this inequality true? (call on students and graph correct values as points on the number line)

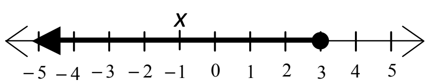
i.e.



What is the largest value that *x* can be? [3]

Since *x* can equal 3 or anything less, we can represent the solution set by marking a closed dot on the three and then shading every value to the left where the values are less.

Draw the graph over the graph you were building with the students above.



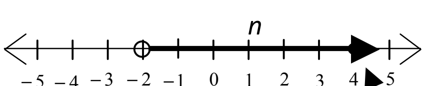
b) $n > -2$

Call on a random student to read the inequality from left to right. "n is greater than – 2"
Then another to read from right to left. "–2 is less than n"

Can *n* equal –2? [no]

Since *n* can't equal – 2, we put an open dot on the – 2 to show that it isn't a solution.

Which values would be greater than – 2: the values on the left or right of – 2? [right]



Check a solution:

Our graph shows that $n = 4$ *is a solution. Let's check to see if it works in our inequality.*

$n > -2$

$4 > -2$ True!!

c) $w \le -4$

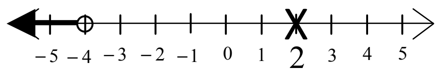
<u>Choral Response</u>
"Can *w* equal – 4?" [yes]
"Should we put an open dot or closed dot on the – 4? [closed dot]

Another way to figure out which way to shade is by testing a point. For instance, test to see if $x = 2$ is a solution by plugging it in to the inequality:

$x \leq -4$

$2 \leq -4$ False!!

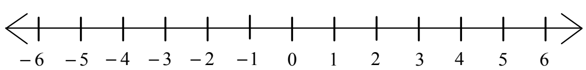
Since $x = 2$ is not a solution and it is to the right of our boundary point $(x = -4)$, then the solutions to the inequality must be to the left:



Write the two problems for students to try (missing from note taking guide):

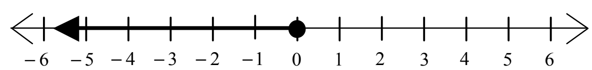
You Try: Graph.

d) $1 < x$



You Try: Write an inequality represented by the graph.

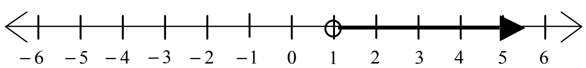
e)



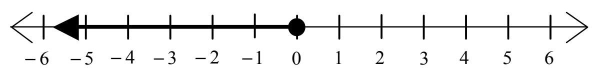
Answers:

d) $1 < x$

"x is greater than 1."



e)



"all the values are less than or equal to 0."

$z \leq 0$

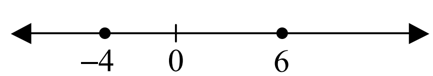
<u>Solving Inequalities</u>

If we add or subtract the same number from both sides of an inequality, will the inequality sign remain the same or have to be reversed?

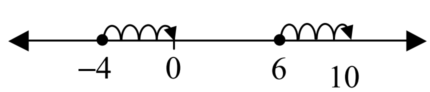
Let's investigate.

Write the following on the whiteboard:

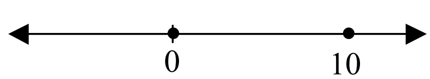
$-4 < 6$



$-4+4 \quad 6+4$



$0 \quad 10$



Since $0 < 10$, the sign remains the same after adding the same value to both sides.

Go back and write the inequality signs:

$$-4 < 6$$

$$-4+4 < 6+4$$

$$0 < 10$$

When we added 4 to both sides, the two values moved to the right on the number line. The smaller value (the point on the left) would still be the smaller value when compared to the other, since it is still further to the left.

Would adding a negative number reverse the sign?
[No, the values would move to the left, but the bigger value (the point on the right) would still be the bigger value when compared to the other (further to the right)]

Show students that subtracting doesn't have an effect either as it would be similar to adding a negative number:

$$-4 < 6$$

$$-4-4 < 6-4$$

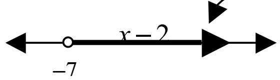
$$-8 < 2$$

Show this example to the students with an open number line to the right:

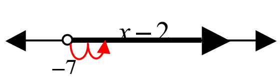
Example 2: Solve and graph.
a)

If $x-2$ is greater than -7, then any of these points are two less than x.

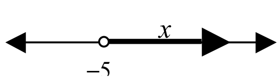
$$x-2 > -7$$



$$x-2+2 > -7+2$$



$$x > -5$$



Therefore x would have to be greater than -5.

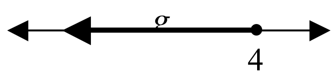
Solve this inequality first and then graph the solution.

b)

$-6 \ge -10 + g$

$-6 + 10 \ge -10 + g + 10$

$4 \ge g$



Call on students randomly:
"What do I need to do to solve for *g*?" [add 10 to both sides]
"What side is the variable on?" [right]
"Since the variable is on the right, how do I read the inequality from right to left?" [*g* is less than or equal to 4]
"Does the graph have an open or closed circle at 4? Why?" [closed, *g* can equal 4]
"Is the graph shaded to the left or the right? Why?" [left, because *g* is less than or equal to 4]

Write the problem for students to try (missing from note taking guide):

You Try: Solve and graph.

c) $-5 \le -7 + n$

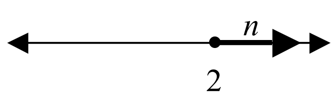
Walk around the room and check for understanding. If the majority of students seem to be having no problems have them share their answers with a neighbor. If not, use the "you try" to reteach and give a similar example (i.e. $-10 > x - 8$, but try to tailor it to the mistakes you see).

Answer:

$-5 \le -7 + n$

$-5 + 7 \le -7 + n + 7$

$2 \le n$



If we multiply or divide the same number from both sides of an inequality, will the inequality sign remain the same or have to be reversed?

Let's investigate.

Write both inequalities on the board side-by-side and investigate with your class multiplying by a positive and negative 2:

Multiplying both sides by 2

$-4 < 6$

$2(-4) \quad 2(6)$

$-8 \quad 12$

Since $-8 < 12$, the sign remains the same to make a true statement.

Multiplying both sides by –2

$-4 < 6$

$-2(-4) \quad -2(6)$

$8 \quad -12$

Since $8 > -12$, the sign needs to be reversed to make a true statement.

Go back and write the inequality signs:

Multiplying both sides by 2

$-4 < 6$

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

$-8 < 12$

Multiplying both sides by –2

$-4 < 6$

$-2(-4) > -2(6)$

$8 > -12$

Show students that dividing has the same effect:

Dividing both sides by 2

$-4 < 6$

$\frac{-4}{2} < \frac{6}{2}$

$-2 < 3$

Dividing both sides by –2

$-4 < 6$

$\frac{-4}{-2} > \frac{6}{-2}$

$2 > -3$

Example 3: Solve.

a) $-2x > 10$ **b)** $2x > -10$

What do we need to do to solve part a)? [Divide both sides by –2]

How about part b)? [Divide both sides by 2]

Before working it out, do a Think-Pair-Share:

When we solve these inequalities, are we going to reverse the sign for one inequality or both? Why?

After letting a few partners share, work the problems out side-by-side

a) $-2x > 10$

$$\frac{-2x}{-2} < \frac{10}{-2}$$
$$x < -5$$

We divided by a –2 so we reverse the sign

b) $2x > -10$

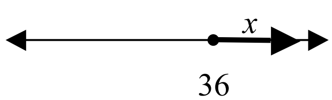
$$\frac{2x}{2} > \frac{-10}{2}$$
$$x > -5$$

We divided by a +2 so we do not reverse the sign

Example 4: Solve and graph.

Let students guide you in solving the inequality. Then show students the second way where you don't have to reverse the inequality.

$$-12 \geq -\frac{x}{3}$$
$$-1(-12) \leq -1\left(-\frac{x}{3}\right)$$
$$12 \leq \frac{x}{3}$$
$$3(12) \leq 3\left(\frac{x}{3}\right)$$
$$36 \leq x$$



$$-12 \geq -\frac{x}{3}$$
$$-12 + \frac{x}{3} \geq -\frac{x}{3} + \frac{x}{3}$$
$$-12 + \frac{x}{3} \geq 0$$
$$-12 + \frac{x}{3} + 12 \geq 0 + 12$$
$$\frac{x}{3} \geq 12$$
$$3\left(\frac{x}{3}\right) \geq 3(12)$$
$$x \geq 36$$

Write the problem for students to try (missing from note taking guide):

You Try: Solve and Graph.

$$-\frac{5}{2}y < 10$$

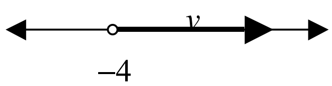
$$2\left(-\frac{5}{2}y\right) < 2(10)$$

Have students check their answer with a partner.

$$-5y < 20$$

$$\frac{-5y}{-5} > \frac{20}{-5}$$

$$y > -4$$



Example 5: Use an inequality to represent the situation and solve.

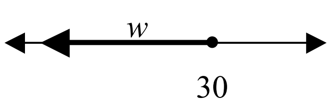
You are checking a bag at the airport. Bags can weigh no more than 50 lbs. If your bag already weighs 20 lbs, find all possible weights, *w*, that you can add to the bag?

w = weight you can add to the bag

$$20 + w \le 50$$

$$20 + w - 20 \le 50 - 20$$

$$w \le 30$$



**Students will say the answer is 30, so remind them that we are not looking for the most you can add.

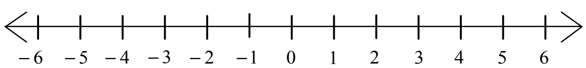
Set up the inequality with your students and solve. When you graph the solution, talk about what values of w are possible (even though it appears –40 is a solution, there are only 20 lbs. in the suitcase so it wouldn't make sense even if you thought of negatives as removing weight). Whatever you decide is possible or not, adjust your minimum value on the graph.

Warm-Up

Algebra: A.REI.3.1

Solve the equation and then graph your solution on the number line below.

$$-2+3x=10$$



Review

Write $<$ or $\geq$ in the box to make the sentence true.

$a)$ 10 ☐ 6

$b)$ −7 ☐ −4

$c)$ 2 ☐ 2

Algebra: A.REI.3.1

Solve two ways.

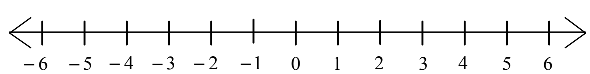
$$4=-\frac{2}{5}x$$

Algebra: A.REI.3.1

List 5 possible solutions to the inequality below. Then graph all possible solutions.

$x \neq 4$ (x doesn't equal 4)

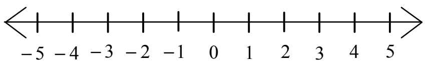
$x =$ ____, ____, ____, ____, ____,L



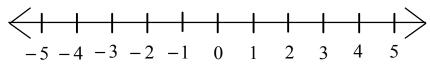
Graphing Inequalities

Example 1: Graph.

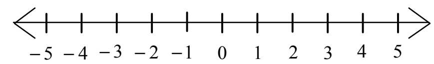
a) $3 \geq x$



b) $n > -2$

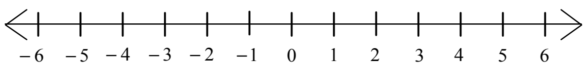


c) $w \leq -4$



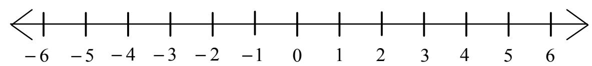
You Try: Graph.

d)



You Try: Write the inequality represented by the graph.

e)



Solving Inequalities

Example 2: Solve and graph.

a) $x - 2 > -7$

b) $-6 \geq -10 + g$

You Try: Solve and graph.

c)

Solving Inequalities (cont.)

Example 3: Solve.

a) $-2x > 10$

b) $2x > -10$

Example 4: Solve and graph.

$$-12 \geq -\frac{x}{3}$$

You Try: Solve and graph.

Example 5: Use an inequality to represent the situation and solve.

You are checking a bag at the airport. Bags can weigh no more than 50 lbs. If your bag already weighs 20 lbs, find all possible weights, *w*, that you can add to the bag?